Literature Review and Analysis of Scientific Information

for the Conservation Assessment for Columbia Spotted Frogs and Boreal Toads on the Bridger-Teton National Forest

— A Reference Document —
Version 3.0

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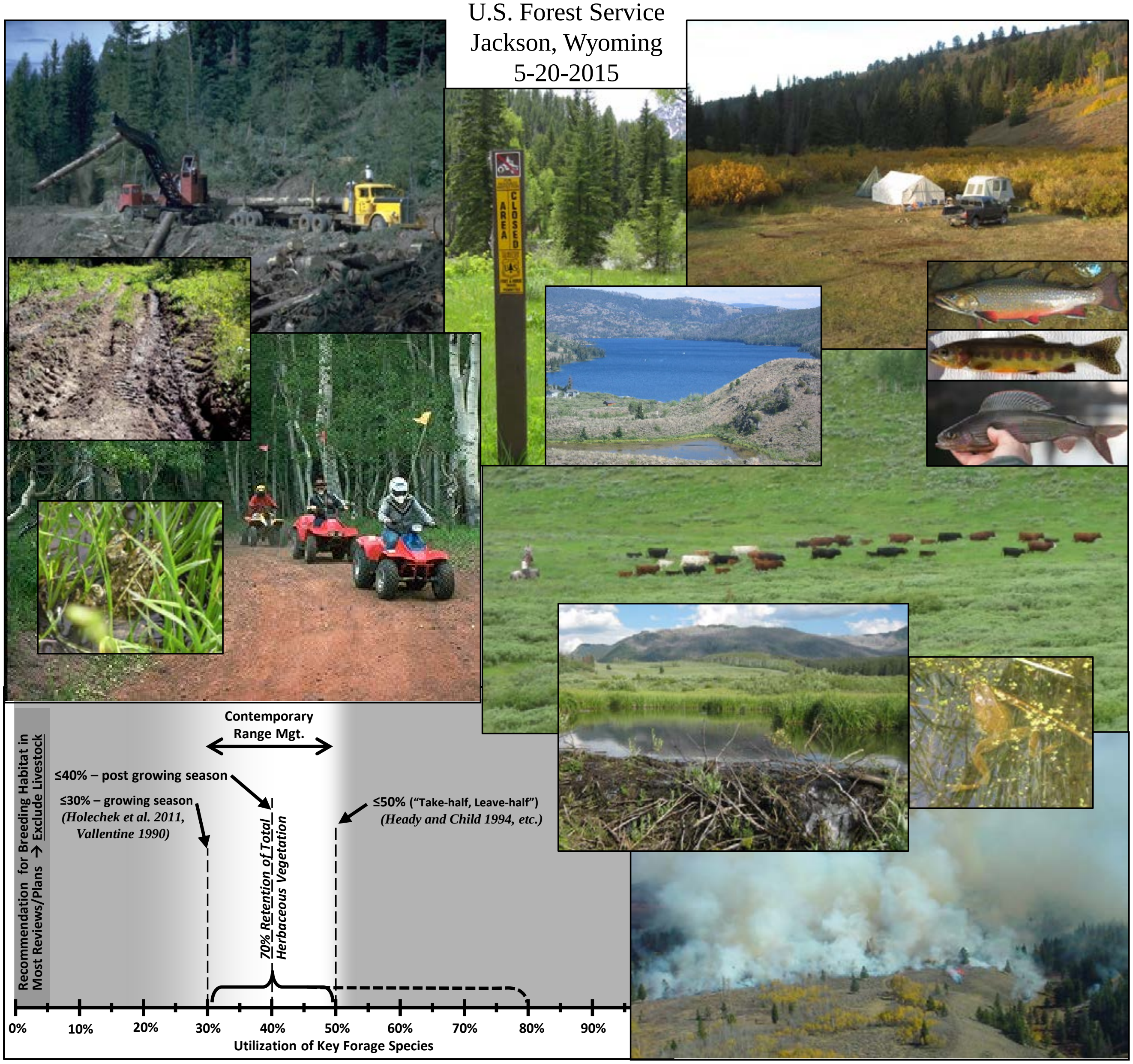

An effort to find ways to conserve frogs and toads while providing for multiple uses.

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INTRODUCTION

The Sensitive Species Management Standard of the Bridger-Teton National Forest (BTNF) Land and Resource Management Plan (Forest Plan) requires that quantifiable objectives be developed for sensitive species. Objectives for Columbia spotted frogs (*Rana luteiventris*) and boreal toads (*Bufo boreas boreas*) were developed to meet Objective 3.3(a) of the Forest plan, with respect to these species, and the higher-level direction upon which this Forest Plan objective was based.

The targeted level of specificity and a question of whether numbers should be identified in objectives has shifted back and forth several times during the process of developing objectives for sensitive species on the BTNF, with an interim result being a set of generally-stated objectives approved by the Forest Leadership Team. To minimize confusion with these objectives and to focus on the key element of Forest Plan Objective 3.3(a), this technical analysis report focuses on defining suitable conditions (suitable condition statements) for spotted frogs and boreal toads. The meaning of conservation measures has been variously used in reference to management actions and constraints and suitable conditions. To provide utility regardless of how objectives are stated and regardless of the scope of conservation measures, the main focus of this report is to define suitable habitat conditions for spotted frogs and boreal toads on the BTNF, and a secondary focus is to identify potentially important limiting factors and management actions and constraints to consider in addressing these limiting factors in order to meet suitable conditions. Suitable conditions are addressed at two main scales:

1. *Healthy, relatively-naturally functioning ecosystem* — Of greatest importance in achieving Objective 3.3(a) and Sensitive Species Management Standard of the Forest Plan with respect to spotted frogs and boreal toads is the restoration and maintenance of healthy, relatively-naturally functioning riparian areas, wetlands, rangelands, and forests.

   This is a prerequisite to having habitat effectiveness, connectivity, and survival conditions (outlined under 2, below) successfully contribute to achieving Objective 3.3(a) and the Sensitive Species Management Standard. To the extent this prerequisite is not met, the thresholds identified for habitat effectiveness, connectivity, and survival elements later in this report may need to be adjusted in order to achieve Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

2. *Conditions pertaining to habitat effectiveness, connectivity, and survival elements that are affected by human activities* — Habitat effectiveness, connectivity, and survival elements are addressed in this report as localized (fine-scale) factors, and this report focuses on those that are affected by commercial, recreational, and/or management activities. To ensure that Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard would be achieved when suitable conditions for these elements are attained, it is important that the conditions at and just above the minimum threshold are in fact suitable for the spotted frogs and boreal toads. Making this assurance requires that scientific information affirmatively demonstrates that conditions at and just above minimum thresholds adequately meet applicable needs of spotted frogs and boreal toads. A declaration that conditions at and just above a minimum threshold meet the needs of these species because of the absence of information demonstrating that needs are not met (i.e., a positive declaration based on the absence of information) is inadequate and not supportable as discussed later in this report.

   Because ecological attributes addressed in this category typically are affected by commercial, recreational, or management activities, it is important to note that the need to delineate conditions at the lower limit of suitable habitat conditions is driven by the need to accommodate these activities, not that conditions near the threshold are favorable or desirable for spotted frogs and boreal toads relative to conditions in the middle and upper end of range of suitability.

   There are two parts of conditions for habitat effectiveness, connectivity, and survival elements (a) identification of suitable conditions for spotted frogs and boreal toads for each respective element and (b) adjustments to suitable conditions to accommodate recreational and/or commercial uses.

This report is not a conservation assessment; it is a literature review and analysis of scientific information, prepared for the purpose of writing a conservation assessment for spotted frogs and boreal toads. Besides taking a hard and thorough look at the scientific information, this report is somewhat longer than it may otherwise have been for several reasons, including (1) the BTNF has not yet defined coarse-filter conditions (e.g., desired mix of succession stages, desired stream channel integrity, desired plant species composition) and, and in lieu of this direction for the forest, this report identifies coarse-filter conditions based on available scientific information; (2) several people (e.g., District Rangers, range management specialists, livestock permittees, staff of conservation districts, and Wyoming Department of Agriculture) questioned and challenged several of the draft numeric objectives and their scientific basis, making further examination of scientific information warranted; (3) amphibians occupy a range of aquatic and terrestrial habitats, have complex life stages, are affected by a large number of human activities, and are sensitive species; and (4) while relatively few studies have been conducted on some aspects of human-related activities on amphibians, a large volume of literature from a range of disciplines exists on some of these. Regarding number 2, a common assessment was that science was lacking to support recommendations. It was not enough to summarize the science and summarize findings. Given the level of scrutiny this analysis is receiving, explanation was needed on how findings and conclusions were arrived upon.

A large number of habitat and other elements are identified that, when changed or altered by human activities, have the potential to affect spotted frogs and boreal toads, and therefore the ability to achieve Objective 3.3(a) and higher-level management direction for sensitive species with respect to spotted frogs and boreal toads. However, despite this large number of elements that need to be considered, suitable condition statements for spotted frogs and boreal toads were developed in a way that greatly simplifies the approach to conserving these two species in the context of conserving native wildlife-communities as a whole. An effort was made to tailor suitable condition statements toward the restoration and maintenance of relatively-natural habitat conditions which is applicable to a wide range of wildlife (e.g., in hopes of minimizing conflicts between objectives for different species). In part, the approach is viewed as simplified because most of the suitable condition statements identified for sensitive amphibians are broadly applicable to native wildlife-communities as a whole. In other words, suitable condition statements pertaining to healthy, relatively-naturally functioning riparian areas, wetlands, rangelands, and forests are redundant with the foundation of the conservation of most or all native wildlife species, meaning that adding dozens to hundreds of wildlife species would not increase the complexity of suitable condition statements for these elements.

Although dealing with a large number of factors can become unwieldy, cumulative effects caused by a wide variety of factors likely have substantially greater impact on spotted frogs and boreal toads than any one, two, or three factors. USFWS (2011) cited a large number of references in stating that "Many of the threats discussed [for Columbia spotted frogs] do not act alone. Multiple stressors can alter the effects of other stressors or act synergistically to affect individuals and populations." Patla and Keinath (2005:38, 39) presented a detailed illustration of the numerous factors that affect tadpole spotted frogs and those that affect adult spotted frogs, and Keinath and McGee (2005:34) did the same for boreal toads.

Additionally, boreal toads and boreal chorus frogs are management indicator species (MIS). This report outlines suitable conditions that apply to these two species, although chorus frogs are not specifically addressed in this report. As such, this report provides updated information on suitable habitat conditions that was first summarized in USFS (2009) with respect to issues related to livestock grazing. Chorus frogs have very similar habitat needs as spotted frogs and spotted frogs.

ORGANIZATION AND STRUCTURE OF THIS REPORT

This report has four main parts:

Part I — Background and Foundations. This part of the report summarizes management direction for developing suitable condition statements for sensitive species; the approach of developing suitable condition statements; basis of suitable conditions in laws, regulations, and the Forest Plan; status and natural history of spotted frogs and boreal toads; basis of and background information on buffer zones and levels of protection; and provides other background information.

Part II — Suitable Condition Statements, Risk Factors, and Conservation Actions. This is the heart of the report, and is organized around the key habitat, habitat effectiveness, and survival elements for which suitable conditions were developed and described. Part II of the report is discussed in more detail below.

Part III — Monitoring

Part II of the report is further divided into the following major sections:

A. Long-Term Health / Functionality Elements — The elements addressed in this section play central roles in shaping habitat conditions for spotted frogs and boreal toads, even though some parts or aspects of some elements do not directly affect these species (e.g., mix of succession stages indirectly can affect flow volumes of springs, herbaceous species composition in uplands can affect sedimentation in wetlands). There are many synergist effects, both in terms of some elements within this group setting the stage for achieving suitable conditions for other elements in this group as well as setting the stage for achieving suitable conditions for elements in other sections (i.e., sections B and C). Also, elements addressed in this section affect wildlife communities as a whole, and restoring or approximating the conditions under which wildlife communities developed in this area represent the best possible conditions for native wildlife-communities as a whole. Conditions of these elements change relatively slowly and, therefore, may take years, decades, or longer, depending on the specific element and location.

B. Short-Term (e.g., Annual) Habitat Elements — The elements in this section can change from year to year and through a given season, recognizing that effects in one year can affect some elements the following year or years (e.g., a large input of contaminants into a water body can affect water quality for years). Also, soil looseness typically is not just affected by livestock use or motorized activity in one season; changes in soil looseness on any given site commonly is affected by several years of activity. However, soil looseness can change faster than elements addressed in section A.

C. Habitat Effectiveness and Survival Elements Affected by Human Activities — These elements do not address “physical” parts of habitat, but rather are oriented to direct and typically immediate effects of activities (e.g., crushing of individuals by vehicles, displacement of individuals due to loud noises, predation of individuals by fish). They are important parts of the habitat of spotted frogs and boreal toads, for which it is important to identify suitable conditions for these species.

Each of the major sections in Part II (i.e., A, B, and C) covers the following topics:

- Introduction and Background
- Development of Suitable Condition Statements — This subsection presents information upon which suitable conditions were developed. The overall approach to developing suitable condition statements the purposes of each of the following subsections are outlined in the “Approach to Developing Suitable Condition Statements” section.
    - Summary of Management Direction
    - Estimated Natural Conditions
    - Deviations from Estimated Natural Conditions to Meet the Needs of the Species
    - Deviations from Estimated Natural Conditions to Accommodate Other Uses
- Suitable Condition Statements — Suitable conditions for spotted frogs and boreal toads step down from Forest Plan direction, policy, regulation, executive orders, and laws. This management direction focuses on the provision of an adequate amount of suitable habitat being provided for sensitive species, but also includes direction to protect them from activities that are managed by the Forest Service on National Forest System lands. Meeting this direction over the long term in nearly all cases is founded in the approximation of natural conditions. The low-end of suitability takes into consideration the need to provide for other uses, as discussed above.

Attempts were made in this subsection to succinctly define suitable conditions, qualitatively where possible, with suitable conditions being limited to "conditions" and not the means to attain these conditions. Suitable condition statements identify the on-the-ground conditions that need to be attained and maintained in order to meet Forest Plan objectives and the standard identified above. If these conditions are not maintained or attained, it is questionable whether the distribution and abundance of spotted frogs and boreal toads can be maintained at satisfactory levels. As such, the definition of suitable conditions forms the foundation of conserving spotted frogs and boreal toads on the BTNF.

- Risk Factors and Restoration Factors **—** Factors that have potential to limit the attainment and maintenance of suitable conditions are listed and described in this subsection. Because they are limiting factors, they typically are discussed as problems. In contrast to suitable condition statements, which are stated in the affirmative as on-the-ground conditions to be attained and maintained, risk factors are stated in the negative as conditions or adverse effects to be avoided or resolved. In some cases, factors or specific habitat components that are important in the restoration of suitable conditions (i.e., proactive, positive "restoration" factors) are also listed.

  Risk factors were also used to guide which specific habitat and survival components were addressed in suitable condition statements (i.e., as part of an iterative process), although this is not the main function of risk factors. While risk factors and threats help steer objective development by helping identify specific habitat/survival elements that should be addressed, they do not drive the development of objectives.

- Conservation Actions to Consider **—** This subsection lists and briefly describes a range of management actions that can be taken to accomplish suitable conditions. They are distinguished from suitable conditions by being the *means to attain or achieve* suitable conditions and are therefore not expressed as conditions on the ground that we want to maintain or attain.

  As opposed to suitable condition statements, conservation actions are expressed as options to consider in the process of working toward the attainment of Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species.

- Measures and Indicators **—** This subsection summarizes the parameters that should be monitored to determine the extent to which suitable conditions are being met at any given time.

REVIEW

A draft copy of this report was reviewed, in whole or in parts, by Dale Deiter (District Ranger, Jackson Ranger District), Wendy Estes-Zumpf (Wyoming Natural Diversity Database), Doug Keinath (Wyoming Natural Diversity Database), Zack Walker (Wyoming Game and Fish Department), Eric Peterson and Glen Owings (Sublette County Conservation District), Tyler Johnson (NEPA Specialist and Botanist, North Zone), and Cynthia Tate (Regional Aquatic Biologist). Changes were made to the 09-26-2014 version of the report as warranted and a response-to-comment document was prepared (Appendix D). After this, comments were received from the Ecosystem Research Group, contracted by the Sublette Conservation District. Changes were made to the report as warranted, and their comments and responses-to-their-comments were added to Appendix D.

Several presentations were made, and questions were asked and issues and concerns were raised. Presentations were made to the District Rangers (May, 2013); and Forest Leadership Team and others, including the Forest Supervisor, District Rangers, two Regional Biologists, and about another 20 BTNF employees (June, 2014). Changes were made to the report based on these questions, issues, and concerns.

Additionally, presentations on the basis of ≥70% retention of herbaceous vegetation for wildlife as a whole (including spotted frogs and boreal toads) were given to the Wyoming Chapter of The Wildlife Society (October 2009); Regional Office Wildlife and Range programs in Ogden (February 2010, BTNF biologists on conference call); Alma Winward, retired Regional Ecologist (July 2011); BTNF and WGFD biologists in Jackson (July 2011); Mike Smith, University of Wyoming (August 2011); 18 Greys River Ranger District cattle permittees and Mike Smith, University of Wyoming (November 2011); and District Rangers (June 2012).

Part I — Background and Foundations

A. FOUNDATIONS AND APPROACH FOR DEVELOPING SUITABLE CONDITION STATEMENTS

1. DIRECTION FOR DEFINING SUITABLE CONDITIONS FOR SENSITIVE SPECIES

The Forest Plan, FSM 2670.22, and other higher-level direction for sensitive species require that an adequate amount of suitable conditions be provided for sensitive species. Providing an adequate amount of suitable habitat for sensitive species is identified in the referenced management direction as the primary means of preventing further declines in their populations, improving their population status, and eliminating the need for listing. Also, the requirement in the Sensitive Species Management Standard and FSM 2670.22 to develop objectives for sensitive species habitat and/or populations **—** especially given the central role that suitable conditions play in preventing further declines, improving status, and eliminating the need for listing **—** shows that more detail on suitable habitat conditions is needed than what is provided in the Forest Plan. Although the Forest Plan requires that an adequate amount of suitable habitat be provided for sensitive species, it does not identify, describe, or define what these conditions are. For land managers to be able to provide an adequate amount of suitable habitat conditions, these conditions must be defined in a way that can be compared to existing conditions. This is typically done in the form of habitat objectives (Adamcik et al. 2004, Laubhan et al. 2012); the general process for developing habitat objectives is generally illustrated in Figure 1 later in this report. However, because this information may not be incorporated into habitat objectives for sensitive species on the BTNF (as per FLT direction), suitable conditions and adequate amounts thereof are succinctly defined in "suitable condition statements."

The requirements to provide an adequate amount of suitable habitat for sensitive species and to protect sensitive species are affirmative requirements, and the agency is directed to meet these components of Objective 3.3(a) and Sensitive Species Management Standard to the extent practical in balance with competing objectives depending on direction for individual DFC areas (e.g., see USFS 1990a:6 and USFS 1990b:93,145 for the BTNF). Before an action is implemented on the BTNF, biologists must be able to demonstrate that an adequate amount of suitable conditions for pertinent sensitive species will continue to be provided (or restored if currently below suitable conditions) by (1) designing actions specifically to restore and/or maintain these conditions, and (2) modifying the design of projects (e.g., through the use of mitigation) to ensure an adequate amount of suitable conditions will continue to be maintained or will be restored (i.e., so the project does not move conditions further from suitable conditions). Conversely, because the requirement is an affirmative one, the agency is not required to demonstrate (1) that suitable conditions are not being provided before making any adjustments to current management to restore an adequate amount of suitable habitat, or (2) that suitable conditions would not be provided before implementing a project that could potentially hinder the attainment of these conditions.

Requirements to Protect Sensitive Animal Species

FSM 2672.1 requires that "Sensitive species of native plant and animal species must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for Federal listing." FSM 2670.32.3 requires the agency to "Avoid or minimize impacts to species whose viability has been identified as a concern."

Forest Plan Objective 3.3(a) calls for the Forest Service to "Protect [Region 4] sensitive plant and animal species… to ensure that activities do not cause long-term or further declines… and… trends toward federal listing." This is supported by FSM 2670.23.3 (WO Amendment 2600-2005-1), which requires the agency to "Avoid or minimize impacts to species whose viability has been identified as a concern."

Protecting sensitive animal species, in the context of its provision in Objective 3.3(a), is distinguished from providing an adequate amount of suitable habitat (also in Objective 3.3(a)) and protecting their habitat (as addressed in the Sensitive Species Management Standard). Protecting sensitive animals involves protecting individuals from being harmed or killed (e.g., by being crushed by vehicles and livestock, by being eaten by introduced fish, by introduced diseases). The requirement to protect sensitive animals is not an absolute prohibition on the taking of individual animals, and it is recognized that activities on National Forest System lands will result in some incidental mortality of some sensitive animals regardless of how carefully activities are managed.

The ultimate intent of protecting sensitive animals (and providing an adequate amount of suitable habitat) is to "…ensure that activities do not cause: (1) long-term or further decline in population numbers or habitats supporting these populations; and, (2) trends toward federal listing" (Objective 3.3(a)).

Also, one of the responsibilities of Regional Foresters is to "Approve closures of National Forest System lands as necessary to protect habitats or populations of threatened, endangered, proposed, or sensitive species (36 CFR 261.70)" (FSM 2670.44.15); and one of the responsibilities of District Rangers is to "Prohibit the collection or taking of sensitive plants except as authorized by Regional policy" (FSM 2670.46.5).

Requirements to Provide an Adequate Amount of Suitable Habitat

Objective 3.3(a) — Sensitive Species

In addition to protecting sensitive species, this objective calls for an adequate amount of suitable habitat to be provided for sensitive species. The Forest Plan goal and objective for sensitive species are as follows:

- Forest Plan Goal 3.3 — Sensitive species are prevented from becoming a federally listed threatened species in Wyoming.
    - Objective 3.3(a) — "Protect [Region 4] sensitive plant and animal species and provide suitable and adequate amounts of habitat to ensure that activities do not cause: (1) long-term or further decline in population numbers or habitats supporting these populations; and, (2) trends toward federal listing."

This goal and objective provide the most important direction for conserving sensitive species on the the BTNF because "…the first and most important part of the [Forest] Plan is…. Goals and Objectives" (USFS 1990a:6-7). The Sensitive Species Management Standard is important, but the role of standards is to support Forest Plan goals and objectives (USFS 1990a) and direction in the Sensitive Species Management Standard only provides limited direction for achieving Objective 3.3(a).

The ultimate target of the objective is to prevent long-term declines in populations and habitat conditions and to prevent trends toward federal listing, and this is to be accomplished primarily through the protection of sensitive species and provision of an adequate amount of suitable habitat for these species. To meet Objective 3.3(a) — and the higher-level directives upon which it is based — we must first (1) define suitable habitat conditions and (2) determine how much suitable habitat must be restored and maintained.

Other Forest Plan Objectives

The main impetus of the Forest Plan is to address problems; the plan starts by stating that "The Bridger-Teton Land and Resource Management Plan—the Forest Plan— attempts to solve or prevent serious problems associated with existing natural resources and people's continuing use of them. Major problem categories identified in this Forest Plan include: human access to, and commercial or recreational use of, the BTNF; the needs of threatened, endangered, and sensitive plant and animal species; and the need to mitigate the impacts of human use and access to natural resources…"

The Forest Plan clearly paints the picture that "Increased demands on all resources has the potential to increase… the number of species listed [as threatened or endangered]" (USFS 1990b:63), and the Forest Challenge statements on pages 72-82 identify the need to place enough constraints on recreational and commercial uses to not adversely impact wildlife, particularly sensitive, threatened, or sensitive species.

Goals and objectives were developed for each major problem category. The Forest Challenge Statement for sensitive species is as follows: "Some plant and animal species on the BTNF have been declared sensitive. If the challenge to keep the species off the Threatened list is not met, human use of many areas of the National Forest could be changed, reduced, or stopped until the species are taken off the list" (USFS 1990b:77).

In addition to problems specific to sensitive species, goals and objectives were developed to address a range of problems on the BTNF:

- Goal 4.1 — Road management preserves wildlife security, soil, visual resource, and water-quality values.
    - Objective 4.1(b) — Design roads and structures to retain soil, visual resource, and water-quality values.

      When the Forest Plan was adopted, wildlife security primarily was applied to native ungulates, but today recognition is increasingly being given to the fact that it has application to a wide range of wildlife species, including frogs and toads (Maxell and Hokit 1999, Forman et al. 2003, Andrews et al. 2008, Beebee 2013).
- Goal 4.2 — Other resource values are retained or improved as timber is removed from the Bridger-Teton National Forest.
    - Objective 4.2(b) — Cut or remove timber to meet documented, site-specific recreation, wildlife, visual, or water-production objectives on land not suited — unscheduled — for timber production.
    - Objective 4.2(d) — Prevent logging or certain logging practices where potential effects on other resource values, including wildlife, threatened and endangered species, recreation, soils, air, visual resource, and water-quality values are unacceptable.

      This goal and the two objectives point strongly in the direction of restoring and maintaining suitable habitat conditions for sensitive species and designing logging and mechanical treatments to avoid unacceptable impacts to sensitive species (i.e., to maintain suitable habitat conditions and to protect sensitive species).
- Goal 4.3 — Overall diversity of [forest] and riparian habitat within the Bridger-Teton National Forest are enhanced as timber is removed.
    - Objective 4.3(a) — Provide for vegetative species and age diversity, genetic quality, and forest appearance.
    - Objective 4.3(c) — Provide and rehabilitate riparian areas to retain and improve their value for fisheries, aquatic habitat, wildlife, and water quality.
- Goal 4.4 — Other resources are protected during exploration and development of subsurface resources.
    - Objective 4.4(b) — Prevent surface occupancy where potential effects on other resources, including wildlife, threatened and endangered species, recreation, soils, air, visual resources, and water are unacceptable.
- Goal 4.7 — Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreation values or experiences.
    - Objective 4.7(b) — Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present.
    - Objective 4.7(d) — Require that suitable and adequate amounts of forage and cover are retained for wildlife and fish.

These goals and objectives in part call for roads, timber, oil and gas, and livestock grazing to be managed to maintain suitable habitat conditions for spotted frogs and boreal toads, given the identification of wildlife in these goals and objectives and because sensitive species have a higher management priority than other wildlife (besides threatened and endangered species).

Requirement to Maintain Sufficient Distribution to be Resilient and Adaptable to Stressors

In addition to requirements to maintain an adequate amount of suitable habitat, Objective 2 in FSM 2670.23.2, WO Amendment 2600-2005-1 calls for the agency to "Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands." Similarly, the 2012 Planning Rule requires "…plan components for the conservation of all native aquatic and terrestrial species with the aim of providing the ecological conditions to contribute to the recovery of federally listed threatened and endangered species, conserve candidate species, and maintain viable populations of species of conservation concern" (USFS 2012:21166). The 2012 Planning Rule does not yet apply to the BTNF, but it will soon and this general direction does not conflict with existing direction, recognizing there are some differences in the treatment of viability between the 1982 and 2012 rules (USFS 2012). Spotted frogs and boreal toads have not been identified as species of conservation concern for the BTNF, but this is the most applicable direction in the planning rule that may apply to these species in the near future.

The 2012 Planning Rule defines a viable population as "A population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments" (USFS 2012:21272, § 219.19). This definition does not define viable populations in terms of the minimum number of reproductive individuals needed to maintain a population, as did the 1982 Planning Rule and there is no mention of "minimum viable" populations in the 2012 Planning Rule. In responding to public comments on the subject of species diversity and viability in the draft planning rule, the Federal Register notice stated that "The Department's intent is to provide for the diversity of plant and animal communities, and keep common native species common, contribute to the recovery of threatened and endangered species, conserve proposed and candidate species, and maintain species of conservation concern within the plan area, within Agency authority and the inherent capability of the land" (USFS 2012:21174). With part of this intent being to keep common native species common, it would make little sense to consciously define suitable condition statements and objectives in ways that allow a particular species to drop to a population level that is just above a minimum viable population threshold.

Furthermore, the phrase "…with sufficient distribution to be resilient and adaptable to stressors…" holds special significance to spotted frogs and boreal toads given the likelihood that multiple stressors are acting on these species on the BTNF and in surrounding areas. The "Multiple Stressors" section identifies implications of a range of stressors on populations of spotted frogs and boreal toads on the BTNF.

Finally, the 2012 Planning Rule "…requires the responsible official to develop coarse-filter plan components, and fine-filter plan components where necessary, to provide the desired ecological conditions necessary to maintain viable populations of species of conservation concern within the plan area, or to contribute to maintaining a viable population of a species of conservation concern across its range where it is not within the Agency's authority or is beyond the inherent capability of the plan area to provide the ecological conditions to maintain a viable population of that species within the plan area" (USFS 2012:21175).

The concept of metapopulations has application to viability given the part of the viable-population definition addressing "*sufficient distribution* to be resilient and adaptable to stressors and likely future environments" (emphasis added). A metapopulation was defined by Smith and Green (2005: 111) as "a collection of partially isolated breeding habitat patches, connected by occasionally dispersing individuals whereby each patch exists with a substantial extinction probability," and they added that long-term persistence only occurs at the metapopulation level. Similarly, in their review of metapopulation dynamics of amphibians, Marsh and Trenham (2001:47) concluded that "Aggregations of amphibians at individual breeding ponds may not represent distinct populations and in many cases should not be managed as distinct populations… groups of ponds may often be a more meaningful unit of management than individual ponds." Thus, the distribution and conservation of breeding-pond complexes (metapopulations) is of importance.

Pertinent Direction Specific to Livestock Grazing

There are two Forest Plan objectives, two Forest Plan standards, and direction provided in Chapter 90 of WO Amendment 2209.13-2005-10 that point strongly in the direction of managing livestock grazing in ways that allow suitable habitat conditions to be maintained for sensitive species and, where it has been degraded, to restore suitable habitat conditions.

Specific to livestock grazing management (e.g., Objectives under Goal 4.7), the Forage Utilization Standard of the Forest Plan (USFS 1990b:127-128) requires that site-specific utilization levels be prescribed *to meet* Forest Plan objectives (e.g., Objectives 3.3(a) and 4.7(d) as they pertain to spotted frogs and boreal toads) and that site-specific utilization levels on key wildlife ranges be developed. Breeding sites of spotted frogs and boreal toads are clearly key wildlife ranges, and summer-long habitat and migration routes of these sensitive species arguably are key wildlife ranges. Furthermore, the Fish; Wildlife; and Threatened, Endangered, and Sensitive Species Standard requires that, among other things, livestock management activities and trailing will be coordinated with and designed to help meet fish and wildlife habitat needs, especially on key habitat areas, with special emphasis being placed on helping to meet the needs of threatened, endangered, and sensitive species. Again, breeding sites, summer-long habitat, and migration routes are key wildlife ranges.

Two objectives of range management contained in Forest Service policy are “To integrate management of range vegetation with other resource programs to achieve multiple objectives contained in Forest land and resource management plans,” and “To provide for livestock forage, wildlife food and habitat, outdoor recreation, and other resource values dependent on range vegetation” (FSM 2202.1.2, WO Amendment 2200-2005-1). This supports the management of vegetation and livestock grazing to restore and maintain suitable habitat for spotted frogs and boreal toads.

Additional support for managing livestock grazing to ensure suitable habitat conditions are restored and maintained is found in FSH 2209.13 (Chapter 90):“Under the National Forest Management Act (NFMA) of 1976 (16 U.S.C. 1600 et seq.), project-level decisions, which authorize the use of specific National Forest System lands for a particular purpose like livestock grazing must be consistent with the broad programmatic direction established in the [Forest Plan]. Consistency is determined by examining whether the project-level decision implements the goals, objectives, desired conditions, standards and guidelines, and monitoring requirements from the [Forest Plan]. Where necessary, grazing permits must be modified to ensure consistency with the [Forest Plan].” In the case of spotted frogs and boreal toads, consistency is determined primarily by examining whether suitable habitat conditions can and will be restored (where needed) and maintained while being grazed by livestock.

Suitable Conditions and Adequate Amount Undefined in Forest Plan

A critical step in determining whether an adequate amount of suitable habitat is being provided for spotted frogs and boreal toads is to define what constitutes (1) suitable habitat conditions and (2) an adequate amount of suitable habitat. This is particularly important given the reliance of Objective 3.3(a) on providing an adequate amount of suitable habitat and protection of sensitive species as the means to prevent “(1) long-term or further decline in population numbers or habitats supporting these populations; and, (2) trends toward federal listing.” What constitutes suitable habitat and an adequate amount of habitat were not defined in the Forest Plan for any species.

Requirement to Protect and Maintain Crucial Habitat

The Sensitive Species Management Standard requires that “Crucial habitats of priority I, II, and III species as listed by WGFD and the Intermountain Region sensitive species list will be protected and maintained.” The requirement to protect habitat, on top of the requirement to “provide” an adequate amount of suitable habitat, elevates the level of importance of providing this habitat. Taken without any interpretation, the requirement implies that all habitat of spotted frogs and boreal toads must be protected regardless of adequacy and suitability in any particular area. Spotted frogs and boreal toads are WGFD species of special conservation concern and are classified as a Tier II species and Tier I species, respectively (WGFD 2010a, WGFD 2010b); see the “Status and Natural History Information” section for more details.

The most crucial habitat of spotted frogs and boreal toads obviously is breeding habitat, given the utmost importance of reproductive success in improving that status of these species on the BTNF, but migration habitat, summer-long habitat, and hibernation habitat are also very important in the conservation of these species on the BTNF.

Central in the process of protecting and maintaining crucial habitat is knowing what constitutes suitable habitat conditions where crucial habitat exists and knowing how much of this habitat needs to be maintained.

Crucial habitats for spotted frogs and boreal toads include the following:

- Breeding Wetlands, including shorelines — Adequate amounts and distributions of suitable breeding wetlands are critical for sustaining spotted frog and boreal toad populations (Wind and Dupuis 2002, Keinath and McGee 2005, Patla and Keinath 2005). Protection of breeding wetlands includes protection against loss of wetlands, reduction in long-term attributes of wetlands, and temporary reductions in habitat conditions that can impact reproduction, especially if temporary reductions occur more than infrequently.

- Migration and Dispersal Corridors and Areas, especially within 1/3-mile of Breeding Wetlands — Migration and dispersal corridors and areas are recognized as being very important to both spotted frogs (Pilliod et al. 2002, Wind and Dupuis 2002, Patla and Keinath 2005) and boreal toads (Carey et al. 2005, Keinath and McGee 2005, Goates et al. 2007, Bull 2009). Keinath and McGee (2005:42-44), for example, stressed the importance of protecting boreal toad migration corridors from disturbances that could potentially threaten the survival of toads (e.g., being crushed by vehicles, barriers created by roads, livestock grazing, trampling by livestock).

- Terrestrial Habitat within 1/3-mile of Breeding Wetlands (Boreal Toads) — Increasing recognition is being given to the importance of terrestrial habitat and conservation of terrestrial habitat (Marsh and Trenham 2001, Pilliod et al. 2002, Wind and Dupuis 2002, Keinath and McGee 2005, Patla and Keinath 2005, Smith and Green 2005, Bull 2006, Pierce 2006, Browne et al. 2009, Bull 2009, Browne and Paszkowski 2010, Moore et al. 2011, Bishop et al. 2014). As an example, Keinath and McGee (2005:3, 38, 43) emphasized that terrestrial habitat provides “critical” habitat for boreal toads. They stressed the importance of protecting network of upland habitat and migration corridors from disturbances that could potentially threaten the survival of toads. “Exclusively pond-based studies generally lead to pond-based explanations for patterns of abundance and persistence,” (Marsh and Trenham 2001:42) which in turn can limit conservation to pond-based protective measures.

- Summer-long Wetland Habitat within 1/3-mile of Breeding Wetlands (Spotted Frogs) — Wetlands used by metamorph, juvenile, and adult spotted frogs after the breeding season are also critical because, if these habitats are not available or if they are in less-than-suitable condition, this would impact survival. In some populations, aquatic habitat beyond 1/3-mile is also important, but the most crucial summer-long habitat is within 1/3-mile (see the “Buffer Zones and Levels of Protection” section). Summer-long wetland habitat for spotted frogs is listed after Summer-long terrestrial habitat for boreal toads because of the greater concern for boreal toads and because there are more protective measures for aquatic habitat than for terrestrial habitat.

- Hibernation Habitat within 1/3-mile of Breeding Wetlands — The importance of hibernation habitat is increasingly being recognized (Wind and Dupuis 2002, Keinath and McGee 2005, Patla and Keinath 2005, Brown and Paszkowski 2010). Browne and Paszkowski (2010) assessed that hibernation habitat may be limited at high elevations.

Also, one of the responsibilities of Regional Foresters is to “Approve closures of National Forest System lands as necessary to protect habitats or populations of threatened, endangered, proposed, or sensitive species (36 CFR 261.70)” (FSM 2670.44.15).

Requirements to Prevent Further Population Declines and Eliminate the Need for Listing

The 1982 Planning Rule did not directly address sensitive species, but it laid the framework for direction on maintaining, at a bare minimum, viable populations of all native wildlife species:

> "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area" (Sec. 219.19 of USFS 1982).

The 2012 Planning Rule, which will apply to the BTNF in the near future, changed the definition and treatment of viable populations:

> "A population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments" (USFS 2012:21272, § 219.19).
>
> Requirements for "…maintaining the diversity of plant and animal communities and the persistence of native species in the plan area…" is primarily reliant on requirements "…to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area…" (USFS 2012:21265, § 219.9). To the extent this approach does not suffice to maintain viable populations, it can be adjusted accordingly.

Objective 3.3(a) of the Forest Plan requires that "activities do not cause: (1) long-term or further decline in population numbers or habitats supporting these populations; and, (2) trends toward federal listing," and it specifically calls for the protection of sensitive species and provision of an adequate amount of suitable habitat as the means to attain this. The Sensitive Species Management Standard, which was developed to support Objective 3.3(a), similarly requires the agency to "…improve the status of sensitive species and eliminate the need for listing." Since the standard falls under Objective 3.3(a), this requirement summarizes the requirements spelled out in more detail in Objective 3.3(a). Because improving the status of sensitive species summarizes the requirement of Objective 3.3(a) quoted in the first sentence of this paragraph, the requirement of the Sensitive Species Standard to "improve the status of sensitive species and eliminate the need for listing" is to be attained by protecting sensitive species and by providing an adequate amount of suitable habitat, as specified in the objective this standard was designed to support. Standards are designed to support, and are subordinate to, Forest Plan objectives (USFS 1990a:6).

The parts of Objective 3.3(a) and Sensitive Species Management Standard outlined above support (1) the attainment of Objective no. 2 in FSM 2670.22.2 (WO Amendment 2600-2005-1), which is to "Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands;" and (2) a related policy of the Forest Service, which is to "Avoid or minimize impacts to species whose viability has been identified as a concern" (FSM 2670.23.3, WO Amendment 2600-2005-1). Maintaining an adequate amount of suitable conditions for sensitive species is central to meeting this direction.

Part of the second objective in FSM 2670.22.2 (WO Amendment 2600-2005-1) is to maintain viable populations "…in habitats distributed throughout their geographic range…" on national forests, which means that suitable habitat needs to be distributed throughout the geographic range of spotted frogs and boreal toads on the BTNF.

Requirements to Develop Habitat and/or Population Objectives for Sensitive Species

The requirement to develop quantifiable objectives comes from the Sensitive Species Management Standard and Forest Service policy. The standard states that "Quantifiable objectives will be developed to identify and improve the status of sensitive species and eliminate the need for listing…" The purpose of standards in the Forest Plan is to support the attainment of Forest Plan goals and objectives, with standards being subordinate to Forest Plan goals and objectives (Forest Plan 1990a:6). Therefore, while direction to develop objectives for sensitive species comes from the Sensitive Species Management Standard, the focus of the objectives is to achieve Forest Plan goals and objectives, which call for sensitive species to be protected and for an adequate amount of suitable habitat to be provided for sensitive species.

The set of objectives approved by the Forest Leadership Team (USFS 2013) to address this standard establish a timeline for compiling additional information and collecting additional data to better address the needs of sensitive species in order to meet Objective 3.3(a). The 2013 objectives identify timelines for the process of developing quantifiable objectives for sensitive species.

Forest Service policy also requires that objectives be developed. The third objective for sensitive species in FSM 2670.22 (WO Amendment 2600-2005-1) is to "Develop and implement management objectives for populations and/or habitat of sensitive species." This not only requires objectives to be developed, it requires that they be implemented on the ground. One of the responsibilities of Forest Supervisors is to "… Develop quantifiable objectives for managing populations and/or habitat for sensitive species" (FSM 2670.45.2).

The requirement to develop population and/or habitat objectives for sensitive species, in combination with Forest Plan objectives calling for the provision of an adequate amount of suitable conditions being provided without actually defining what constitutes "suitable habitat" and an "adequate amount" of suitable habitat provides strong indication of the intent to provide additional detail on suitable conditions. And this is reinforced by wildlife habitat and population planning procedures, which call for objectives to be specific and numeric (Crowe 1992, Adamcik et al. 2004, Laubhan et al. 2012). Having a numeric component specifically refers to the quantification of suitable habitat or population conditions (Crowe 1992, Adamcik et al. 2004, Laubhan et al. 2012).

Summary

The Forest Plan goals, objectives, and standards outlined above provide direction to (1) maintain an adequate amount of suitable habitat conditions for spotted frogs and boreal toads where an adequate amount of suitable conditions exist, and to restore suitable habitat conditions where an adequate amount of suitable habitat conditions do not exist; and (2) protect spotted frogs and boreal toads from recreational and commercial activities that would otherwise cause unacceptable adverse impacts to these species, either through direct mortality, reduced habitat effectiveness, or reduced reproductive success.

Forest Plan goals, objectives, and standards and Forest Service policy applicable to sensitive species call for suitable conditions to be restored and maintained for the following sets or groups of parameters. In addition to a large number and wide range of direction calling for an adequate amount of suitable conditions to be restored and maintained, part of the basis for identifying these groups comes from direction to protect sensitive species and "…to prevent long-term declines in populations and habitat conditions and to prevent trends toward federal listing." The major groups that are addressed throughout the rest of this report are as follows:

- Biophysical habitat conditions, including vegetation, soils, and water.
- Habitat effectiveness, including factors that influence the use of available suitable habitat.
- Survival and reproductive success.

Based on the direction outlined above, there are two and possibly three habitat elements (underlined) and several purposes of these habitat elements that, in combination, provide direction for defining suitable conditions and adequate amounts of suitable habitat:

- Adequate amount of suitable conditions of the three groups of parameters, above, will be provided to:
    1. *ensure that activities* do not cause long-term or further declines in population numbers or habitats supporting these populations,
    2. *ensure that activities* do not cause trends toward federal listing, and

3. *improve the status* of sensitive species and eliminate the need for listing.

And possibly,

- Crucial habitats will be protected and maintained to:
    1. *ensure that activities do not cause* long-term or further declines in population numbers or habitats supporting these populations,
    2. *ensure that activities do not cause* trends toward federal listing.

Near-Future Direction — 2012 Planning Rule

In the near future, wildlife on the BTNF will need to be managed consistent with the 2012 Planning Rule (USDA 2012). Wildlife conservation in the planning rule relies heavily on a coarse-filter/fine-filter approach, the basic premise of which is to approximate as close as possible the conditions under which native wildlife-communities developed or formed (i.e., natural conditions) and to make fine-filter adjustments to this where the needs of species of conservation concern are not adequately met by the coarse-filter approach (USDA 2012). Particularly if spotted frogs and boreal toads are identified as species of conservation concern on the BTNF, this will require that natural habitat conditions for these species be identified and that targeted conditions be adjusted as needed to ensure their needs are adequately met. This means that suitable habitat conditions need to be defined for these species. This report was written such that information can hopefully be directly integrated into this process when the BTNF needs to comply with requirements of the 2012 Planning Rule.

2. PRINCIPLES OF WILDLIFE CONSERVATION

A principle of wildlife management, as defined in the *Principles of Wildlife Management* text by Bailey (1984:6), is “a widely accepted generalization based on abundant and diverse research and experience and having wide application for managing wildlife.” Bailey provides the following example to illustrate the meaning of a principle. Experience with many species of wildlife has demonstrated that wildlife populations can be managed on a sustained yield basis. This does not mean that they *should* be, but rather only that they *can* be. For this reason, he explained that “Principles of wildlife management are concepts to consider in formulating management objectives and in reaching management decisions. Principles do not tell the wildlife manager what to do...” Management principles help managers determine whether goals and objectives being considered can be reasonably achieved; they provide one measure for determining whether strategies being considered can realistically be used to accomplish the goals and objectives; and they help in assessing potential consequences of taking action.

A long-standing basic principle of wildlife management is that wildlife populations and communities require an adequate amount of suitable habitat to be sustained (Leopold 1933, Dasmann 1981, Burger 1979, Kie et al. 1994, WGFD Staff 1995, Peek 1986, Morrison et al. 1998), and this is recognized in range management (Holechek et al. 2011). Key elements of habitat are food, water, cover from predators and adverse weather, nesting or denning sites, and interspecific competition (Peek 1986, Kie et al. 1994, Morrison et al. 1998). In some cases, insufficient cover may contribute to increased predation and in other cases, behavior of wildlife may inhibit their use of the area with insufficient cover. In discussing basic concepts concerning wildlife habitat, Holechek et al. (2011:283) stated “Wildlife populations are regulated by the availability of food, water, and cover, the basic components of wildlife habitat.” If basic habitat elements preferred or required by a particular wildlife species or group of species are absent or of insufficient quality in a given area, this species or group of species will not exist or will exist in lower numbers, depending on the extent of unsuitability. Providing suitable habitat for wildlife is a fundamental underpinning of Forest Plan objectives for wildlife (USFS 1990b).

The principle outlined above supports the Forest Plan requirement to restore and maintain an adequate amount of suitable habitat for sensitive species in order to ensure populations of sensitive species are sustained over the long term.

3. SCOPE OF SUITABLE CONDITIONS

In combination, Forest Plan goals, objectives, and standards and Forest Service policy applicable to sensitive species call for an adequate amount of suitable conditions to be restored and maintained for the following:

- Habitat, including live and dead vegetation, soil, water, and food resources, as well as habitat connectivity.
- Habitat effectiveness, which is the degree to which wildlife are able to use suitable habitat; i.e., the degree to which they are not displaced by human activities and facilities.
- Survival and reproductive success.

Restoring and maintaining an adequate amount of suitable conditions for each of these groups of attributes is need to protect sensitive species, to prevent long-term or further declines in population numbers or habitats supporting these populations, and to prevent federal listing. Maintaining suitable habitat effectiveness, survival, and reproductive success in spotted frogs and boreal toads would indicate they are being adequately “protected” from activities that can directly or indirectly reduce habitat effectiveness, survival, and/or reproductive success.

4. SUITABLE CONDITIONS VS. DESIRED CONDITIONS

The intent in this report is to only define *suitable* conditions of each of the habitat/survival elements for spotted frogs and boreal toads, not desired conditions for each of these elements. Defining suitable conditions for the range of habitat and survival elements affecting spotted frogs and boreal toads is driven primarily by sensitive species management direction (Forest Plan, National Forest Management Act) and scientific information, and is done by wildlife biologists. On the other hand, defining desired conditions for each of these habitat and survival elements, for resources and uses on the BTNF overall, is driven by the full range of management authorities for resources and recreational/commercial uses and pertinent scientific information, and is done by interdisciplinary teams. Suitable conditions for spotted frogs and boreal toads are considered in the formulation of desired conditions. Negotiation and compromise may be needed in the development of desired conditions, so long as Forest Plan direction is met. As an example, if changes in management that would be needed to achieve suitable conditions for spotted frogs and boreal toads in a DFC 1B area conflict with the attainment of Objective 1.1(h) for livestock grazing, a decision needs to be made whether to meet Objective 1.1(h) at the partial expense of meeting Objective 3.3(a) for sensitive species.

It needs to be recognized that defining the low end of suitable conditions in this report took into account recreational and commercial uses to some degree, with the question being asked, how far down can conditions be taken while still meeting the needs of spotted frogs and boreal toads? This is addressed in the “Deviations from Estimated Natural Conditions to Accommodate Other Uses” subsection of each habitat/survival element. No attempt was made to fully integrate effects of recreational and commercial uses into suitable conditions because suitable condition statements must not go outside the scope of what can readily be supported as being suitable.

5. APPROACH FOR DEVELOPING SUITABLE CONDITION STATEMENTS

The focus of this report is on defining suitable conditions and on documenting the legal/policy and scientific basis for the identified suitable conditions.

Two basic approaches were used. The focus was on a coarse-filter, fine-filter approach combined with adjustments to accommodate activities and uses. For each habitat and survival element, suitable conditions were also assessed starting with the needs of spotted frogs and boreal toads.

A coarse-filter/fine-filter approach provided the basic framework for defining the conditions that eventually were written into suitable condition statements, but because the use of coarse-filter and fine-filter terminology seemed to throw off several reviewers of the draft document, these terms were removed from the main body of the document. However, the terms are used in this section in describing the central framework of the process used to develop suitable condition statements for spotted frogs and boreal toads.

The coarse-filter/fine-filter approach is particularly relevant to spotted frogs and boreal toads given (1) their use of a wide range of types of habitats (i.e., wetlands, streams, riparian areas, rangelands, and forestlands); (2) their dependency on healthy, functioning ecosystems; and (3) the wide range of activities and altered conditions in wetlands, riparian areas, rangelands, and forestlands that affect these species, including activities and altered conditions long distances from occupied habitat.

Many references are made to the 2012 Planning Rule in this section of the report; although management of the BTNF does not yet fall under the purview of the 2012 Planning Rule, (1) discussion in the *Federal Register* (USDA 2012:21213-21219) clearly articulates that the USDA and Forest Service see the coarse-filter/fine-filter approach as the most effective way to meet requirements of the National Forest Management Act, Multiple-Use Sustained Yield Act, Endangered Species Act with respect to wildlife in the context of multiple-use management; (2) discussion in the *Federal Register* demonstrates that the USDA and the Forest Service, as an agency, agree with and support the principals of this approach; (3) identifying the coarse-filter/fine-filter approach in the 2012 Planning Rule adds credence and support to the use of the approach on National Forest System lands; and (4) the BTNF will fall under the purview of the 2012 Planning Rule within the next few years.

A fundamental premise of the coarse-filter/fine-filter approach is that the needs of most native species, including sensitive species, would be adequately met where environmental conditions approximate the conditions under which native wildlife-communities formed (i.e., natural conditions), as explained in the *Federal Register* notice of the final 2012 Planning Rule:

> “The ‘if then’ statement in paragraph (b)(1) [of section 219.9] conveys the Department’s expectation that for most native species, including threatened, endangered, proposed, candidate, and species of conservation concern, the ecosystem integrity and ecosystem diversity requirements (coarse-filter) would be expected to provide most or all of the ecological conditions necessary for those species’ persistence within the plan area. However, for threatened, endangered, proposed, candidate, and species of conservation concern, the responsible official must review the coarse-filter plan components, and if necessary, include additional, species-specific (fine-filter) plan components to provide the ecological conditions to contribute to recovery of threatened and endangered species, to conserve proposed and candidate species, and to maintain viable populations of species of conservation concern in the plan area…” (USDA 2012:21214)

The central focus of the coarse-filter approach is on restoring and maintaining overall ecosystem integrity and ecosystem diversity, as described in the *Federal Register* notice of the 2012 Planning Rule:

> “Based upon the current science of conservation biology, by working toward the goals of ecosystem integrity and ecosystem diversity with connected habitats that can absorb disturbance, the Department expects that over time, management would maintain and restore ecological conditions which provide for diversity of plant and animal communities and support the abundance, distribution, and long-term persistence of native species. These ecological conditions should be sufficient to sustain viable populations of native plant and animal species considered to be common or secure within the plan area. These coarse-filter requirements are also expected to support the persistence of many species currently considered imperiled or vulnerable across their ranges or within the plan area.
>
> For example, by maintaining or restoring the composition, structure, processes, and ecological connectivity of longleaf pine forests, national forests in the Southeast provide ecological conditions that contribute to the recovery of the red-cockaded woodpecker (an endangered species) and conservation of the gopher tortoise (a threatened species), in addition to supporting common species that depend on the longleaf pine ecosystem.” (USDA 2012:21212)

Specific to spotted frogs and boreal toads, restoring and maintaining ecosystem integrity, ecosystem diversity, and habitat connectivity (coarse-filter conditions) in wetland systems, riparian areas, rangelands, and forestlands would (1) provide the foundation upon which specific habitat elements are produced and maintained; (2) allow the effects of major disturbances to be absorbed, with impacts to spotted frogs and boreal toads being mitigated to some degree; and (3) otherwise provide ecological conditions that would prevent further declines in spotted frog and boreal toad populations on the BTNF, facilitate improved status, and prevent federal listing. Providing first for ecosystem functioning and ecological integrity is a fundamental principle of wildlife conservation (Dasmann 1981, Robinson and Bolen 1989, Noss and Cooperrider 1994, Hunter 1996, Everett and Lehmkuhl 1999).

Estimations of relatively natural conditions at a broad scale, especially at landscape scales and other broad scales, provided a set of coarse-filter conditions that were used as a starting point for defining suitable conditions, and these conditions were subsequently adjusted (1) as needed to meet the needs of spotted frogs and boreal toads where coarse-filter conditions would not adequately meet their needs or where a narrower set of conditions within coarse-filter conditions would be needed to meet their needs (fine-filter adjustments) and (2) where the restoration or provision of coarse-filter conditions would substantially hinder the provision of opportunities for recreational or commercial activities, so long as the lower threshold of conditions in these cases would still provide suitable conditions for spotted frogs and boreal toads (i.e., so long as the specified lower-than-natural conditions would still meet the needs of these species). Regarding the first item, few adjustments needed to be made to estimated natural conditions to better meet the needs of these species.

In situations in which scientific information is limited on the level of suitability of a given habitat element, the habitat element was deconstructed into component parts and assessments were made on these component parts using scientific information from a range of disciplines, for example, the extent to which different conditions provide for the needs of spotted frogs and boreal toads or the degree to which they affect these species.

The basic steps in the process of developing specific suitable condition statements, after identifying habitat elements that influence spotted frog and boreal toad populations on the BTNF, are outlined in the subsections of the “Development of Suitable Condition Statements” section of each habitat/survival element. The basic steps in the process, indicated by subsection headings, are as follows and are shown in Figure 1:

a. ***Summary of Management Direction —*** There are several reasons for listing and discussing, in this report, Forest Plan goals, objectives, standards, prescriptions and guidelines, and provisions of policy, regulation, executive orders, and laws that provide direction for managing the particular habitat or survival element. Suitable condition statements for spotted frogs and boreal toads step down primarily

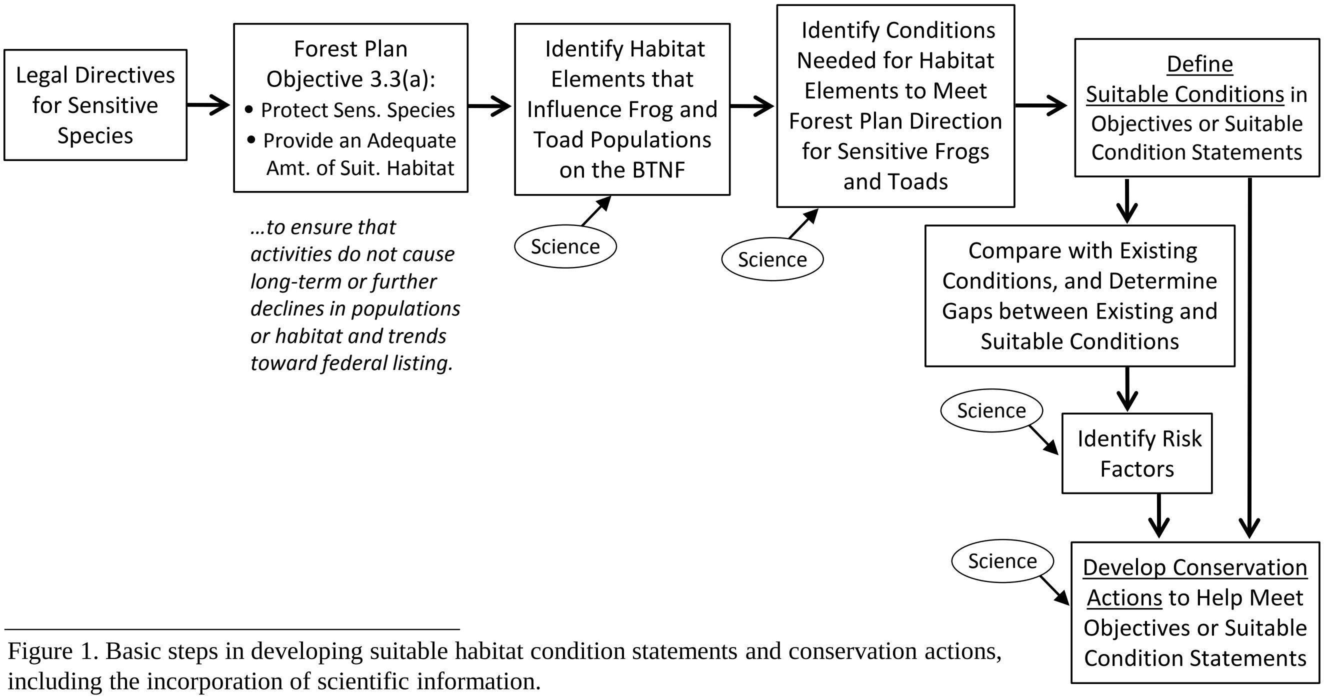

Figure 1. Basic steps in developing suitable habitat condition statements and conservation actions, including the incorporation of scientific information.

from Forest Plan Objective 3.3(a) and Sensitive Species Management Standard, but also from Objectives 4.1(a), 4.2(a), 4.2(b), 4.2(d), 4.3(a), 4.3(c), 4.4(b), 4.5(a), 4.7(b), and 4.7(d) as they pertain to conserving sensitive species, with each of these being based on higher-level direction. Objective 3.3(a) and the Sensitive Species Management Standard directly apply to sensitive species and are discussed in the "Legal, Regulatory, and Forest Plan Direction" section of this report. They are not quoted or described in the "Summary of Management Direction" subsection in each habitat/survival element. Each of the other Forest Plan objectives and other pertinent management direction is summarized and discussed in the "Summary of Management Direction" subsection of each habitat/survival element.

One of the purposes of the "Summary of Management Direction" subsection in each habitat/survival element is to determine the extent to which gaps exist in protective provisions of the Forest Plan, policy, executive orders, and laws for each habitat/survival element aside from direction provided by Objective 3.3(a) and Sensitive Species Management Standard. By outlining all pertinent Forest Plan direction, policy, regulation, executive orders, and laws, it may become apparent there are little or no other protective requirements for particular habitat/survival elements or individual parameters. In these situations, suitable condition statements provide important information for developing, considering, and implementing conservation actions to restore and/or maintain these conditions.

For other habitat/survival elements, a substantial amount of management direction outside of direction for conserving sensitive species may exist. For example, because suitable water quality is important for maintaining high reproductive success, Objective 3.3(a) and the Sensitive Species Management Standard require that suitable water quality be maintained; but it is helpful to understand whether there is sufficient other direction in the Forest Plan (e.g., Water Quality Standard) and in elsewhere (Clean Water Act) that require high water quality be maintained. Even where this other management direction exists for a given habitat/survival element (e.g., water quality), it is still important to define pertinent suitable conditions for at least two reasons. First, it provides yet another reason for meeting this management direction. Second, if Forest Plan direction changes in the future, the definition of suitable conditions will continue to inform decisions.

There was considerable discussion by biologists, District Rangers, and others during the last couple years on implications of management direction pertaining to individual habitat/survival elements. There was agreement that applicable laws, executive orders, regulations, policies, and Forest Plan direction should be outlined. Some argued that, where there already is direction to protect a given habitat/survival element, there is little need to develop objectives or define suitable conditions for that element. Others felt that suitable conditions should still be defined and objectives developed. Just because there already exists management direction does not mean it is being followed. Defining suitable conditions (and possibly objectives) for the given habitat/survival element would add further emphasis to take action to meet the existing direction. This report takes the latter approach.

b. ***Estimated Natural, Pre-Activity Conditions —*** The process of defining suitable conditions for each habitat/survival element began with estimating natural (or pre-activity) conditions because (1) the conditions under which the composition of the amphibian community formed or evolved are sufficient to maintain populations of spotted frogs and boreal toads, else these species would not have existed in the BTNF area when Euro-Americans settled here; (2) natural conditions represent the capability of what the land can produce, with the exception of a range of human-related ecosystem alterations (e.g., plant species introductions, changes in climate); and (3) the needs of native wildlife-communities as a whole are best met by natural conditions and, therefore, the provision of natural conditions reduces the potential for conflicts among species.

The only realistic way to sustain the full complement of native wildlife species, including spotted frogs and boreal toads, on a given landscape over the long term is to approximate habitat conditions within the natural range of variability, which requires both allowing natural processes to shape and sustain habitat elements and actively managing habitat to mitigate a range of changed conditions that have occurred since Euro-American settlement (Diamond 1981, Reid and Miller 1989, Keystone 1991, Noss and

Cooperider 1994, Hunter 1996, Aplet and Keeton 1999, Everett and Lehmkuhl 1999, Haufler 1999a, Hughes et al. 2000, Cooperrider 2002, Samways 2005). This is reinforced by the "coarse-filter approach" generally outlined in Section 43 of WO FSH Amendment 1909.12-2006-5 and as explained on page 21212 of the *Federal Register*, April 9, 2012 (USDA 2012). There are far too many wildlife species (many with specific habitat needs) and unknowns to attempt to manage for the needs of each individual species or group of species if the ultimate goal is to maintain populations of all native species. It is well recognized that our understanding of habitat needs and wildlife-habitat relationships is incomplete (Peek 1986, Hunter 1996, Samways 2005). Given the large unknowns, combined with our knowledge of the sometimes strong dependencies between specific plant and animal species, symbiotic relationships, food webs, and other ecological relationships (Leopold 1939, Krebs 1978, Ricklefs 1979, National Research Council 2007), the concept of keeping all the parts is sound.

Although management of the BTNF does not yet fall under the purview of the 2012 Planning Rule, provisions of the rule outlines the current thinking of the Forest Service with respect to wildlife conservation and, according to Regis Terney (Pers. Comm., Planning Specialist in the Washington Office, Aug. 1, 2011), the Forest Service has been moving in the direction of coarse-filter/fine-filter management for more than 10 years. For example, the Ecological Sustainability section (Section 43) of WO FSH Amendment 1909.12-2006-5 states that "The National Forest Management Act (NFMA) provision for the diversity of plant and animal communities uses a hierarchical approach that evaluates and provides guidance for ecosystem and species diversity. The initial focus is on ecosystem diversity to develop plan components for a framework that provides characteristics of ecosystem diversity and contributes to diversity of native plant and animal species…" Schultz et al. (2012) contend that the Forest Service has been managing under the coarse-filter/fine-filter approach since the 1982 Planning Rule was adopted. Furthermore, it is anticipated that the BTNF will be required to start following the 2012 Planning Rule within the next few years. Thus, any efforts to move in this direction will facilitate future management when requirements of the planning rule will apply to BTNF.

The 2012 Planning Rule explains that "…native species evolved and adapted within the limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Maintaining or restoring ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area, subject to factors outside of the Agency's control, such as climate change…" (USDA 2012:21212). Ecological conditions "similar to those under which native species have evolved" equate to relatively natural conditions, or natural range of variability (WO Amendment 1909.12-2015-1, section 12.14). The Planning Rule went on to explain that the intent of taking a coarse-filter/fine-filter approach is "…to keep common native species common, contribute to the recovery of threatened and endangered species, conserve candidate and proposed species, and maintain viable populations of species of conservation concern within the plan area." A new addition to the Forest Service Handbook identifies the description of the natural range of variability as the "reference model" (WO Amendment 1909.12-2015-1, section 12.14), or starting point for defining desired conditios.

A first step of estimating natural conditions is consistent with new guidance on implementing the 2012 Planning Rule, as the first step in WO Amendment 1909.12-2015-1 (section 12.14a) is to estimate the natural range of variability of ecosystems.

The approach outlined in the 2012 Planning Rule was described in more detail in Haufler (1999a) and Applet and Keeton (1999). Haufler (1999a:24) stated this very similarly: "…the native species of a region adapted to and occurred within the historical range of ecosystem conditions, and that by maintaining ecosystems within this range, the needs of all species will be met (Risbrudt 1992, Morgan et al. 1994)," and Applet and Keeton (1999) made a very similar assessment with respect to the historic (natural) range of variability and Haufler et al. (1999) incorporated the historical range of variability into the process of defining coarse-filter conditions.

Discussion in the planning rule provides additional information on the approach of restoring and maintaining conditions under which native wildlife-communities developed or evolved as the primary focus of management:

> "The final rule adopts a complementary ecosystem and species specific approach to provide for the diversity of plant and animal communities and the long-term persistence of native species in the plan area. Known as a coarse-filter/fine-filter approach, this is a well-developed concept in the scientific literature and has broad support from the scientific community and many members of the public. This requirement retains the strong species conservation intent of the 1982 rule but with a strategic focus on those species that are vulnerable paired with a focus on overall ecosystem integrity and diversity. The final rule requires the use of the best available scientific information to inform the development of the plan components including the plan components for diversity. It also recognizes limits to agency authority and the inherent capability of the plan area.
>
> The Department's intent in providing the requirements in this section is to provide for diversity of plant and animal communities, and provide ecological conditions to keep common native species common, contribute to the recovery of threatened and endangered species, conserve candidate and proposed species, and maintain viable populations of species of conservation concern within the plan area.
>
> The premise behind the coarse-filter approach is that native species evolved and adapted within the limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Maintaining or restoring ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area, subject to factors outside of the Agency's control, such as climate change. The final rule recognizes the importance of maintaining the biological diversity of each national forest and grassland, and the integrity of the compositional, structural, and functional components comprising the ecosystems on each NFS unit.
>
> The coarse-filter requirements of the rule are set out as requirements to develop plan components designed to maintain or restore ecological conditions for ecosystem integrity and ecosystem diversity in the plan area. Based upon the current science of conservation biology, by working toward the goals of ecosystem integrity and ecosystem diversity with connected habitats that can absorb disturbance, the Department expects that over time, management would maintain and restore ecological conditions which provide for diversity of plant and animal communities and support the abundance, distribution, and long-term persistence of native species. These ecological conditions should be sufficient to sustain viable populations of native plant and animal species considered to be common or secure within the plan area. These coarse-filter requirements are also expected to support the persistence of many species currently considered imperiled or vulnerable across their ranges or within the plan area USFS 2012:21212)."

Supporting literature for the coarse-filter approach with fine-filter adjustments made as needed includes Noss and Cooperrider (1994:104-107), Hunter (1996:71-75), Haufler (1999a), and Haufler et al. (1999b). Supporting literature also includes literature on the importance of sustaining ecological integrity and on the ecosystem management approach (Franklin 1993, Grumbine 1994, Pimentel et al. 2000, Naeem 2006). Franklin (1993:202) asserted that "I contend that we cannot even come close to attaining our goal of preserving biological diversity, let alone sustainability, if we continue to focus our efforts primarily on species. Why? First and foremost, for practical reasons—there are simply too many species to handle on a species-by-species approach. Such an approach will fail as it will quickly exhaust (1) the time available, (2) our financial resources, (3) societal patience, and (4) scientific knowledge. This will happen long before we have even begun making serious progress on this task." The coarse-filter approach recognizes that habitat conditions prior to Euro-American settlement fluctuated over the course of decades and were not stagnant, but that they generally fluctuated within limits (Aplet and Keeton 1999).

In their comments on the draft report, W. Estes-Zumpf and D. Keinath of the Wyoming Natural Diversity Database, University of Wyoming, said that using natural conditions as a starting point of defining suitable conditions is the most defensible approach for conserving spotted frogs and boreal toads. W. Estes-Zumpf sent several references of scientific documents supporting this approach.

Optimum conditions for spotted frogs and boreal toads were not used as a starting point for several reasons, including (1) the difficulty and limited information for identifying, with any degree of certainty, optimum conditions for these species in western Wyoming; (2) the potential impracticality of producing and sustaining optimum conditions, if identified as targets for management, due to the low capability of the land and climate to produce and sustain optimum conditions for these species; and (3) likely conflicts with a large number of other wildlife species, other resources, and uses and activities (without a clear or strong basis for producing and maintaining optimum conditions).

Alternatives to using estimated natural conditions as the starting point are discussed in the "Alternatives to using Estimated Natural Conditions as a Starting Point" subsection, below.

c. Deviations from Estimated Natural Conditions to Meet the Needs of the Species — In the far majority of cases, it is expected that estimated natural conditions would provide suitable habitat for spotted frogs and boreal toads for reasons outlined above. This is the assessment of the Department of Agriculture with respect to threatened and endangered species and species of conservation concern in most cases (USDA 2012:21212-21214). Likely all concerns about the population levels and trends of spotted frogs and boreal toads stem from deviations from natural conditions. However, because the potential exists for natural conditions to inadequately meet one or more important needs of these species, a mechanism was added to the process to (1) determine if estimated natural conditions for particular habitat/survival elements would contribute to downward trends in populations or would otherwise not allow viable populations to be maintained across the BTNF, and (2) identify the extent to which estimated natural conditions for the particular habitat/survival elements would need to be shifted outside the range of natural variability to adequately meet the needs of spotted frogs and boreal toads. This process does not include the identification of measures to mitigate the impacts of management actions and recreational and commercial activities.

This step is an important part of the coarse-filter/fine-filter approach. Where coarse-filter (i.e., estimated natural) conditions are determined to fall short of meeting important needs of species of conservation concern[A], the coarse-filter/fine-filter approach calls for coarse-filter conditions to be adjusted (Haufler 1999a, Haufler et al. 1999, USDA 2012:21214, 21265). Haufler et al. (1999:107) described this approach as using "…a coarse-filter applied at a landscape scale and provid[ing] mechanisms to check the coarse filter through individual species assessments." He recommended the use of habitat suitability index modeling, but a modeling approach is not necessary so long as habitat needs of species can be identified and compared to the conditions that would exist when in relatively natural condition or within the historic range of variability. Species assessments are used as checks to determine whether coarse-filter conditions sufficiently meet the needs of sensitive species and, if not, how far coarse-filter conditions need to be adjusted in order to meet these needs (Haufler et al. 1999). The use of habitat suitability index models as a starting point or co-starting point for identifying suitable conditions for spotted frogs and boreal toads has the potential to identify conditions that may not even be possible on the BTNF (i.e., emphasizing habitat suitability models to this extent is not consistent with the coarse-filter/fine-filter approach).

The 2012 Planning Rule describes the fine-filter step as follows:

> "The responsible official shall determine whether or not the plan components required by paragraph (a) of this section [coarse-filter conditions] provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve

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[A] Spotted frogs and boreal toads have not been identified as species of conservation concern, but the designation as sensitive species is similar for the purposes of applying the concepts of the coarse-filter / fine-filter approach.

> proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area. If the responsible official determines that the plan components required in paragraph (a) are insufficient to provide such ecological conditions, then additional, species-specific plan components, including standards or guidelines, must be included in the plan to provide such ecological conditions in the plan area."

The fine-filter approach described in the 2012 Planning Rule (USDA 2012) corresponds to the species diversity approach outlined in subsection 43.2 of WO FSH Amendment 1909.12-2006-5. As stated in the planning rule, the fine-filter approach is to be undertaken as a complementary approach to the coarse-filter approach to focus "…on additional provisions if needed for specific federally listed species, species-of-concern, and species-of-interest."

While the fine-filter approach provides a useful and necessary mechanism for supplementing the coarse-filter approach in order to meet specific legal and regulatory requirements for certain species, using a fine-filter approach as the initial or overarching approach[B] (i.e., single-species management) would be impractical and not very accurate. Attempting to ascertain all the individual needs of each pertinent element (e.g., for individual watershed elements, for livestock, for each of dozens of vertebrate and invertebrate species at different seasons, and for recreation) and then compiling them into a succinct set of conditions in a suitable condition statement and objectives is unrealistic. This is probably a key reason the FSM 2070 and the proposed Planning Rule call for a coarse-filter approach to be the main driver in the process of identifying desired habitat conditions.

The purpose of this subsection in each habitat/survival element, therefore, is to identify any fine-filter adjustments that may need to be made to estimated natural conditions to meet the needs of spotted frogs and boreal toads. Scientific information was reviewed to determine if any fine-scale adjustments were needed.

It is important to confine any adjustments to conditions to be consistent with the inherent capability of the land. For example, it would be impractical to attempt to sustain a much larger-than-natural proportion of late-seral forestland because fires, insect epidemics, and other disturbances will eventually prevent this from being sustained (Hessburg and Agee 2003, Hessburg et al. 2005, Lehmkuhl et al. 2007); and it would be futile to attempt to attain a higher-than-natural level of stream channel integrity or streambank stability; and so forth. The 2012 Planning Rule (USFS 2012) makes repeated references to accounting for the inherent capability of the land.

***d. Deviations from Estimated Natural Conditions to Accommodate Other Uses* —** This subsection for each habitat/survival element identifies some of the adjustments that were made to the starting point of estimated natural conditions to accommodate recreational and commercial uses, while still providing suitable conditions for spotted frogs and boreal toads. Two realities of managing wildlife on lands managed for multiple uses are that a variety of uses affect the conditions under which wildlife persist (or don't persist) and the provision of optimum conditions for the majority of wildlife species is not realistic. Also, while natural conditions are clearly within the range of suitable conditions for spotted frogs and boreal toads, as discussed previously, suitable conditions for individual habitat/survival elements can extend outside the natural range of variability. As an example, even though most mountain meadows and wetlands were grazed by native ungulates no more than minimally under natural conditions — which left large amounts of herbaceous vegetation as cover, for humidity retention, and invertebrate habitat, and resulted in minimal trampling effects and water quality effects — it may be possible for somewhat lower amounts of herbaceous vegetation and somewhat lower water quality to still be within the range of suitable conditions for spotted frogs and boreal toads.

[B] The reference to using a fine-filter approach as the initial or overarching approach is merely a play on words, as this defeats the intent of the coarse-filter/fine-filter approach, but this is one way to characterize single species management.

Despite these management realities, the coarse-filter/fine-filter approach — as described in documents outlining the approach, such as Haufler et al. (1996), Haufler (1999a), and Applet and Keeton (1999) — and 2012 Planning Rule do not include any steps for adjusting coarse-filter conditions to accommodate multiple uses. Nonetheless, this is a key step that must be taken to define suitable conditions in a multiple-use context.

For each habitat/survival element, human-related factors that cause deviations from natural conditions (Figure 2) are identified in this subsection for each habitat/survival element, as are the effects they have had or could potentially have on spotted frogs and boreal toads. Where scientific information exists, supporting references are cited. This information and supporting references are provided because they (1) show the extent to which a range of human-related factors have shifted or could potentially shift habitat/survival conditions away from the conditions under which the amphibian community in the BTNF area formed, and (2) provide an indication of the degree to which the range of conditions for a given element may need to be lowered in order accommodate particular recreational and commercial uses. Figure 2 shows that the conditions caused by these human-related factors are on a continuum, from a relatively low degree of deviation that does not shift conditions beyond the range of suitable conditions for spotted frogs and boreal toads to higher degrees of deviation that shift conditions beyond the range of suitable habitat conditions. Risk factors specifically refer to human-related factors that shift or have the potential to shift conditions beyond suitable conditions (i.e., beyond the range of b-d in Figure 2), and they are addressed in more detail in the “Risk Factors and Restoration Factors” section of each habitat/survival element. Note that risk factors, for the purposes of this report, do not include factors that cause shifts in conditions beyond natural conditions but do not cause shifts beyond suitable conditions.

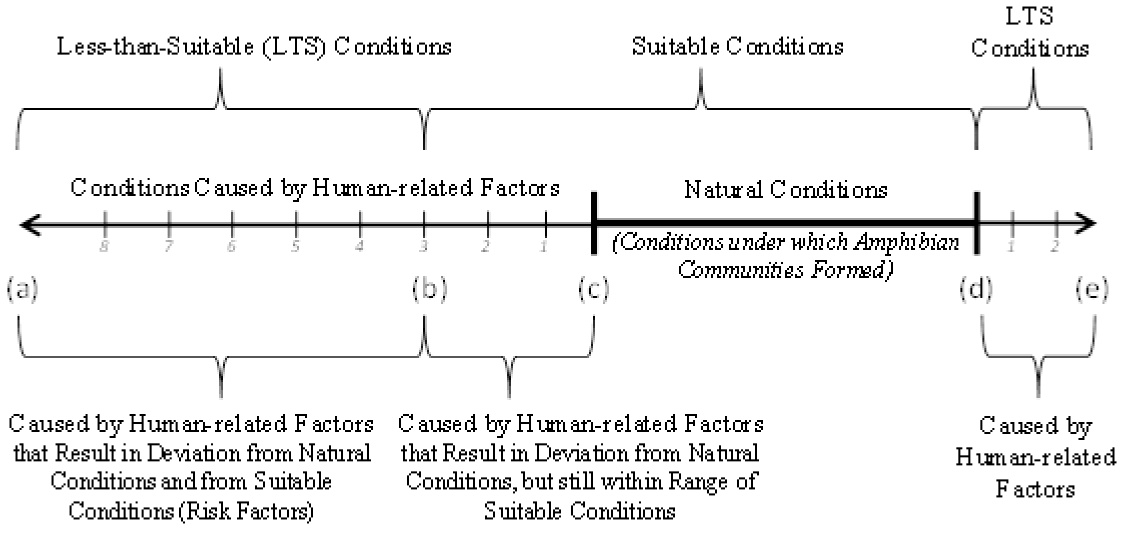


Figure 2. Conceptual illustration showing (1) the relationship between suitable conditions and less-than-suitable conditions in terms of natural conditions and altered conditions stemming from human-related factors, and (2) how “risk factors” relate to other human-caused factors that result in deviations from natural conditions.

A central question is how far down can the lower limit of habitat/survival conditions be drawn to accommodate recreational and commercial uses while still assuredly meeting Objective 3.3(a) and the Sensitive Species Management Standard? The basic concept of the approach was to start with estimated natural conditions and then determine whether there was sufficient information at each incrementally lower-quality condition (with incrementally lower-quality conditions depicted by numbered hatch marks when moving from “c” toward “a” and from “d” toward “e” in Figure 2) to demonstrate that the needs of spotted frogs and boreal toads would be met and, ultimately, that Objective 3.3(a) and the Sensitive Species Management Standard would be met. In other words was there sufficient information to demonstrate that conditions at “1” in Figure 2 would meet the needs of these species and, if so, was there sufficient information at “2,” and so forth. Where sufficient information was no longer available to demonstrate that their needs would adequately be met, the previously assessed condition category was identified as the lower limit to habitat suitability with respect to the given habitat/survival element. In Figure 2, “4” represents the first condition category in the progression that would not provide suitable conditions and, therefore, “3” represents the previously assessed condition category for which sufficient information existed to demonstrate the needs of spotted frogs and boreal toads would be met. Therefore, “3” represents the low end of the range of suitable conditions (as represented by “b). Where sufficient numeric information existed, the lower limit was identified numerically.

Another option was to start the assessment at existing conditions with ongoing activities, and assume the conditions are suitable unless there is local data showing that spotted frog or boreal toad populations had declined due to the activities or are declining due to the activities. However, treating existing conditions as default suitable conditions until proven otherwise has no basis in policy, ecological and wildlife conservation principles, and the current status of spotted frogs and boreal toads (e.g., NSS3 (Bb) and NSS1 (Aa) ratings at the state level, and sensitive species status in Region 4 of the Forest Service). Where an argument is made that no changes to existing management are needed until it can be demonstrated that existing management has reduced or is reducing spotted frog or boreal toad populations, the approach generally equates to the approach characterized earlier in this paragraph. This approach was not used in this report.

Two important points are as follows. Low-end thresholds represent the low end of a range of suitable conditions, and (1) management that allows a low-end threshold to be routinely hit across large portions of the range of spotted frogs and boreal toads for a given habitat/survival element has the potential to negatively affect these species; and (2) hitting low-end thresholds of several habitat/survival elements in a given area has the potential to negatively affect spotted frogs and boreal toads in that area.

A danger in carrying out this step without assessing all other wildlife species is that the bounds of suitable conditions can be expanded to the point that habitat conditions are no longer suitable for a wide range of wildlife species. This would only be recognized if a much wider range of species was assessed.

The intent of this step (subsection) for each habitat/survival element was not to identify limitations to achieving suitable conditions (a-b in Figure 2), as this is covered in the “Risk Factors and Restoration Factors” sections. Risk factors, as used in this report, refer to factors that have the potential to move conditions outside the range of suitable conditions.

e. ***Suitable Condition Statements —*** The last step is to succinctly capture the suitable conditions developed in the previous four steps. Management direction and supporting scientific information typically are not cited in this section for each habitat/survival element, as this information is presented in the four steps (subsections) leading up to the suitable condition statements.

The subsection, “Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements,” was included to identify the relationship with other suitable condition statements, especially with respect to those that support the attainment of suitable conditions for the habitat/survival element being addressed.

Alternatives to using Estimated Natural Conditions as a Starting Point

New planning guidance in WO Amendment 1909.12-2015-1 (section 12.14a) lists several alternatives to using the natural range of variability as a starting point for assessing ecological integrity in some situations, such as where “…there is not enough information to understand the natural range of variation under past disturbance regimes for selected key ecosystem characteristics or the system is no longer capable of sustaining key ecosystem characteristics identified as common in the past based upon likely future environmental conditions.” This guidance was developed and approved after the process of defining suitable conditions had been completed for spotted frogs and boreal toads on the BTNF, but it is worthwhile presenting this information given concerns by some entities about the scientific information used in the process (see next section).

The guidance continued by stating that the ecological reference model may include the following factors. After each factor is identified, a short discussion is provided on whether it would be worth at this point .

1. Representativeness. This appears to be similar to estimated conditions and natural range of variability. The planning guidance defined representativeness as “The presence of a full array of ecosystem types and successional states, based on the physical environment and characteristic disturbance processes” (WO Amendment 1909.12-2015-1, zero code, section 5).

2. Effects of stressors on the integrity of ecosystems in terms of composition, structure, function, and connectivity. Sufficient information was found to estimate natural conditions, such that there would have been no need to take this approach as a replacement for estimating natural conditions. However, effects of stressors on the integrity of ecosytems were considered in the process of defining suitable conditions for spotted frogs and boreal toads, as the process was iterative.

3. Redundancy. Sufficient information was found to estimate natural conditions, such that there would have been no need to take this approach as a replacement for estimating natural conditions. This was was not directly addressed in the report, but it has relevance given the importance of addressing multiple stressors in conserving amphibians.

4. Habitat associations of particular species or species groups with different home ranges, migration patterns, and/or habitat affinities. Sufficient information was found to estimate natural conditions, such that there would have been no need to take this approach as a replacement for estimating natural conditions. Furthermore, there is more known about natural conditions of habitat used by spotted frogs and boreal toads than specific habitat conditions for these species. Furthermore, habitat associations of spotted frogs and boreal toads were considered as part of the fine-filter phase.

5. Existing biotic integrity, using biological or ecological indices. Sufficient information was found to estimate natural conditions for this reporr, such that there was no need to take this approach as a replacement for estimating natural conditions. Also, gaps between estimated natural conditions and existing condition typically represent resource problems, stressors, and/or deviations from the conditions under which native wildlife-communities developed (e.g., Noss and Cooperider 1994, Hunter 1996, Aplet and Keeton 1999, Everett and Lehmkuhl 1999, section 92.13 of WO Amendment 2209.13-2005-10), meaning that designation of existing conditions as the foundation of suitable conditions would build-in these resource problems and short-comings. Where there are gaps between estimated natural conditions and existing conditions in amphibian habitat, available information shows there is a high potential for existing conditions in some situations (e.g., where roads, motorized use, nonnative fish, livestock grazing, and reservoirs exist or take place) to be negatively impacting spotted frogs and boreal toads (based on the large volume of scientific information cited throughout this report). Finally, there does not appear to be any scientific support for starting with existing conditions in the process of determining suitable conditions.

Haufler (1999a) noted there are several approaches to the coarse-filter approach, and described two of them: strategies based on habitat diversity and strategies based on historic range of variability. His first approach appears to align with the fourth listed approach, above, “Habitat associations of particular species or species groups…” This approach focues on providing “balanced” mixes of different habitats without giving any direction on what the mix should be, and it does not support the basic premise that the composition of native wildlife-communities depends upon the mixes that occurred when communities formed. The second is the approach described in the “b. Estimated Natural, Pre-Activity Conditions” subsection, above.

6. USE OF SCIENTIFIC INFORMATION

A relatively large number of comments received on the 01-09-2013 version of the report addressed the use of scientific information (Appendix D). Scientists with expertice in amphibian ecology expressed support for the approach used in the report (e.g., as outlined in the “Approach for Developing Objectives and Suitable Conditions Statements” sections in the 01-09-2013 version of the report) and they did not express any concerns about the way in which scientific information was used in the report. In contrast, entities concerned about potential effects of added amphibian protective measures on commercial activities expressed concern about the way in which scientific information was used, locations of cited scientific studies (e.g., regarding different climates, disturbances, and habitats), the way in which scientific studies were cited, and completeness of the “Literature Cited” section.

Given the interest in and the concerns surrounding the use of scientific information in the report, this section was expanded.

Framework for Using Scientific Information

In the process of developing suitable condition statements (see “5. Approach for Developing Suitable Condition Statements”) and identifying risk factors and potential conservation actions, scientific information was compiled and used generally in the following step-wise pattern, recognizing the process was iterative:

a. Estimated natural conditions of each habitat and survival element in Part II of the report (i.e., conditions between ‘c’ and ‘d’ of Figure 2 of the previous section) were documented and supporting scientific information was cited. For elements that are most directly affected by system drivers (e.g., mix of succession stages, stream channel integrity/streambank stability), Forest Service reports from the local area and central Rocky Mountains were heavily relied upon.

b. Next, scientific information was used to determine if conditions identified in ‘a’, above, needed to be expanded in order to satisfactorily meet the needs of spotted frogs or boreal toads. This is the fine-filter adjustments highlighted in the 2012 Planning Rule (USFS 2012). The only expansion beyond estimated natural conditions that was identified in this report was the possible creation of openings in shallow-water areas for tadpole development where extensive stands of dense emergent vegetation exist in spotted frog or boreal toad breeding habitat and where too few openings exist to provide for tadpole development. This likely only involves a very small proportion of breeding wetlands on the BTNF.

c. Then, scientific information was used to determine if range of defined suitable conditions could be further expanded beyond conditions identified in ‘a’ and ‘b’, above, in order to accommodate commercial activities, recreational activities, management actions, and associated facilities. This is illustrated as the area between ‘c’ and ‘d’ in Figure 2 in the previous section.

   Starting with estimated natural conditions, the bounds of suitable conditions were incrementally shifted outward as scientific information demonstrated that conditions were suitable. At the point at which scientific information did not strongly demonstrate that conditions were suitable, the previously-assessed condition (for which there presumably was strong evidence of suitable conditions) was identified as being a threshold of suitable conditions (see the “d. Deviations from Estimated Natural Conditions to Accommodate Other Uses” subsection of the “5. Approach for Developing Suitable Condition Statements” section, above).

   If there is insufficient scientific information to demonstrate that a given set of conditions is suitable, then it would not be scientifically defensible to conclude they are. As an example, several entities that commented on the 01-09-2013 version of the report assessed there is insufficient scientific information to define 70% retention of total herbaceous as the low-end threshold. If this were to be the case, the next highest retention level (80%) would need to be identified as the low-end threshold (assuming there is sufficient scientific information to support this). If 70% retention is not scientifically defensible, there obviously is no need to assess 60% retention.

This step (i.e., to determine if suitable conditions could be further expanded beyond conditions identified in ‘a’ and ‘b’ in order to accommodate commercial activities) was added to the process despite this not being identified as a step in the new guidance (January 2015) for implementing the 2012 Planning Rule, nor being a step in the coarse-filter / fine-filter approach as described in Haufler (1999a) and Haufler (1999b). Without this step, there is no mechanism for expanding the scope of suitable conditions beyond what is identified in ‘a’ and ‘b’, above.

There are several potential consequences of applying results of studies with low power and high alpha values in expanding conditions identified in ‘a’ and ‘b’ to accommodate commercial and recreational activities. Low power against committing Type II errors, combined with the identification of treatment effects only when it is very highly likely that treatment occurred (e.g., $p < 0.01$ or < 0.05), can readily result in no effects of activities (e.g., livestock grazing, timber harvest, motorized use) being detected when treatment effects actually occurred. As such, use of this type of information to define suitable conditions could result in thresholds being delineated somewhere between ‘a’ and ‘b’ of Figure 2. This in turn would result in management constraints not being stringent enough to prevent spotted frogs and boreal toads from being negative impacted.

Where existing conditions lie somewhere between ‘a’ and ‘c’ of Figure 2 (previous section) due in part to an ongoing commercial activity (e.g., livestock grazing), some reviewers of the 01-09-2013 version of the report (those concerned about potential effects of added amphibian protective measures on commercial activities) argued that local data needed to demonstrate that spotted frogs or boreal toads were being negatively impacted by the activity before concluding that existing conditions are outside the range of suitability. This would entail starting with existing conditions as the starting point instead of estimated natural conditions. This has little or no basis and is discussed further in the “Burden of Proof” subsection, below.

d. Scientific information was used to identify and examine factors that are negatively impacting spotted frogs or boreal toads on the BTNF and those that have the potential to do so. There is substantial overlap in the scientific information addressed in this phase and in ‘c’, above.

e. Scientific information was assessed in the process of identifying potential conservation actions. Where scientific information was used in the development or identification of potential conservation actions, it was cited.

Existing conditions were not examined in detail in this report, as the expectation is for this to be done on a project by project basis and in landscape scale assessments.

Use of Scientific Information from Other Disciplines and from Other Areas

Concerns were raised that scientific literature beyond the realms of amphibian ecology and management are cited in the report, and that scientific information from locations other than the BTNF and immediately surrounding area is used in the report (Appendix D). This section explains why information from other disciplines and other areas is used in the report, but why it is important in defining suitable conditions for habitat and survival elements.

Most scientific information cited in this report is cited in the “Development of Suitable Condition Statements” and “Risk Factors and Restoration Factors” sections for each of the major habitat and survival elements, and in Appendix A, which provides further detail on the basis of suitable conditions related to herbaceous retention and livestock grazing intensity.

There were not sufficient scientific studies on spotted frogs and boreal toads in the BTNF area, or even in the central Rocky Mountains, to define suitable conditions for any of the 15 habitat and survival elements (A.1 – A.6, B.1 – B.4, and C.1 – C.5). Scientific information on spotted frogs and boreal toads in the central Rocky Mountains was only available to define suitable conditions for specific aspects of some of the habitat and survival elements.

Use of Scientific Information from Disciplines other than Amphibian Conservation

Use of scientific information from a wide range of disciplines has been identified as central to wildlife management (Bailey 1984:6-8), biodiversity conservation (Hunter 1996:16-17), and range management (Holechek et al. 2011:6). Bailey (1984:7) explained it as follows:

> “Wildlife is a diverse resource. There are many species of vertebrates, even on small areas. Each species population is influenced by its behavior and physiology and by many factors of its environment: foods, weather, soils, predators, and land-use practices, for example. Wildlife management is the application of knowledge about wildlife and about all of these other factors. The principles of wildlife management include some that are specific to the profession and many that are shared with other professions and sciences (Fig. 1.1). Therefore, the education of a wildlife manager should include the study not only of wildlife biology and management, but also of basic sciences, such as chemistry and meteorology, and applied sciences related to land use, such as forestry, agriculture, and economics (King 1938a).”

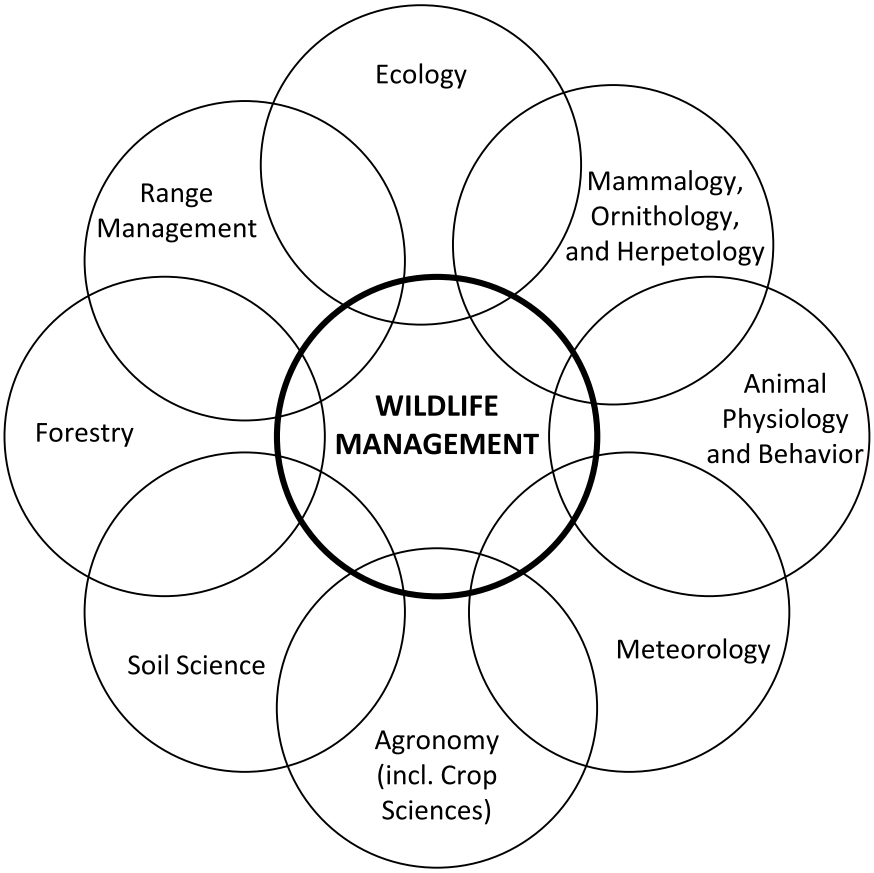


Figure 3. Adapted from Figure 1.1 of Bailey (1984:8). “The principles of wildlife management, portrayed by the central circle, include many concepts shared with several sciences and other professions, only a few of which are shown. Wildlife management requires application of an abundance and diversity of information and is one of the most complex occupations” (Bailey 1984:8).

Note the last sentence in Figure 1.1 of Bailey 1984:8): “Wildlife management requires application of an abundance and diversity of information and is one of the most complex occupations.” Bailey’s Figure 1.1 was modified and included as Figure 3. Others have made similar assessments. For example, the Texas A&M AgriLife Research webpage stated that “Wildlife Management… has become an integrated science using disciplines such as mathematics, chemistry, biology, ecology, climatology and geography to gain the best results” (http://agriliferesearch.tamu.edu/topics/natural-resources/wildlife-management/; accessed January 31, 2015).

Use of Scientific Studies from Areas beyond the BTNF and Central Rocky Mountains

Results of studies from areas with different climates and ecology were not applied directly to the definition of suitable conditions. Quantitative information on water chemistry, water depth patterns, emergent plant species composition, composition of tree size-classes, density and sizes of large woody material, livestock trampling levels, and other parameters from areas like the Sierra Nevada Range of California, Oregon, Missouri, Tennessee, British Columbia, and Australia were not directly applied to suitable condition statements on the BTNF. As an example, suitable shoreline conditions on the BTNF were not defined as a minimum 60% canopy cover of ≥2 ft. tall shoreline vegetation based on results of a study conducted in Tennessee (Burton et al. 2009).

This is because natural conditions in other types of ecosystems cannot be expected to represent conditions on the BTNF. One exception to this is that maximum concentrations of nitrogen (in various forms) were directly applied to suitable condition statements, recognizing that differences in water temperature, pH, and other variables can affect the degree of negative impacts on tadpoles. Another partial exception is the application of percent utilization and percent-reduction in Robel pole readings. This is treated as a "partial" example because figures used in the report are percentages and percentages from one locale can more readily be applied to another locale than absolute measures like plant height.

Instead, for a majority of studies cited in the report, individual aspects of research results from other areas were used to support or formulate basic ecological principles that were applied to the development of suitable condition statements, rather than applying measures or numbers from other locations to suitable condition statements. Study results from a wide range of areas were examined to tweeze out and characterize patterns. In general, results of studies from other areas were indirectly applied to the definition of suitable conditions and identification of risk factors through the examination of things like (1) the general importance of moist or humid habitat or microsites (without application of any specific densities of microsites needed) and consequences of not having sufficient moist/humid microsites; (2) the importance of non-forested or early-seral habitat without enumerating proportions of non-forest to forest vegetation; (3) the importance of high water quality to tadpole survival and consequences of dimished water quality; (4) importance of beaver ponds and aspen to support beaver ponds in steeper gradients without using studies from other areas to identify desired beaver pond densities across the landscape; (5) relationships between specific habitat components (ground-level humidity, shade, hiding cover, invertebrate habitat) and proportional changes in vegetation structure, and consequences of insufficient vegetation structure, without application of numeric measures to suitable conditions; and (6) relationships between mortality rates (e.g., caused by motorized vehicles, livestock trampling) and different intensities of these uses.

Another important consideration in applying research from other areas is, the more that similar results are found in different environmental conditions (e.g., different states, countries) and from a range of approaches and by different disciplines (e.g., wildlife, range management, environmental protection, crop sciences, hydrology), the greater the confidence in those principles and patterns derived from them.

Examples of How Scientific Information from Other Disciplines and From Other Areas was Used

The scope of references used in analyses in this report was limited to amphibian-related documents when directly identifying known aspects of suitable conditions and risk factors. However, where documents on amphibian literature did not identify specific aspects of amphibian habitat or risk factor that needed to be addressed in the report, other sources were searched for the information. The following examples should help clarify the use of scientific information from other disciplines and from other locations:

a. Streambank stability and streamchannel integrity are critical for sustaining suitable habitat for spotted frogs and spotted frogs in riparian areas (see the "Distribution and Amount of Wet/Moist Riparian Habitat" section in Part II). None of the scientific studies examining relationships between streambank stability, stream channel integrity, and estimated natural riparian habitat were conducted by amphibian scientists. A large number of studies have been conducted by riparian scientists and hydrologists (only a small number were cited in the "Distribution and Amount of Wet/Moist Riparian Habitat" section), and it would be irresponsible to not use this information in developing suitable condition statements and identifying risks in riparian areas merely because it was not conducted by amphibian scientists or as part of studies involving amphibian habitat or ecology.

b. Spotted frogs and boreal toads require moist or humid conditions (supported by amphibian-related literature cited in the report), but amphibian-related literature does not define the amount of herbaceous canopy cover needed to maintain suitable near-ground humidity under environmental conditions occurring on the BTNF (or anywhere else), nor does it address the mechanics of how herbaceous vegetation traps humidity below their canopies and how changes in canopy cover affect humidity retention at ground level. Crop science was the only source of information that was located in searches for information. While specific measures of near-ground humidity and temperatures in soybean and cereal crops differ from that of mountain meadows in western Wyoming, the basic relationships and principles summarized in this report (e.g., wind speed in herbaceous vegetation is lowest at ground level, ground-level humidity is highest where percent canopy cover of herbaceous vegetation is highest, and ground-level humidity levels decline as percent canopy cover of herbaceous vegetation declines) apply regardless of the type of habitat and regardless of location.

No attempts were made to define suitable ground-level humidity levels or mid-day temperatures for spotted frogs or boreal toads in meadows based on scientific information obtained in soybean and cereal crops in other states. In fact, no attempt was made to quantify suitable ground-level humidity levels or mid-day temperatures for meadows.

d. Concern was raised about the application of study results of Schmutzer et al. (2008) and Burton et al. (2009) to the BTNF since these studies were conducted in Tennessee where wetland conditions and processes are quite different than that of western Wyoming (comments by Sublette County Conservation District and the Ecosystem Research Group, Appendix D). This would be a valid concern if attempts were made in the report to directly apply measures of water quality, egg-mass densities, emergent or shoreline vegetation height, vegetation structure, or tadpole abundance to suitable condition statements or objectives for the BTNF.

   However, although the studies were conducted in an ecosystem that is different than wetland systems in the intermountain West, many mechanisms by which livestock grazing affects frogs and toads are similar, for example: urination and defecation altered water quality (e.g., increases in nitrate, ammonium), reductions in the height and structure of herbaceous vegetation reduced hiding cover, reductions in emergent vegetation reduced the forage base for tadpoles, and walking cows had the potential to crush tadpoles, metamorphs, and adults. Results of the studies also provided further demonstration that, as livestock grazing intensities increase, there is an increase in the potential for tadpoles and metamorphs to be impacted by such things as reduced water quality, reductions in hiding cover, reductions in forage, and increased trampling. Individual results of these studies were able to inform the development of suitable condition statements by providing additional information on relationships between herbaceous retention/livestock grazing intensity and parameters like water quality, hiding cover, tadpole forage, tadpole diversity, and abundance of individual species.

   Given the small number of studies that have examined the effects of livestock grazing on frogs and toads, Schmutzer et al. (2008) and Burton et al. (2009) add substantively to the information available to assessing cause-and-effects relationships between livestock grazing and frog/toad breeding and survival. It is noteworthy that results of Schmutzer et al. (2008) and Burton et al. (2009) for frogs appear to be consistent with findings of Munger et al. (1994), Munger et al. (1996), and possibly Bull and Hayes (2001) which were conducted on spotted frogs in southeastern Idaho and Oregon.

e. Similar concerns were raised about using results of studies by Rittenhouse et al. (2008) and Semlitsch et al. (2008) since they were conducted in Missouri where ecosystems are quite different than those of western Wyoming (Appendix D). Again, specific (numeric) densities of large woody material / brush piles, size classes of logs, ground-surface temperatures, and sizes of clearcuts were not directly applied to defining suitable conditions for these parameters on the BTNF. The studies support basic relationships such as desiccation and mortality rates being higher in clearcuts without large woody material or brush piles than in clearcuts with an abundance of large woody material or brush piles. Also, the point was made that, while ambient temperatures are higher in the Missouri study site, ambient humidity and soil moisture are higher in Missouri (given an average of about 17 inches of rain from March through May) than it is on the BTNF, which could make large woody material in clearcuts more important on the BTNF.

   While there clearly are differences between the ecology of amphibians using forests in Missouri and amphibians using forests in western Wyoming and while ambient temperature/humidity combinations differ, mechanisms of effects are similar. As pointed out by Semlitsch et al. (2009), "…because all the basic needs of amphibians (e.g., food, shelter) usually require movement overland, every aspect of their lives in the terrestrial environment is affected by water loss." This applies in Wyoming just as it does in Missouri, and likely more so. Not only is this intuitive given the need for moist microsites in otherwise dry environments (clearcuts without large woody material), it is supported by studies conducted adjacent to the BTNF on the Caribou-Targhee National Forest (Bartelt et al. 2004) and studies cited by Wind and Dupuis (2002), which was highlighted by ERG as showing that timber harvest is compatible with conserving boreal toads. Wind and Dupuis (2002) recognized the importance of moist microsites and to mitigating timber harvest accordingly.

Similarly, Semlitsch et al. (2009:857) attributed the strong results for clearcut units to the alteration of "…the fundamental structure of forests by removing the canopy and exposing the forest floor to more sunlight and wind, leading to warmer, drier surface microclimate…" Bartelt et al. (2004) characterized this basic principle in nearly the same way, based on results of their study on boreal toads on the Caribou-Targhee National Forest.

f. Two concerns were raised about citing results of Dumas (1964). One commentor expressed concern about it being a laboratory study and another felt that temperatures are not comparable on the BTNF (Appendix D). There are two issues involved here. The first is that results of Dumas (1964) were applied to characterizing basic relationships between spotted frogs and their environment, but temperatures and humidity levels identified in the study were not incorporated into suitable condition statements. Dumas (1964) found that a relative humidity of 65% at 78 ºF (25 ºC) is lethal to spotted frogs. The main point of citing this information in the report was not so much to identify a specific threshold but rather to highlight one of the most basic characteristics of of amphibians in general and frogs in particular: bodies of frogs have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist. This makes them susceptible to environments with low ambient humidity, and this is exacerbated as temperatures rise.

   Second, the temperature identified in Dumas (1964) is applicable to the BTNF, although ambient humidity levels can be substantially lower than 65% on the BTNF, meaning that conditions can be more extreme than identified in Dumas (1964). Daytime ambient humidity in open country at lower elevations of the BTNF during late June through early September can range widely, depending on specific location and weather conditions, but is substantially less than 50% on most days, with humidity as low 20% or lower not being uncommon. Maximum daytime late-June through early September temperatures at NRCS weather stations on the BTNF between about 7,000 and 8,500 feet typically range from the low 70s to the mid 80s (NRCS temperature data for Hams Fork, Snider Basin, Base Camp, and Loomis Park SNOTEL sites; expressed in ºF). About 72% of spotted frog breeding sites occur between 7,000 and 8,500 feet in elevation or lower.

   It was not clear in Dumas (1964) whether results were obtained in a field setting or in a laboratory. Even if results were obtained in a lab, this does not make the information any less applicable. The purpose of wildlife-related laboratory studies is to apply them to field situations. The effects of relatively low humidity levels (at a particular temperature) on spotted frogs in a lab setting are applicable to field conditions because lab settings can isolate effects (e.g., effects of relatively low humidity) better than can be done in field settings.

Upshot — Why a Small Number of Scientific Studies on Spotted Frogs and Boreal Toads in the Central Rocky Mountains did not Limit the Process of Defining Suitable Conditions

There are four main reasons why a relatively small number of scientific studies on spotted frogs and boreal toads in the BTNF area and central Rocky Mountains did not limit the process of defining suitable conditions for these species:

a. The starting point for the process of defining suitable conditions and developing objectives for spotted frogs and boreal toads was the estimation of natural conditions (just as outlined in section 12.14 of WO

Amendment 1909.12-2015-1, and as illustrated in Figure 2 as ‘c’ through ‘d’), which does not require or make use of studies on specific wildlife species (Columbian spotted frogs and boreal toads in this case). A large volume of scientific information exists to estimate these conditions and, to the extent possible, Forest Service reports from the BTNF and geographic area surrounding the BTNF were relied upon.

Scientific information on spotted frogs and boreal toads is only needed to expand suitable condition statements beyond estimated natural conditions (i.e., to the left of ‘c’ and to the right of ‘d’ in Figure 2), and this is only done (i) where estimated natural conditions would not satisfactorily meet the needs of these species, or (ii) to accommodate commercial and recreational activities to the extent it can be demonstrated the “expanded conditions” still provide suitable conditions for spotted frogs and boreal toads. Where insufficient scientific information exists to expand statements of suitable conditions beyond estimated natural conditions, regardless of the purpose (“i" or “ii,” above), the only repercussion is that the scope of suitable condition statements is not expanded. Because natural conditions are the conditions under which the amphibian community developed in the BTNF area, the risks posed by not expanding the scope of suitable conditions is low. With respect to expanding conditions to accommodate commercial and recreational activities, the burden of proof is on demonstrating, with scientific information, that the “expanded conditions” still provide suitable conditions (including protection from parts of activities that increase direct mortality) for spotted frogs and boreal toads. In Figure 2, ‘b’ through ‘c’ represents expanded conditions that were demonstrated to still provide suitable conditions. Again, therefore, scientific information is only needed to the extent there is a need to expand suitable condition statements beyond natural conditions.

This is discussed further in the “5. Approach for Developing Suitable Condition Statements” and “Framework for Using Scientific Information” sections above, and the “Burden of Proof” subsection, below. The coarse-filter / fine-filter approach fits well with situations in which limited information exists on specific aspects of habitat conditions for particular wildlife species.

b. There is a large volume of scientific information on spotted frogs, boreal toads, and related species throughout their ranges (not just from the BTNF area and central Rocky Mountains), on specific aspects of their habitat including biological relationships, and on factors affecting their survival (see the “Use of Scientific Information from Other Disciplines and from Other Areas” section, above. Results of studies from other areas can be applied to the BTNF, taking care to recognize differences in climatic conditions, ecosystem functioning, and disturbance processes.

c. There is a large volume of scientific information from a wide range of disciplines (e.g., wetland sciences, hydrology, range science, crop science, water quality; Figure 3) from a wide range of locations and laboratories that can be used to better understand specific relationships, patterns, and processes that affect or make up suitable habitat conditions.

d. Results of studies on spotted frogs and boreal toads in the BTNF area and central Rocky Mountains are similar to results found in studies in other areas, and the large volume of scientific information identified above mostly verifies and provides greater explanation to results of studies conducted in the BTNF area and central Rocky Mountains.

Absence of Evidence of Effects is not Evidence of Absence of Effects

One line of reasoning put forth by proponents of commercial activities like livestock grazing and timber harvest is that, because there is no monitoring data demonstrating that spotted frogs or boreal toads have declined in abundance on the BTNF or parts of the BTNF and because there is no data collected on the BTNF showing that commercial activities or facilities are responsible for any declines, there is no reason to define suitable conditions outside the scope of existing conditions, to change ongoing management (e.g., livestock grazing), or to place limits on proposed new activities to protect these species (Appendix D).

> “Absence of evidence is not evidence of absence.”
>
> *(Carl Sagan, Astronomer)*

This line of reasoning is indefensible because the absence of data showing a negative population trend has no meaning when there currently are no estimates of population trends (i.e., no data to demonstrate a downward, stable, or upward trend). It is especially indefensible given the preponderance of information showing there to be a high probability that the distribution and abundance of spotted frogs and boreal toads have declined on the BTNF, including historic breeding sites no longer being used by these species and the large amount of scientific information showing that spotted frogs and boreal toads are negatively affected by a range of commercial activities where herbaceous retention levels are too low or where grazing intensity is otherwise too high (e.g., due to reduced water quality, elevated mortality due to trampling).

> “The basic approach, guided by USGS-ARMI, is to apply statistical methods using species presence-absence data to estimate the proportion of sampling units (catchments and sites) occupied by each amphibian species. Sampling and analysis were designed to provide inference about amphibian status and trends (Corn et al. 2005a). The decision to use presence-absence data, rather than population estimates, was based on both practical and biological reasons. Practically speaking, population estimates are difficult, expensive, and nearly impossible to apply with acceptable accuracy to small animals over large areas. Biologically, the highly variable nature of amphibian populations results in large yearly fluctuations, resulting in low power to detect change (Corn et al. 2005a). Occupancy, as an alternative to estimating abundance, has a long history of use in wildlife studies. It can reveal changes in species status over large areas and is thought to be appropriate for species with wide, short-term population fluctuations (Bailey and Adams 2005).” (Patla et al. 2008; see this publication for citations)

Also, the framework of monitoring program on the BTNF newly established by W. Estes-Zumpf (Wyoming Natural Diversity Database), based on the USGS-ARMI approach outlined in Patla et al. (2008), will not allow population trends to be examined in relation to levels of livestock grazing. The monitoring program is a “mid-level” approach, designed by the USGS for the Amphibian Research and Monitoring Initiative, which is best for monitoring population changes of small animals across large areas (Patla et al. 2008). See text box for more detail. This approach is being used on Yellowstone National Park and Grand Teton National Park (both of which, by the way, have substantially higher funding for monitoring than the BTNF). Data collected using the “mid-level” approach is inadequate for answering questions at fine scale, for example, assessing effects of habitat changes on local populations (Patla et al. 2008). Answering these types of questions would require what they called “intensive research” at a relatively small number of select sites, recognizing that monitoring results likely would only apply to the sites that are monitored.

While there does not appear to be any population data definitively demonstrating that activities and developments on the BTNF (such as roads, motorized use, fish stocking, livestock grazing, and reservoirs) have negatively affected spotted frog or boreal toad populations on the BTNF, insufficient data exists on historic population levels, long-term population trends, habitat and survival elements of spotted frogs and boreal toads, distribution and levels of activities, and other influencing factors to evaluate this. Therefore, baseless is the argument that no changes are needed in current management and no mitigation measures are needed for future activities because no adverse effects of current retention levels have been identified.

Implications of Type I and Type II Errors

In the process of applying results of scientific research to suitable condition statements and identification of risk factors, biologists and resource managers need to be cognizant of implications of the degree to which Type I and Type II errors were addressed in statistical analyses of the research. The degree to which Type I and Type II errors were addressed has a direct bearing on whether results erred on the side of failing to reject the H_O of “no treatment effect” (by greatly minimizing the potential for a Type I error) or on the side of rejecting the null hypothesis (by minimizing the potential for a Type II error) (Snedecor and Cochran 1967, Finney 1972, Zar 1974, Kleinbaum and Kupper 1978). Minimizing Type I errors has come at the expense of an elevated probability of concluding “no treatment effect” when there actually was a treatment effect (Type II error). Where research results are applied directly to wildlife management in a multiple-use setting without taking into account their implications, minimizing Type I errors errs on the side of protecting activities while minimizing Type II errors errs on the side of protecting resources such as wildlife (Peterman 1990, Fairweather 1991, Steidl et al. 1997, Barrett and Raffensperger 1999, Fisher et al. 2006); this has particular implications when the wildlife species in question are designated as sensitive species.

Most scientific studies currently available in the published literature on the subjects addressed in this report set the null hypotheses as H_O of "no treatment effect," set alpha at low levels (e.g., <0.05, <0.01), and either did not address beta (power) or power was low. Many of the statistics textbooks prior to a decade ago emphasized minimizing Type I errors (Snedecor and Cochran 1967, Zar 1974, Kleinbaum and Kupper 1978). These factors combine to make it very difficult for the null hypotheses to be rejected (i.e., no treatment effects detected at the specified alpha level) (Finney 1972, Peterman 1990, Fairweather 1991, Steidl et al. 1997, Fisher et al. 2006). Most statistical analyses in the published literature were specifically designed to make it very difficult for researchers to reject the null hypothesis of "no treatment effect" and to conclude that a treatment effect occurred (Snedecor and Cochran 1967, Finney 1972, Zar 1974, Kleinbaum and Kupper 1978). Finney (1972:30-31), for example, explained that the null hypothesis of no effect is rejected only when the chance of erroneously concluding the occurrence of a treatment affect is very improbable. Statistical analyses typically have not minimized the potential of concluding "no treatment effects detected" when treatment effects actually occurred (i.e., minimizing Type II errors received little or no attention) (Peterman 1990, Fairweather 1991, Steidl et al. 1997, Barrett and Raffensperger 1999, Fisher et al. 2006). Thus, most published statistical analyses have erred on the side of <u>not</u> detecting treatment effects. Making it very difficult to reject the null hypothesis was an intentional part of the design in order for scientists to be able to place high confidence that treatment effects actually took whenever they conclude that treatment effects occurred. A central problem with respect to treatment effects on fish and wildlife, when power in statistical analyses was low or was not addressed, is that traditional statistical analyses have likely resulted in treatment effects (e.g., from livestock grazing, timber harvest, roads, motorized use) not being detected in many situations when negative impacts actually occurred (Finney 1972, Peterman 1990, Fairweather 1991, Steidl et al. 1997). Beyond failing to reject the null hypothesis (i.e., failure to detect treatment effects), some researchers erroneously have concluded that treatments did not affect the response variables they studied, which compounds the problem; technically, the most a scientist can conclude is that treatement effects were not detected.

Figure 2 can be used to illustrate implications to defining suitable conditions. The null hypothesis (H_O) of "no treatment effect" of an activity can be viewed as falling between 'b' and 'c' in Figure 2. This is because (a) treatment, with respect to resource management, typically entails an activity or facility of some sort, which places it between 'a' and 'c' or between 'd' and 'e'; and (b) the central tenent of the null hypothesis is that there is "no effect" of the activity and, in the absence of an effect on spotted frogs or boreal toads, this would mean conditions are suitable for these species. (So far, the discussion only involves hypotheses, not what actually took place in a study.) In studies in which alpha was set at a low level (e.g., <0.05, <0.01) and power was not addressed or was low, the stage is set to reject the null hypothesis (i.e., fail to detect treatment effects) unless there is considerable evidence to the contrary. In Figure 2, minimizing Type I errors means there is a very low potential of concluding that conditions are to the left of 'b' when they actually are not, and lack of attention to Type II errors (or low power) means there is potential of concluding that conditions are to the right of 'b' when they actually are not. Therefore, in terms of Figure 2, scientific studies err on the side of concluding there is insufficient evidence that conditions are actually to the left of 'b'.

This helps to highlight the difference between the burden of proof in scientific studies and the conservation of sensitive species. In contrast to the burden of proof outlined above for traditional scientific research, the burden of proof in meeting requirements for sensitive species on the BTNF is on having high confidence that conditions are to the left of 'b' in Figure 2 before concluding they are. This is the opposite of the burden of proof in traditional scientific studies, although increasing attention is being paid to power in scientific research. See the "Burden of Proof" section below for more discussion. Also, using scientific information that started with conditions between 'b' and 'c' in Figure 2 conflicts with the approach of starting with conditions between 'c' and 'd', or estimated natural conditions (as outlined in the "5. Approach for Developing Suitable Condition Statements" section).

In no way does this mean avoiding scientific studies with high alpha levels and low power. It only means that biologists and managers need to understand the way in which Type I and II errors were addressed in studies that are being applied to management issues, and how treatment of Type I and II errors affect the application of the results to management. For example, one or two scientific studies in which the null hypothesis of "no treatment effect" was *not* rejected provides no more than weak evidence that a given activity at the level in question *does not* adversely affect the studied species, unless the design included concerted effort to account for and reduce Type II errors. As explained by Howard and Munger (2003:11) in their study of spotted frogs in eastern Idaho, "The failure to reject a statistical null hypthosesis (H_O: no effect of grazing) should not lead to outright acceptance of that hypothesis (Parkhurst 1984)."

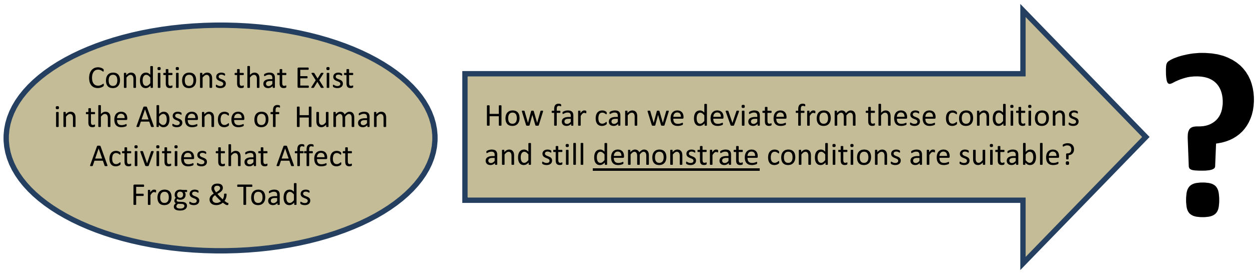
The follow exerpt from Steidl et al. (1997:278) further illustrates implications of Type I and II errors in the application of scientific research to wildlife management: "…in the Pacific Northwest, there is a question as to the amount of timber that can be harvested without adverse effects on songbird populations. A relevant null hypothesis might be that a particular level of timber harvest has no effect on the density of songbird populations. In this and similar instances, the null hypothesis might be stated as one of no effect. If an experiment with low statistical power is performed to test this hypothesis, the probability of rejecting the null hypothesis will be low, whether or not the true effect was biologically significant. If songbird populations were adversely affected by a certain level of timber harvest, but forests continued to be managed as if songbirds were not affected because of decisions based on low-power tests, then this Type II error could lead to population declines."

Also, the magnitude of the benefit or negative impact of a given management action needs to be considered in setting the alpha level (e.g., whether 0.01, 0.05, 0.10, 0.20) (Finney 1972). Finney (1972) provided several practical applications pertaining to agriculture. The following two examples are tailored from his examples. In a given hypothetical study on the effects of logging on elk, a p-value of 0.15 may indicate there is insufficient information to support a management finding that a given logging system would negatively affect elk, which are over-objective in this hypothetical example. On the other hand, a p-value of 0.15 in another hypothetical study on the effects of livestock grazing on spotted frogs may be sufficient to support a management finding that livestock grazing at the studied utilization level would detrimentally affect spotted frogs, which is a sensitive species. A more cautious approach is warranted given the sensitive species status of spotted frogs compared to an overabundant species like elk, in these hypothetical examples.

Burden of Proof

Discussion of the burden of proof was limited in the 01-09-2013 version of the report, was expanded somewhat in the 09-26-2014 version of the report, and it was expanded still further in this version of the report (1) due to some people being unaware of or resistant to Forest Service biologists having to demonstrate that a certain set of conditions (conditions resulting from a given proposed action) are suitable before making an affirmiative declaration that they are suitable, and (2) more published literature being found on the subject.

For the purposes of this report, the burden of proof — with respect to defining suitable conditions for spotted frogs and boreal toads when dealing with habitat and survival elements that are affected by human activities — is on demonstrating that deviations from conditions without human-related activities (e.g., absence of roads, motorized use, livestock grazing, fire suppression) to conditions with some specified maximum level of a given activities (or activities) will still be suitable (or, minimum level with respect to activities like fire suppression):



For the purposes of this report, the burden of proof — with respect to determining whether a given proposed action (including continued management of an activity at current levels) meets Forest Plan requirements for spotted frogs and boreal toads — is on demonstrating that suitable conditions, including adequate protection, will be maintained or restored for spotted frogs and boreal toads at the proposed level of management. This has been standard practice in evaluating activities like logging and vegetation treatments in forestland on sensitive species like goshawks and threatened species like lynx; the onus has been on demonstrating that requirements can be met while implementing a proposed logging or treatment project before implementing the project. This has not necessarily been the case with the management of activities like ongoing livestock grazing; the onus has tended to be on biologists to demonstrate impacts on wildlife populations before changes are made to current management in order to mitigate impacts to the species.

The basis for (1) placing the burden of proof on affirmatively demonstrating that a given set of conditions is suitable before declaring they are suitable conditions and (2) placing the burden of proof on demonstrating that suitable conditions will be maintained before declaring that a given proposed action meets sensitive species requirements is summarized below:

a. Spotted frogs and boreal toads are USFS Region 4 sensitive species, the U.S. Fish and Wildlife Service is assessing whether to list the eastern clade of boreal toads as threatened (or endangered), both species are listed as Species of Greatest Conservation Concern by the State of Wyoming, and WNDD ranked them as vulnerable and critically imperiled, respectively. Even if the U.S. Fish and Wildlife Service does not list the portion of the boreal toad population that exists in the BTNF, the fact they are reviewing the species for listing demonstrates the concern about past and future reductions in distribution and abundance of this species.

b. A large volume of scientific information demonstrates there to be substantive potential for a wide range of human activities and developments on the BTNF (e.g., motorized routes and motorized use, livestock grazing use, fish stocking, large reservoirs, spring developments, land conversion) to be negatively impacting spotted frogs and boreal toads (see "Risk Factors and Restoration Factors" subsections in Part II of this report), particularly because these human activiteis and developments occur within spotted frog and boreal toad habitat. This scientific information and the overlap in distribution of human activities/ developments and sensitive amphibian habitat shows there to be a major risk in assuming 'no impacts unless local data shows otherwise,' particularly in situations in which there is little or no local data available to make this assessment.

c. The Forest Service has affirmative requirements to protect sensitive species, provide an adequate amount of suitable habitat, and to ensure activities do not (1) cause long-term or further declines in populations or habitat or (2) trends toward federal listing (Forest Plan Objective 3.3(a), Sensitive Species Management Standard, FSM 2670.22.1, and ultimately the National Forest Management Act). The agency is not required — before implementing changes to an activity or before implementing a conservation measure to protect a sensitive species or provide suitable habitat — to demonstrate the species is being negatively impacted by the activity. The burden of proof is not on the agency to demonstrate a given activity is inhibiting the provision of suitable habitat for a sensitive species or is contributing to a downward trend in the population before changing management of the activity. This would err on the side of the activity and, especially given the low level of information available on most sensitive species, this would give the activity higher standing than meeting sensitive species requirements.

   The same is true of defining suitable conditions. Because the Forest Service has affirmative responsibilities for providing suitable conditions for sensitive species, as summarized above, the agency has affirmative requirements for *defining* suitable conditions for sensitive species. This means that biologists must be able to demonstrate with scientific information that a certain set of conditions are suitable before they are deemed suitable. If a biologist cannot demonstrate a certain set of conditions are suitable, then they cannot be deemed suitable, and concluding the conditions are suitable would not be supportable by available information. Therefore, the Forest Service cannot take the approach of declaring that existing conditions are suitable for a given sensitive species unless local monitoring data demonstrates that the species' population has declined or is declining as a consequence of these conditions, particularly given the limited data available. Starting the process of defining suitable conditions by estimating the conditions under which the amphibian community formed in this area provides a much more defensible alternative to starting with existing conditions.

Also, to the extent that wildlife are emphasized over recreational or commercial activities in a given DFC area, conflicts between the needs of sensitive species and an activity need to be resolved in favor of the sensitive species (USFS 1990b:93, 145)[C]. More specifically, if in these DFCs there is a conflict between a commercial activity and a wildlife habitat objective that stepped-down from a Forest Plan objective and that is supported by a reasonable analysis of available scientific and natural history information — even if it lacks definitive "scientific proof" — the burden of proof is on demonstrating that the adjusted desired condition statement or objective (adjusted to better accommodate the activity) still meets desired conditions defined by Forest Plan objectives and higher-level direction since there is an affirmative requirement to meet Forest Plan objectives. This is particularly important for sensitive species, and any elevated status of sensitive species in other DFC areas needs to be considered.

d. Estimated natural conditions or pre-activity conditions (i.e., absence of commercial and recreational activities that have potential to impact spotted frogs and boreal toads) is the most logical and defensible starting point for defining suitable conditions for reasons outlined in the "Upshot…" subsection and "5. Approach for Developing Suitable Condition Statements" section, above.

e. This approach is consistent with a growing body of ecological and wildlife/fisheries management literature (Peterman 1990, Steidl et al. 1997, Fairweather 1991, Barrett and Raffensperger 1999, Fisher et al. 2006, Walshe 2007). These authors argued that the burden of proof, especially when dealing with resources of concern, should be on proponents of a given activity to demonstrate with high power that the activity does not have a detrimental effect on wildlife populations before the activity is permitteed.

It is important to recognize the differences between the burden of proof as outlined above and the burden of proof in most published scientific studies cited in this report, and the implications of these differences in applying research results to the management of spotted frogs and boreal toad as sensitive species on the BTNF. Straight application of research results **—** particularly where alpha levels are low (e.g., <0.05, <0.01) and power is low, and where the null hypothesis is not rejected in studies on the effects of a commercial or recreational activity on spotted frogs or boreal toads **—**, without taking into account the difference in burden of proof, can result in (a) suitable condition statements encompassing conditions that are less-than-suitable and (b) definition of risk factors understating the actual effects of a given commercial or recreational activity. Understanding the differences in burden of proof can alleviate these problems. This is addressed in detail in the previous section, "Implications of Type I and Type II Errors."

Placing the burden of proof as outlined earlier in this section will help to mitigate the implications of applying results of scientific studies having low alpha levels and low power.

B. IDENTIFYING RISK FACTORS (STRESSORS) AND CONSERVATION ACTIONS TO CONSIDER

In addition to identifying suitable condition statements for spotted frogs and boreal toads, this report identifies risk factors that limit the achievement of suitable conditions and conservation actions to consider in the process of maintaining and attaining suitable conditions.

[C] On pages 93, the Forest Plan states "…some objectives conflict with others. Consequently, some objectives will not be met on all areas of the Bridger-Teton National Forest… The conflicts are resolved by application of the different Desired Future Conditions to different areas of the National Forest." On page 145, it states notes "That the DFCs exist at all is recognition that not all the Goals and Objectives can be achieved at the same time from the same land areas."

1. ROLE IN THE PLANNING-MANAGEMENT CYCLE

Identification of limiting factors is arguably one of the most important steps in conserving any given wildlife species or wildlife communities as a whole (Leopold 1933, Bailey 1984, Crowe 1992), recognizing that the definition of suitable or desired conditions is a critical step in being able to ascertain limiting factors. Of the total set of factors limiting given species or wildlife communities, the most important problems to address through management are the root causes of problems from which most or all other limiting factors stem (Coughlan and Armour 1992, Bryson 1995, DeLong 1995).

Risk factors, for the purposes of conservation assessments on the BTNF, are the factors that limit or have the potential to limit the attainment of Objective 3.3(a), Sensitive Species Management Standard, and other objectives for sensitive species by reducing or limiting the amount of suitable habitat or by reducing habitat effectiveness or survival (Figure 1). Another term increasingly being used is “stressor.” Stated in another way, risk factors created or have the potential to create gaps between existing and suitable conditions.

Risk factors along with suitable condition statements provide the focal points for developing conservation actions (Figures 1 and 2): (1) suitable condition statements provide the focal point for developing conservation actions for designing habitat treatment projects, and (2) both suitable condition statements and risk factors provide the focal points for mitigating potential negative effects of Forest Service actions. For any given factor (e.g., beaver distribution and abundance, livestock grazing, road density and placement), there is a risk side and there is a restoration side. The restoration side entails movement of particular factors toward relatively natural conditions, including management of activities like livestock grazing and facilities like roads to bring conditions back to inside the range of suitable conditions.

Risk factors were not used in the formulation of suitable condition statements because risk factors do not provide information on what comprise suitable conditions. However, the assessment of risk factors fed back into the process of defining suitable conditions by identifying the habitat/survival elements that are most at risk.

2. RISK FACTORS AND RESTORATION FACTORS

After identifying habitat elements that influence spotted frog and boreal toad populations on the BTNF (Figure 2), risk factors were identified by identifying historical and present-day human-related actions, activities, and facilities that have affected, currently are affecting, or that have the potential to negatively affect spotted frogs, boreal toads, or their habitat on the BTNF. This assessment was based on (a) a thorough review of the scientific literature to ascertain factors (e.g., commercial, recreational, and management activities and facilities; disease; climatic conditions) that can affect the distribution, reproductive success, survival, and abundance of spotted frogs and boreal toads; (b) local knowledge and information on the occurrence of commercial, recreational, and management activities and facilities within spotted frog and boreal toad habitat; (c) assessments of existing management controls that mitigate negative effects of commercial, recreational, and management activities and facilities.

Of the human-related factors that have caused or have the potential to cause deviations from natural conditions, risk factors are those that move conditions beyond the range of suitable conditions (Figure 2). If changes caused by human-related factors remain within the range of suitable conditions, the changes are not considered problems or risk factors.

Risk factors were identified in the report so that a list of conservation-actions-to-consider could be formulated, in contrast to determining limiting factors that have been demonstrated to impact spotted frogs and boreal toads in order to develop a coordinated and comprehensive strategy to restore habitat conditions and resolve or mitigate limiting factors on the BTNF (this report supports a conservation *assessment*). Nonetheless, however, all of the risk factors identified in the report specifically pertain to the BTNF, as all the commercial, recreational, and management activities and facilities examined in the report exist on the BTNF in places where they have potential impact spotted frogs and boreal toads. No risk factors were identified that are not supported by information showing potential for spotted frogs or boreal toad populations to be negatively affected on the BTNF.

The assessment of potential for risk on the BTNF is influenced and/or shown by the level of risk at a state-wide and regional levels, information demonstrating a lower (or higher) risk level on the BTNF, local data on a given component habitat or survival element where this is available, scientific information demonstrating impacts from a given activity or form of development, and management controls on the BTNF that prevent or sufficiently mitigate impacts. Despite limited or no cause-and-effect data available on the BTNF, it is likely that spotted frogs and boreal toads have been impacted by some or large number risk factors identified in this report, based on (a) state-wide and regional assessments of spotted frogs and boreal toads that indicate serious concerns about these species and lack of data showing otherwise on the BTNF; (b) a large and diverse volume of scientific literature demonstrates impacts of commercial, recreational, and management activities and facilities, disease, and climatic conditions, as outlined in the report; (c) commercial, recreational, and management activities and facilities occurring within frog and toad habitat on the BTNF; and (d) lack of management controls specifically aimed at avoiding or mitigating negative impacts of commercial, recreational, and management activities and facilities, and no data demonstrating that negative impacts are otherwise being sufficiently mitigated. This is a particularly important point given the Forest Service sensitive species status of both species, the conservation status of both species in the State of Wyoming, and consideration being given to protection of the boreal toad under the Endangered Species Act.

A subsection entitled “3. Status with Respect to Risk Factors on the BTNF” is included in the “D. Status and Natural History Information” section, below, summarizes risk factors and how they may be affecting the distribution, abundance, and population trends on the BTNF.

3. CONSERVATION ACTIONS TO CONSIDER

The conservation actions to consider were based on suitable condition statements (i.e., where we want to be) and risk factors (i.e., the things that limit getting there). Conservation actions are, by definition, “actions” or the how to’s for achieving and maintaining suitable conditions. Many of the conservation actions identified in this report were obtained from conservation assessments and conservation plans for spotted frogs and boreal toads and for amphibians in general, and other conservation actions were obtained from scientific literature.

The first objective for sensitive species in FSM 2670.22 (WO Amendment 2600-2005-1) is to “Develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions.” National policy requires the agency to “Avoid or minimize impacts to species whose viability has been identified as a concern [i.e., sensitive species].”

C. MULTIPLE STRESSORS AND VIABILITY

In the process of assessing risk factors and identifying management actions to conserve amphibians at global down through local geographic scales, increasing attention during the last ten years has been given to the realities that (1) amphibians are typically not impacted solely by one or two stressors, but rather are being impacted by multiple stressors some of which may interact synergistically; and (2) the negative impacts of major factors like introduced diseases can be compounded where a range of other stressors are already operating (Lefcort et al. 1998, Hatch and Blaustein 2000, Maxell 2000, Canadian Forest Service 2003, Collins and Storfor 2003, Corn 2003, Rohr et al. 2004, Sih et al. 2004, Smith and Green 2005, Halliday 2005, Boone et al. 2007, Davidson and Knapp 2007, Bancroft et al. 2008, Chen et al. 2008, Groner 2012, Salice 2012, Reeve et al. 2013).

This section provides a fairly cursory assessment of the topics of multiple stressors, metapopulations, and viability. Although they are not addressed in detail, discussions were incorporated into this report because they are highly relevant and important to the conservation of spotted frogs and boreal toads and to the achievement of Forest Plan Objective 3.3(a) and requirements of NFMA with respect to these two species.

1. MULTIPLE STRESSORS

Adequately accounting for and addressing multiple stressors will be critical in any successful efforts to achieve the Forest Plan Objective to (1) "Protect [Region 4] sensitive plant and animal species and provide suitable and adequate amounts of habitat to ensure that activities do not cause: [a] long-term or further decline in population numbers or habitats supporting these populations; and, [b] trends toward federal listing" with respect to spotted frogs and boreal toads, (2) sustain viable populations of spotted frogs and boreal toads on the BTNF, and, more so, (3) one of the intents of the 2012 Planning Rule is to "keep common native species common." Compared to the 1982 Planning Rule, the 2012 Planning Rule places much greater emphasis on identifying and addressing stressors, including as part of maintaining viable population levels (USFS 2012). The 2012 Planning Rule defines a viable population as "A population of a species that continues to persist over the long term with sufficient distribution *to be resilient and adaptable to stressors* and likely future environments" emphasis added (USFS 2012 § 219.19). This could not have been written more appropriately for spotted frogs and boreal toads. The planning rule recognizes that new information continue to emerge on subjects like stressors and encourages the agency to review and integrate this information into plans, and it calls for the agency to use the best available scientific information when applying the definition to management (USFS 2012:21217). It recognizes the agency cannot completely control or mitigate some stressors, but the planning rule does require the agency to identify and evaluate existing information on system drivers such as stressors (USFS 2012:21263, § 219.6(b)(3)), particularly when planning for multiple uses (§ 219.10(a)(8)). The Federal Register notice also stated that "The Department's intent is to provide for the diversity of plant and animal communities, and keep common native species common… within Agency authority and the inherent capability of the land" (USFS 2012:21174). Both species were likely common on the BTNF prior to human-related alterations. Again, while the BTNF is not yet required to comply with the 2012 Planning Rule, this requirement is coming soon and the above direction is consistent with existing direction (e.g., FSM 2020).

Patla and Keinath 2005:57) summarized the situation well:

> "Columbia spotted frogs are further vulnerable to disturbance and stochastic environmental fluctuations leading to population declines due to their dependence on specific habitat patches for survival and reproduction, and demographic factors including high variability in annual recruitment rates, long time period to reach reproductive age (four years in males and five to six years in females for some populations), tendency of females to breed every other year or less, and the likelihood that some populations act as "sinks", sustaining annual or intermittent breeding efforts but producing few if any recruits. Other characteristics that make spotted frogs vulnerable to declines are their attractiveness as prey for a large number of animals, and the potential for mass mortality due to disease outbreaks or habitat catastrophes when frogs are congregated at breeding or wintering sites. Exceptionally high rates of dispersal by juveniles suggests that isolation of populations through habitat fragmentation (e.g., roads, clear-cutting, and urbanization) may increase local extinction rates (Funk et al. 2005). In the event of repeated reproductive failures (which may be common in the highly variable conditions of mountain environments), high levels of adult mortality (or simply reaching the limits of longevity) will lead to local population extinctions within a decade or much shorter time frame if recolonization cannot occur. While spotted frogs have demonstrated an ability to travel long distances (e.g., 6 km), some historical or current populations may be beyond the range of "rescue" in the mountainous landscapes of Region 2, with natural isolation exacerbated by human-caused habitat fragmentation, drought, and non-native fish introduction."

The situation for boreal toads is similar (Maxell 2000, Loeffler et al. 2001, Carey et al. 2005, Hogrefe et al. 2005, Keinath and McGee 2005, Muths 2005).

An implication of introduced diseases, climate change, increases in UV-B radiation, and increases in atmospheric nitrogen is that the combination of other artificial factors directly affecting survival (e.g., crushing by vehicles and livestock) and habitat conditions at the local level need to be at a "more suitable" level than would be needed in the absence of introduced diseases, climate change, and increases in UV-B radiation.

Disease, Climate Change, UV Radiation, and Other Stressors

Literature reviews and conservation assessments identify disease as a major conservation concern for spotted frogs and boreal toads (e.g., Maxell 2000, Wind and Dupuis 2002, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, USFWS 2011) and disease appears to be a major contributor to the current status of spotted frogs and boreal toads on the BTNF (Patla 2001, Pilliod et al. 2010, Corn et al. 2011). Of particular concern at present are non-endemic diseases like chytrid fungus and ranavirus that are highly infectious and can have severe adverse impacts on amphibian populations (Voyles et al. 2009, Padgett-Flohr and Hopkins 2010, Pilliod et al. 2010). If chytrid fungus or ranavirus or one of the other highly infectious diseases are introduced into a population, it commonly has severe impacts on the population regardless of management actions that are taken to reduce the prevalence of the disease. Pilliod et al. (2010) found relatively high annual survival of uninfected adult toads (0.73-0.77) at all three locations they studied in Montana, Wyoming, and Colorado, and lower annual survival of adult toads at the Wyoming and Colorado sites infected with chytrid fungus (0.42 and 0.53, respectively, for Black Rock–BTNF and the Colorado site).

Climate change and increasing UV radiation are receiving increasing attention as a possible contributing factors to the decline of amphibian populations, including boreal toads (Hatch and Blaustein 2000, Blaustein and Beldon 2005, Reaser and Blaustein 2005, Muths 2005, Bancroft et al. 2008, McMenamin et al. 2008, Bull 2009). McMenamin et al. (2008:16988) documented that "…recent climate warming and resultant wetland desiccation are causing severe declines in 4 once-common amphibian species native to Yellowstone. Climate monitoring over 6 decades, remote sensing, and repeated surveys of 49 ponds indicate that decreasing annual precipitation and increasing temperatures during the warmest months of the year have significantly altered the landscape and local biological communities."

Reduced habitat conditions and other stressors have the potential to exacerbate the negative effects of disease on wildlife in general (Cleaveland et al. 2002). Cleaveland et al. (2002:139), for example, asserted that the effects of disease in wildlife populations already adversely affected by other factors (e.g., habitat loss and fragmentation) may be more pronounced, and that disease risks for wildlife are likely to increase "as contact with human and domestic animal populations become more frequent."

More specifically, reduced habitat conditions (e.g., as identified in elements A.1 through B.4 in Part II) and other stressors (e.g., as identified in elements C.1 through C.3 in Part II) have the potential to exacerbate or compound the negative effects of disease and climate change on amphibians (Cleaveland et al. 2002, Corn 2003, Forson and Storfer 2006, Gray et al. 2007, Bancroft et al. 2008, Gray et al. 2009, Gahl and Calhoun 2010, Groner 2012, Adams et al. 2013, Gallana et al. 2013, Reeve et al. 2013). Corn (2003:95) assessed that "Global change, land use change or alien species acting alone or together are among many environmental sources of stress that could increase disease susceptibility or virulence (Carey et al., 2003; Blaustein et al., 2003; Carey & Alexander, 2003)."

Even though Pilliod et al. (2010) and Muths et al. (2011) assessed that at least some populations of boreal toads infected with chitrid fungus have the potential to persist, this assessment did not take into account other artificial stressors and synergistic effects, especially in relation to small and/or isolated populations. The assessment by Muths et al. (2011) was based in part on higher recruitment levels at the infected site (Blackrock, Buffalo RD, BTNF) than at non-infected site (Denny Creek, Colorado), but it is not clear whether the sites had similar effects of stressors and why recruitment at the Denny Creek site was lower. Overall survival was lower at the infected site and the population was declining at an estimated 5-7% per year. If one or more stressors contributed to lower recruitment levels in infected populations (e.g., periodic large losses from crushing by vehicles or livestock), this could contribute to overall lower survival rates than found at the Blackrock site. Therefore, even a portion of mortality caused by disease to be compensatory, the potential remains high for one or more stressors, in combination with disease effects, to "tip the scales."

Adams et al. (2013:3) asserted that "Primary hypotheses to explain global amphibian declines are land use change, disease, global climate change, and interactions of these factors with each other or with other stressors like contaminants or habitat degradation [Collins and Crump 2009]." Gahl and Calhoun (2010:108) stated that "Many stressors have been implicated in creating an environment in which amphibians may be more vulnerable to infection: UV-B (Middleton et al. 2001; Blaustein et al. 2003), acidification (Beebee et al. 1990; Grant and Licht

1993), pollution and heavy metals (Beattie et al. 1992; Horne and Dunson 1995; Jung and Jagoe 1995), habitat destruction (Lehtinen et al. 1999; Brook et al. 2003), and climate change (Beattie et al. 1992; Alexander and Eischeid 2001; Carey and Alexander 2003; Bosch et a. 2006).” Reeve et al. (2013:1) explained that “Prolonged environmental stress is widely thought to suppress immune function, decreasing resistance to and increasing the severity of infectious disease, and thus elevating the risk of disease outbreaks (Pickering and Pottinger 1989; Sheridan et al. 1994). Stress has therefore been implicated as a driver of disease emergence in wildlife (Carey et al. 1999; Acevedo-Whitehouse and Duffus 2009; Martin et al. 2010).”

Sharp declines in populations at local to regional scales can occur fairly quickly and unpredictably in response to predictable/deterministic, stochastic, and as-yet-unknown stressors. Muths et al. (2003b) documented the sharp decline of a large local population of boreal toads in Colorado due to chytrid fungus; it was considered a large, robust population prior to 1999 and was near extinction by 2003. Patla and Keinath (2005:50) reported on an 80% decline in a spotted frog population which likely resulted from the construction of a road near the breeding site. Given all of the variables including synergistic effects which are just beginning to be studied, in conjunction with many questions remaining about the ecology of chitrid fungus, it is necessary at this point to conserve as many local populations as possible during this critical period. Smith and Green (2005) assessed that informed decision-making in the conservation of amphibians having metapopulations entails being able to understand and differentiate between the roles of stochastic and predictable/deterministic stressors such as when deciding whether to focus on local habitat conditions or landscape factors.

Implications of Natural Stressors

Even in the absence of the multitude of artificial stressors that currently affect boreal toads and spotted frogs, populations experienced high mortality rates at different stages in their life history (eggs, tadpoles, metamorphs, juvenile). Carey et al. (2005) identified a range of stressors that naturally impact boreal toads and that now limit recovery of populations reduced due to a range of artificial stressors, including chytrid fungus and climate change, on top of a host of natural stressors. Many of these are discussed in other documents as well (e.g., Keinath and McGee 2005, Patla and Keinath 2005).

Prior to population reductions during the last several decades, metapopulations of boreal toad and spotted frogs were large enough and productive enough, and metapopulations were close enough together for genetic interchange to offset the negative effects of these natural stressors such that boreal toads and spotted frogs remained common to abundant. However, with reduced population levels of metapopulations and larger distances between metapopulations, natural stressors are now compounding the impacts of artificial stressors (Carey et al. 2005). Natural stressors — depending on location, weather conditions, and year — include timing of snowmelt which affects the timing of breeding, cold water temperatures that limit egg and tadpole development, desiccation of breeding wetlands prior to metamorphosis, and high predation rates on tadpoles and metamorphs (Carey et al. 2005). Under natural conditions, breeding wetlands desiccate prior to metamorphosis is completed and cold water temperatures can limit egg and tadpole development to the point that tadpoles do not complete metamorphosis before freezing temperatures in the fall and then freezing kills many or all tadpoles. This can result in major die-offs of tadpoles. Again, however, a large number of spotted frogs and boreal toads were recruited into metapopulations frequently enough to sustain relatively large breeding populations and, where metapopulations either declined substantially or were extirpated, dispersal from adjoining metapopulations contributed to their recovery, in addition to exchange of genetic material.

Today, not only are there additional stressors impacting spotted frogs and boreal toads, some exacerbate the natural stressors listed in the previous paragraph. For example, drinking by livestock, water diversions, lowered water tables, and climate change increase the likelihood of breeding wetlands becoming desiccated prior to metamorphosis.

2. METAPOPULATIONS

The metapopulation concept (Marsh and Trenham 2001, Keinath and McGee 2005, Smith and Green 2005, Maschinski 2006) provides a useful framework for evaluating the potential effects of multiple stressors on spotted frogs and boreal toads on the BTNF, and this compliments the monitoring approach that is being implemented on the BTNF (see “Part III – Monitoring”). It is now widely recognized that breeding amphibians naturally disappear and reappear at individual breeding wetlands, that amphibians generally have low re-colonization capabilities, and that persistence of metapopulations of amphibians is important (Marsh and Trenham 2001, Smith and Green 2005, Patla et al. 2008). The potential for sharp declines at the metapopulation scale (previous subsection) is of concern on the BTNF given the apparent reduced distribution and abundance of spotted frogs and boreal toads on the BTNF, chytrid fungus and a range of multiple stressors acting on amphibians on the BTNF, and given the relatively low capability of these species to re-colonize. “The loss of local populations may influence the persistence of regional populations or metapopulations, even in cases where habitat quantity remains constant (Hanski and Gilpin 1991, Robinson et al. 1992, Simberloff 1993, Fahrig and Merriam 1994)” Keinath and McGee (2005:33).

Genetic interchange among metapopulations in a given area is important to the long-term sustainability of spotted frogs and boreal toads, especially where individual metapopulations are relatively small (Carey et al. 2005, Keinath and McGee 2005, Funk et al. 2005, Murrell 2013). This may have large implications to areas where the size of metapopulations have declined and where some metapopulations have disappeared, which appears to be the case on the BTNF. Carey et al. (2005:235) assessed that “Boreal toad habitat occurs in the valleys of all mountain ranges in Colorado. Historically, at least several breeding areas typically occurred within a valley or just over an adjacent ridge. Therefore, an individual dispersing from one breeding area would likely encounter another breeding site within a short distance.” Murrell (2013:2) similarly assessed that “Habitat loss or modification can result in the extinction of local populations, and contribute to regional declines by inhibiting movements between populations that typically can “rescue” declining populations or recolonize extirpated sites”

Given the abundance of boreal toad habitat in western Wyoming, there is no reason to believe this is not the case for the BTNF. The size of metapopulations appears to be relatively small and many valleys appear to not have boreal toad populations. This also appears to be true of spotted frogs, except their distribution is somewhat different.

Although amphibians likely will continue to be monitored at breeding sites, many amphibian species are terrestrial animals and spend only a small portion of their life in aquatic habitats. For example, boreal toads are terrestrial, but they reproduce in aquatic habitat (Bartelt 2000, Wind and Dupuis 2002, Bartelt et al. 2004, Brazier and Whelan 2004, Keinath and McGee 2005, Bull 2006, Pierce 2006, Schmetterling and Young 2008, Bull 2009, Browne and Paszkowski 2010). Keinath and McGee (2005) highlighted the high importance of vegetated terrestrial foraging habitat for boreal toads. Spotted frogs are semi-aquatic, but feed on many terrestrial invertebrates and regularly travel across terrestrial habitat (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001, Pilliod et al. 2002, Patla and Keinath 2005, Reaser and Pilliod 2005).

Marsh and Trenham (2001:42) asserted that “…exclusively pond-based studies will generally lead to pond-based explanations for patterns of abundance and persistence,” and went on to emphasize the importance of gaining understanding of the relative contributions of breeding ponds and terrestrial habitat to amphibian metapopulation dynamics. As an example, the authors pointed out that, where isolation from terrestrial habitats was studied, it was correlated with amphibian abundance or diversity in every case. They cited two studies showing that pond occupancy may, for some amphibian species, be more indicative of the spatial arrangement of terrestrial habitat than the arrangement of breeding ponds.

In general for amphibians, increasing recognition is being given to the importance of terrestrial habitat and conservation of terrestrial habitat (Marsh and Trenham 2001, Pilliod et al. 2002, Wind and Dupuis 2002, Keinath and McGee 2005, Patla and Keinath 2005, Smith and Green 2005, Bull 2006, Pierce 2006, Browne et al. 2009, Bull 2009, Browne and Paszkowski 2010, Moore et al. 2011, Bishop et al. 2014).

An understanding of the range of migration and dispersal distances is a key element in understanding metapopulation dynamics of local populations (Keinath and McGee 2005:33), which is important in the process of maintaining suitable conditions (where they exist) and working toward suitable conditions (where they do not), and in evaluating potential effects of activities.

3. VIABILITY

There is no intent for this short discussion to capture all aspects of population viability theory or for this report to provide a population viability assessment, but the contents of this report and Appendix A provide substantial information that can be used in modeling predictable/deterministic, stochastic, and as-yet-unknown stressors and events if a population viability analysis were to be undertaken for spotted frogs and boreal toads.

It would make little sense and would not be ecologically or legally justifiable to identify a minimum viable population for spotted frogs and/or boreal toads, and then to knowingly allow management actions, recreation activities, and/or commercial operations to contribute to population reductions toward this minimum viable population level under the philosophy that populations can be further reduced so long as the population remains above the minimum viable population threshold. This is inconsistent with current direction on conserving sensitive species and with the 2012 Planning Rule for several reasons:

- The 1982 Planning Rule defined viable population in the following way. “Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area” (Sec. 219.19 of USFS 1982).

- The 2012 Planning Rule defines a viable population as “A population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments” (USFS 2012:21272, § 219.19).

- No mention was made in the 2012 Planning Rule about maintaining “minimum” viable populations and one of the underpinnings of the coarse-filter, fine-filter approach is to “keep common native species common.” It would make little sense to keep common native species common while knowingly allowing sensitive species to decline to a “minimum” viable population level. Boreal toads were formerly common to abundant throughout their range (Carey 2000, Carey et al. 2005, Keinath and McGee 2005, Muths 2005), the BTNF appears to have provided an abundance of suitable habitat, there is no information showing they were not common or abundant on the BTNF, and there are no apparent reasons why they would not have been common or abundant.

- While it is recognized that breeding amphibians naturally disappear and reappear at individual breeding wetlands within the distribution of any given metapopulation, as discussed previously, artificial stressors in addition to natural stressors can accelerate the disappearance rate. If artificially-induced disappearance rates at breeding wetlands within a metapopulation exceed the appearance rates, metapopulations will eventually disappear.

Hogrefe et al. (2005:14-15) assessed that “Small, isolated populations are more susceptible to permanent extirpations due to stochastic events, human impacts, and other environmental factors (Soulé 1987, Begone et al. 1990). Lack of gene flow may cause loss of genetic variability due to random genetic drift (Wright 1931) and inbreeding depression may occur in small, isolated populations (Franklin 1980). Reduced genetic variability reduces the adaptive potential of species forced with environmental changes.”

4. IMPLICATIONS TO CONSERVATION EFFORTS

Implications to spotted frogs and boreal toads on the BTNF, particularly given direction in Forest Plan Objective 3.3(a) and higher-level direction to protect sensitive species and to provide suitable habitat for sensitive species, include the following:

- Possibly the most important application of the multiple stressor principle is that available information is showing that amphibian populations that are stressed by one or more stressors are more likely to be impacted to a larger degree by diseases like Chytrid fungus and ranavirus, as compared to populations that occur in habitats where these stressors have lesser effects or are lacking. This is particularly important when chitrid fungus-infected populations of boreal toads have the potential to be declining by 5-7%/year (Pilliod et al. 2010) and also highly relevant for two species in which reproduction does not begin until about 4-6 years and mortality rates upon reaching adulthood typically are low.

- More specifically, available information (summarized in this report, including Appendix A) indicates that roads and motorized use, several aspects of livestock grazing use, introduced fish, reservoirs, and other factors have affected and continue to affect the distribution and abundance of spotted frogs and boreal toads on the BTNF (see the "Status with Respect to Artificial Stressors on the BTNF" subsection of the "Status and Natural History Information" section, below), and that there is a reasonable chance they have compounded the effects of chytrid fungus and possibly other diseases like ranavirus. The more stressors there are that sublethally affect a given local population of spotted frogs and boreal toads, the greater the chance of the "right combination" being attained and a major population decline.

- Even where metapopulations were able to persist over time with several artificial stressors (e.g., livestock grazing use, roads and motorized use, introduced fish), the introduction of chitrid fungus, increases in UV radiation, increases in atmospheric nitrogen, and global climate change may contribute to lower populations, loss of local populations, and loss of metapopulations.

- Multiple stressors, including chitrid fungus and global warming, that lead to the extirpation of metapopulations eventually influence the persistance of species at larger scales (e.g., at the scale of the BTNF and larger).

- Identifying and analyzing one or even two indicators for amphibians for any particular project-level analysis is not supportable; a range of indicators is needed. Additional indicators may be needed in assessing cumulative impacts.

- It will be important to put concerted effort into conserving as many of the local populations as possible given (1) direction to provide suitable conditions, to maintain viable populations, and to keep common native species common; (2) the range of stressors acting on spotted frog and boreal toad populations on the BTNF (see "Risk Factors and Restoration Factors" sections in Part II), (3) the added impacts of chytrid fungus and other diseases, (4) apparently low reproductive output at many breeding areas on the BTNF, and (5) the potential for additional major declines or losses of local populations. Therefore, given the prevalence of chytrid fungus in this part of the Rocky Mountains, it is imperative that habitat conditions and survival elements (elements A.1 through C.3) be maintained for each metapopulation in suitable conditions to the greatest extent possible.

- If a viability assessment were to be completed for boreal toads, this would need to include the effects of stochastic and unknown future events on local and regional populations on the BTNF given the large volume of information demonstrating a broad range of multiple stressors.

- Providing for increased reproductive output is an issue that needs to be explored further, as one means to help offset multiple stressors acting on spotted frog and boreal toad populations.

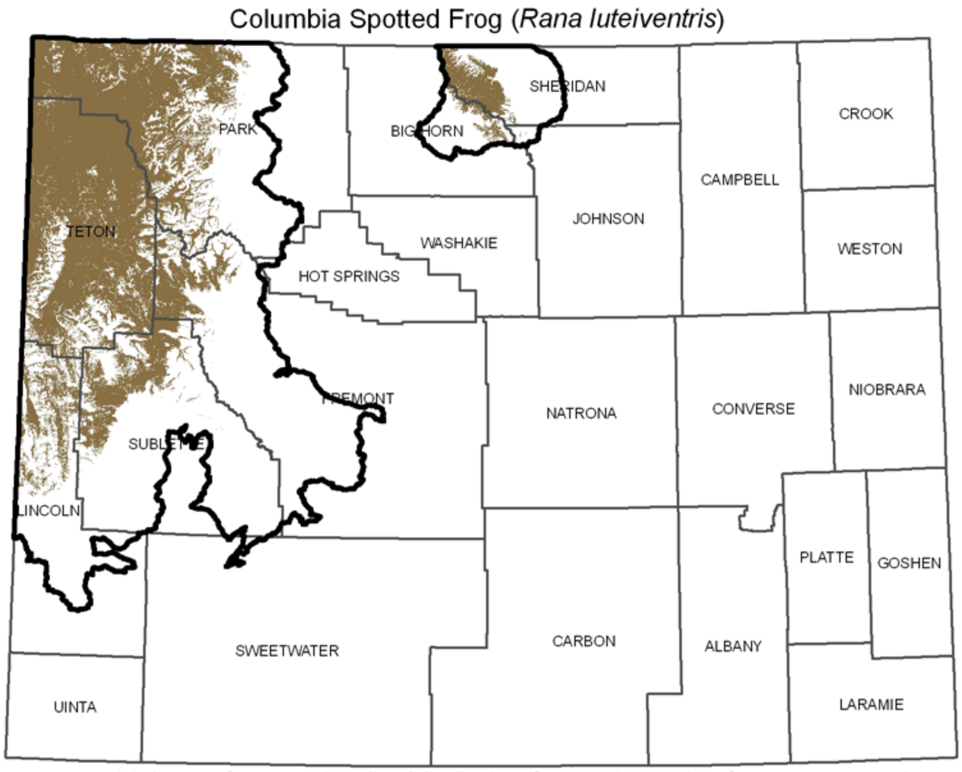
D. STATUS AND NATURAL HISTORY INFORMATION

This section was kept short because natural history information was incorporated into many other sections of this report and natural history information is covered thoroughly in a range of other documents (e.g., Maxell 2000, Patla 2001, Keinath and McGee 2005, Patla and Keinath 2005).

1. COLUMBIA SPOTTED FROG (*Rana luteiventris*)

Range and Status

The range of the Columbia spotted frog extends from southern Alaska south through British Columbia, Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Nevada (Patla and Keinath 2005). Disjunct populations exist south of the main range in southeastern Oregon, Nevada, southwestern Idaho, and Utah; these are isolated, distinct population units (Patla and Keinath 2005). The BTNF is at the very southern end of the main distribution. This species is known to occur within Wyoming's northwest mountain ranges in the Greater Yellowstone ecosystem and in the Bighorn Mountains (WGFD 2010a) (Map 1). The Bighorn Mountain population is disjunct from other spotted frog populations and is concentrated within the central portion of the mountain range (Estes-Zumpf et al. 2012).



SOURCE: Digital maps of ranges and predicted distributions for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Natural Diversity Database. University of Wyoming, Laramie, Wyoming. Note that brown indicates the predicted distribution of the species; heavy black lines indicate outermost boundaries of possible occurrence.

Map 1. Distribution of Columbia spotted frogs in Wyoming. From WGFD (2010)

The U.S. Fish and Wildlife Service currently recognizes four populations of Columbia spotted frogs: the Northern (or main) population, which extends from northwestern Wyoming through western Canada and includes spotted frogs in USFS Region 2; and three smaller, disjunct populations: the Wasatch population in Utah, the West Desert population in Utah, and the Great Basin population in eastern Oregon, southwestern Idaho, and Nevada (USFWS 2002). The Northern population currently has no status under the Endangered Species Act. In 1993, the U.S. Fish and Wildlife Service ranked the three disjunct populations as warranted but precluded for listing under the Endangered Species Act (Worthing 1993).

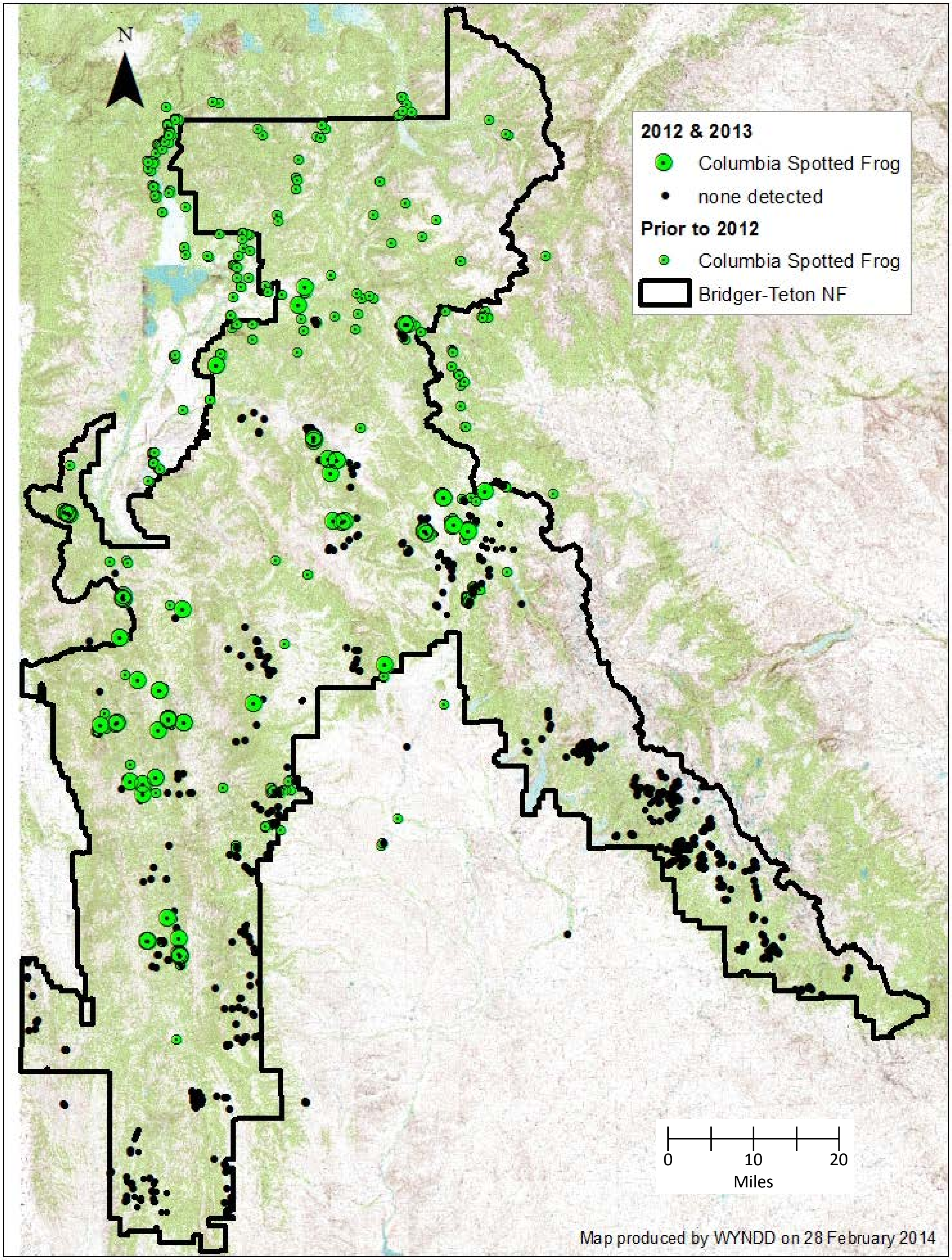
Columbia spotted frogs are classified by Region 4 as a sensitive species (USFS 2011a), and they are also classified in Region 2 as a sensitive species (Patla and Keinath 2005). They are on the Wyoming Game and Fish Department's (WGFD's) list of Species of Greatest Conservation Concern with a NSS Cell rating of NSS3 (Bb), and is classified as a Tier II species, meaning that declining populations and/or habitat losses are not suspected (WGFD 2010a). However, the 2010 rating is a down-grade from 2005 when the species was rated as NSS4. Columbia spotted frogs are also on the sensitive species list of the Wyoming Natural Diversity Database, and the statewide population is ranked as S3 (vulnerable) (NatureServe 2002). Vulnerable is defined as "At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors. Such species are often rare or found locally in a restricted range." (NatureServe 2002).

Available information indicates that spotted frogs likely were once common in suitable habitat on the BTNF, and they continue to be fairly common in parts of the BTNF while their distribution and abundance has declined in other parts. Surveys and incidental observations have recorded the species in all six ranger districts of the BTNF (WYNDD 2011, Map 2). Based on surveys and compilations of incidental observations of amphibians on the BTNF reveal that spotted frogs are relatively widespread and uncommon to common in suitable habitat in the northern half of the BTNF and in the Greys River drainage, but are rare in the remainder of the BTNF (Patla 2000 and Map 2). A compilation of all available location data for spotted frogs on the BTNF prepared by W. Estes-Zumpf, Wyoming Natural Diversity Database is shown in Map 2, recognizing there are very few known locations of spotted frogs and boreal toads prior to Patla's (2000) inventory. Of the locations that were inventoried, spotted frogs appear to be rare or absent from the southern half of the east slope of the Wyoming Range, Commissary/Tunp Ridges, and Gannett Hills. W. Estes-Zumpf identified two places where there may be a decline in active spotted frog breeding sites: the upper Green River area and east slope of the Wyoming Range (email dated March 3, 2014). The likely cumulative impacts of artificial stressors, as summarized in the "Status with Respect to Artificial Stressors on the BTNF" section for both boreal toads and spotted frogs, below, provides further indication of a decline in distribution and abundance of spotted frogs on the BTNF.

Although a relatively large number of breeding sites are known on the BTNF, the locations and distributions of summer-long habitat and wintering habitat remain largely unknown. With respect to historic distribution, the WYNDD (2011) database identifies approximately 271 historic breeding sites within the Greater Yellowstone ecosystem from 1892 to present; a large majority of these are after 1997.

In summarizing some of the problems facing spotted frogs in Wyoming, WGFD (2010a, pg. IV-4-4) stated that "Introduced species, such as the bullfrog, are thought to be a factor in the decline of this species. Other factors such as alterations in habitat quality may be a factor as well. The source and extent of these alterations is not well understood… The disease status of Columbia spotted frogs in Wyoming needs to be determined. These animals share habitat with the boreal toad, which is susceptible to chytrid fungus infections. Populations of the Columbia spotted frogs in Wyoming should be monitored to determine if they are declining." Bullfrogs do not exist on the BTNF and currently are not a threat. Occurrence and distribution of chitrid fungus on the BTNF is improving; it is widely scattered across the BTNF in most populations that have been sampled (see "C.4. Survival as Affected by Disease").

A conservation measure not included in the "Habitat Elements and their Conservation" section, but that is generally applicable across all habitat elements, is the reintroduction of boreal toads and spotted frogs into parts of the BTNF where they previously have existed but no longer exist. Carey et al. (2005) discussed reintroductions in detail for boreal toads and Reaser and Pilliod (2005) discussed this, and breeding-habitat creation, for spotted frogs. Reintroductions may not be initiated by the Forest Service, but it has been used for a wide range of sensitive, threatened, and endangered species, including amphibians. It is only identified here as a future possibility, depending on future status on the BTNF and other parts of their range.



Map 2. Presence data (prior to 2012) and presence/absence location data (2012 and 2013) of Columbia spotted frogs on the Bridger-Teton National Forest, from Wyoming Natural Diversity Database.

Habitat and Ecology

Breeding Habitat

Spotted frogs breed in shallow waters of ponds, marshes, slow streams, river backwater channels, and along lake edges (Hammerson 1982, Patla 2000, Patla and Keinath 2005, Reaser and Pilliod 2005). An important component of breeding sites appears to be emergent vegetation, especially sedges, and/or floating vegetation (Bull and Hayes 2001, Bull 2005:11, Patla and Keinath 2005, Shive et al. 2010). Nearly all breeding sites surveyed on the Greys River Ranger District and many on the Kemmerer Ranger District (as examples) by Patla (2000), McEachern and Brick (2008), McEachern (2010a), McEachern (2010b), and McEachern (2011) contained substantial amounts of cover of sedges, rushes, and/or grasses. Spotted frogs typically lay eggs just after snowmelt (Patla and Keinath 2005), which varies considerably from low to high elevations. In general, the breeding season typically begins in late April or early May (low elevations) to late June (high elevations), and metamorphosis occurs between mid July and late September, depending on elevation and other factors. “Tadpoles require about a month to mature, although this is dependent on habitat parameters such as temperature and food supply” (WGFD 2010a, pg. IV-4-3).

Reaser and Pilliod (2005:560) assessed that breeding sites “…are usually permanent (or were so prior to recent degradation), although naturally ephemeral pools are used successfully by some populations. Springs are often nearby.”

Dispersal and Movements

While some populations of spotted frogs (e.g., those in the Great Basin) typically do no venture far from water after breeding, other populations have a fairly high proportion of individuals that travel as far as about 450-675 yards (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001, Pilliod et al. 2002) and up to 2/3 mile or more (females) between breeding sites and summer foraging habitat and as far as 1¼ miles for males (Pilliod et al. 2002). However, these long distances appear to be uncommon.

Movements by juvenile spotted frogs have been shown to be considerably shorter than adults (Pilliod et al. 2002). However, because some of the breeding sites used by spotted frogs go dry, they must move to permanent wetlands and streams which can be as far as 1/4 to 1/3 mile or more away. This necessitates overland travel. Pilliod et al (2002) reported migrations of juveniles to winter habitat occurring in September and October. However, if breeding pools dry shortly after metamorphosis (e.g., mid-July or August), survival would depend on overland movement to more permanent water prior to September.

Detailed information about migration and movement distances of spotted frogs is presented in the “Buffer Zones and Levels of Protection” section.

Pilliod et al. (2002) reported that spotted frog migrations variably occur at night, during the day, during rain events, and when it is not raining. Published accounts of movement rates during migration have ranged from less than 110 yards/day (Patla 1997) to about 55-205 yards/day (Turner 1960); one individual in Idaho migratied up to 760 yards/day (Pilliod et al. 2002). Migrations from summer to wintering sites were completed in 1-2 days in central Idaho, but they did not report on rates for summer migrations.

Summer-long Habitat

After breeding and for the remainder of the summer and fall, adult spotted frogs move to seasonally moist meadows, ephemeral and permanent pools in meadows and forests, beaver ponds, lake margins, riparian zones, streams, and marshes (Pilliod et al. 2002, Patla and Keinath 2005). Wetland habitat is preferred as summer habitat, but they can travel relatively long distances between breeding sites and summer habitat, with these migrations typically beginning in May and June (Turner 1960) to early July (Pilliod et al. 2002). After dispersal from breeding sites, many individuals follow riparian zones when available, but others make fairly linear migrations across meadows and upland habitats such as big sagebrush communities and forestland (Pilliod 2002). Even for spotted frogs that are moving, the tendency is to occupy small areas for a period of time, followed by short periods of movement (Turner 1960, Patla 1997).

As surface water evaporates from ephemerally moist and wet areas used by spotted frogs after breeding, frogs move to more permanently wet areas.

Migrations across dry land pose particular problems for frogs. Bodies of frogs have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist. They regulate skin moisture by selecting micro-sites in which to inhabit. Dumas (1964) reported that relative humidity of 65% at about 78 °F is lethal to adult spotted frogs in approximately two hours. Therefore, for those that migrate from their breeding site when humidity is low and/or temperatures are high, survival may depend on migration habitat that retains higher moisture/humidity at ground level and protection from the sun and predators (e.g., herbaceous and shrub cover) or that otherwise provides microsites with these qualities. This may be particularly important for adults that migrate during late June and July and juveniles that migrate away from the temporary waters of some breeding sites during late July through mid September (when temperatures are highest, relative humidity is lowest, and rain events may be widely spaced). Pilliod et al. (2002) found that some frogs migrated through subalpine fir and lodgepole pine with sparse whortleberry and bear grass, but seeps, springs, and other water sources were available along the way (8,000-8,500 ft. elevation with an easterly aspect in Idaho).

Food Habits

Columbia spotted frogs are opportunistic and flexible predators, and variety in prey species may be an important aspect of their prey base (Reaser and Pilliod 2005, Patla and Keinath 2005). Variation in diet relates to prey availability and ecological conditions. In a study conducted in Yellowstone National Park, 70-90% of food items collected from the gut contents of 178 spotted frogs were spiders and representatives of four orders of insects: Hemiptera (bugs), Coleoptera (beetles), Diptera (flies), and Hymenoptera (ants, wasps, and bees) (Turner 1959, as cited by Patla and Keinath 2005). Six families of insects (Carabidae, Chrysomelidae, Cordiluridae, Curculionidae, Formicidae, and Gerridae) accounted for 55% of all food items. Spotted frogs also consumed mollusks and earthworms in Turner’s study. A diet study in northeastern Oregon also highlighted the large variety of taxa eaten by spotted frogs and the changes in their diet that occur as availability of different prey items changes (Bull 2003).

Spotted frogs have also been observed to feed on earthworms, mollusks, and crustaceans (WGFD 2010a) as well as other frogs and possibly even young small mammals (Patla and Keinath 2005).

Foraging sites include ephemeral pools in forests and meadows, streams (permanent and intermittent) and river edges, riparian zones, temporary and permanent ponds, lake margins, and marshes (Patla and Keinath 2005). Summer foraging may occur at the same water body used for breeding and overwintering, but in many cases frogs move to other sites in summer for a variety of reasons including predator avoidance and the attractions of more abundant food and less competition (Bull and Hayes 2001 *in* Patla and Keinath 2005).

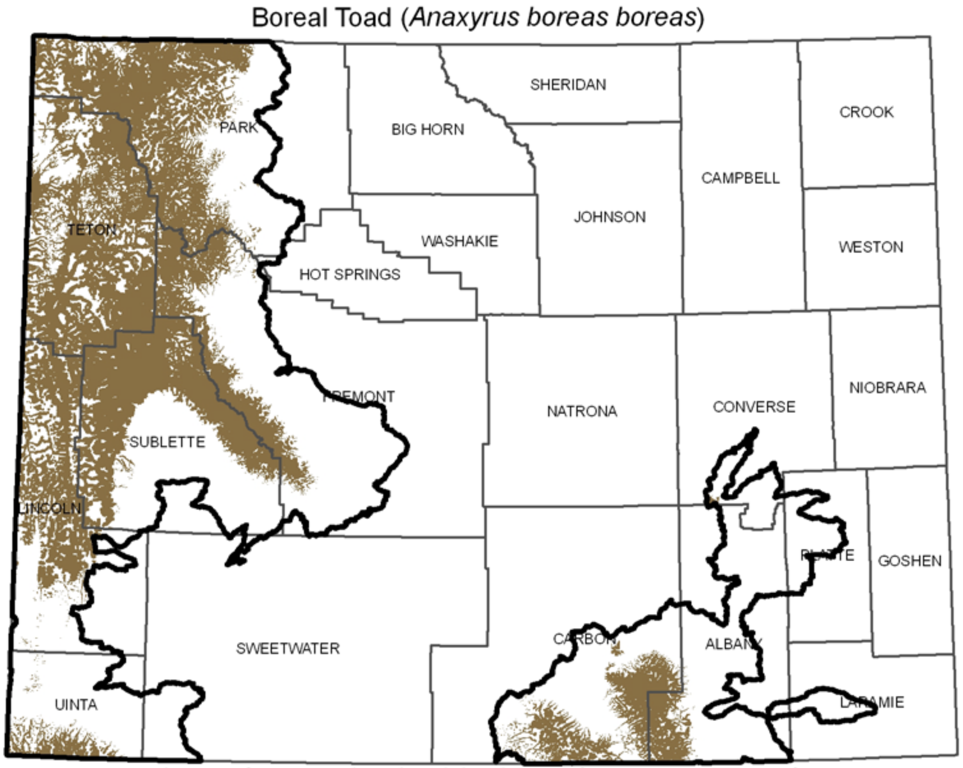
Winter Habitat

Depending on conditions of summer habitat, many individuals leave summer habitat and move to winter habitat during August and/or September (Pilliod et al. 2002, Patla and Keinath 2005). Wintering habitat may include ponds, streams, under stream banks, springs, beaver dams, and underground areas (associated with water bodies), but all such sites must have above freezing temperatures, be moist or wet, and be well oxygenated (Patla and Keinath 2005). Frogs of the genus Rana generally overwinter underwater in permanent water bodies, or terrestrially, depending on species physiological tolerances for chilling and hypoxia (Patla and Keinath 2005). Columbia spotted frogs winter in or immediately adjacent to aquatic sites, where they can avoid the threat of freezing or oxygen depletion (Bull and Hayes 2002, *as cited in Patla and Keinath 2005).*

2. BOREAL TOAD (*Bufo boreas boreas*)

Range and Status

Boreal toads occur from northern New Mexico to Alaska, including the Rocky Mountains and west to the Pacific Coast. Boreal toads were formerly widespread and common, but have declined dramatically in the last three decades in many portions of its extensive range in western North America (Carey 1993, Corn 1994, Rose et al. 1995, Muths 2005). In Wyoming, their range is restricted to mountains and foothills within relatively moist ecotones (Keinath and McGee 2005), ranging in elevation from about 6,500 to 12,000 feet (WGFD 2010b, pg. IV-4-1) (Map 3). The Boreal Toad is thought to have two distinctive population segments in Wyoming, a northern Rocky Mountain population and a southern Rocky Mountain population (WGFD 2010b). The Southern Rocky Mountain population segment, which includes Uinta, Sweetwater, and Lincoln counties, is being considered by the U.S. Fish and Wildlife Service for listing under the Endangered Species Act due to geographic isolation and disease concerns (USFWS 2012).



SOURCE: Digital maps of ranges and predicted distributions for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Natural Diversity Database. University of Wyoming, Laramie, Wyoming. Note that brown indicates the predicted distribution of the species; heavy black lines indicate outermost boundaries of possible occurrence.

Map 3. Distribution of boreal toads in Wyoming. From WGFD (2010)

A majority of existing boreal toad populations and potential boreal toad habitat in this portion of the Rocky Mountains exists on National Forest System lands and in national parks.

Boreal toads are currently considered “extremely rare” in Wyoming and on the BTNF (Patla 2001, WGFD 2010b). With respect to historic distribution and abundance, the WYNDD (2011) database lists approximately 735 historic breeding sites within the Greater Yellowstone Ecosystem from 1892 through 2013, but a large majority of observations have occurred within the last 15 years due to a major increase in inventories. Inventories, surveys, and incidental observations demonstrate the species remains within all six ranger districts on the BTNF, except current records of boreal toads on the Greys River Ranger District only exist for the very upper end of the Greys River (Patla 2000, WYNDD 2011, unpublished district records). The current distribution and abundance on the BTNF are not fully known.

Boreal toads are classified by Region 4 as a sensitive species due to viability concerns and because it is only found within habitats that encompass a small portion of the landscape; this includes breeding habitat comprising a very small proportion of the landscape. Boreal toads are on the Wyoming Game and Fish Department’s (WGFD’s) list of Species of Greatest Conservation Concern (WGFD 2010b) with a NSS Cell rating of NSS1

(Aa), and is classified as a Tier I species because of declining population trend and/or habitat in need of conservation management actions. Boreal toads are also on the sensitive species list of the Wyoming Natural Diversity Database, and the statewide population is ranked as S1 (critically imperiled) (NatureServe 2002). Critically imperiled is defined as "Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction."

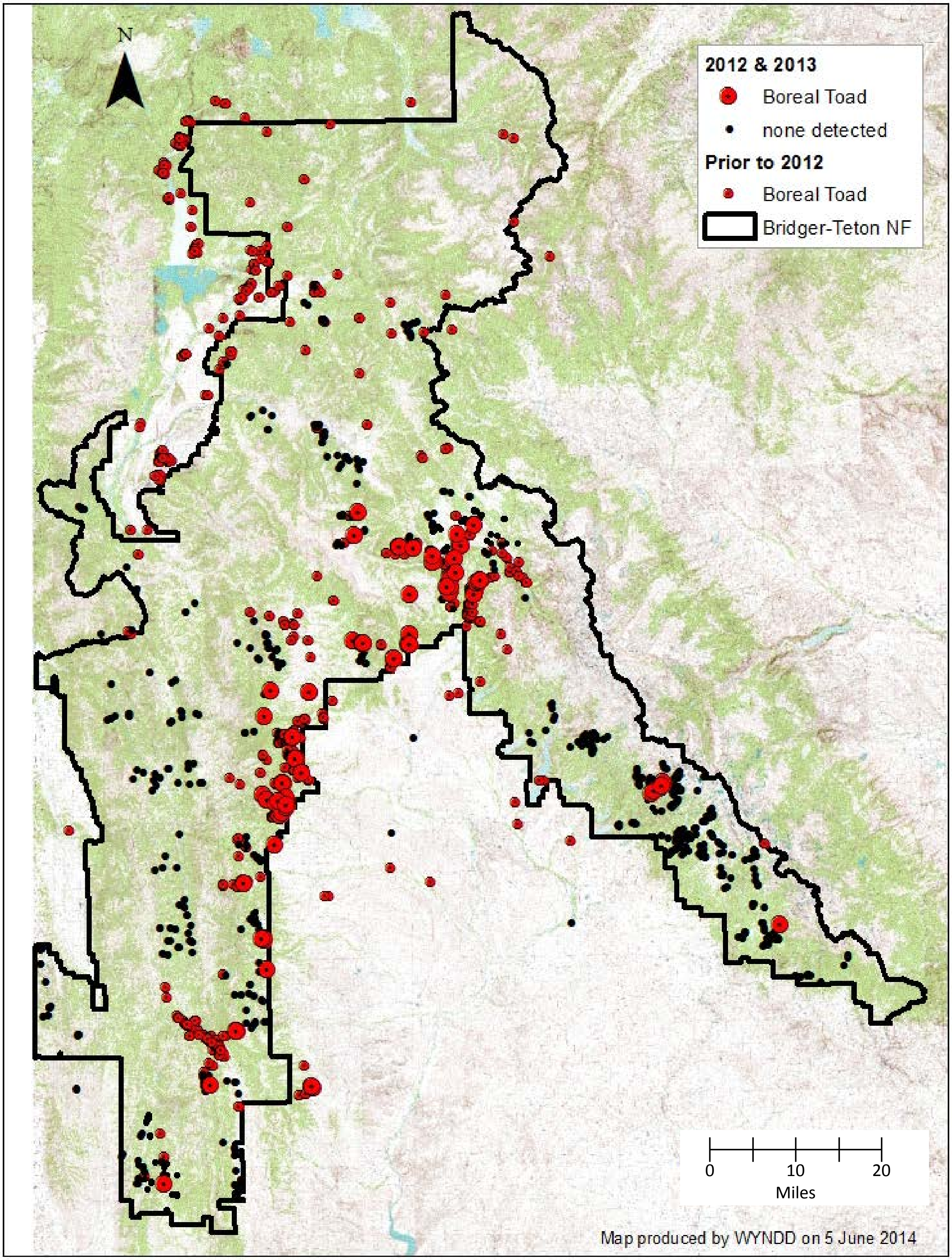
Boreal toad populations in the Rocky Mountains have been in a state of severe decline in areas where they were once abundant, and the species is considered imperiled due to greatly restricted numbers; thus, extirpation is possible (Maxell and Hokit 1999, Muths et al. 2003, Carey et al. 2005, Muths 2005, WGFD 2010b). Corn (2003:251) assessed that "Once considered common and abundant, *B. boreas* in the southern Rocky Mountains has undergone a serious decline in the last 30 years (Carey 1993; Corn 2000; Carey et al. [2005])," with chytrid fungus being a likely leading contributor to declines (Muths et al. 2003). While "southern Rocky Mountains" in Corn's paper did not include the portion of Wyoming encompassing the BTNF, it captures what has happened to boreal toads in the Rocky Mountains immediately south of the BTNF. Also, despite there being some perception that population declines in the Rocky Mountains is a southern Rockies issue (e.g., south of the BTNF), Maxell and Hokit (1999:2.4) said this of boreal toads in Montana: "Although still widespread across the contiguous mountainous regions of Montana, recent surveys have failed to find boreal toads at most historical sites, have found them at less than 10% of sites with suitable habitat, and have found some evidence that breeding is being restricted to lower elevations (Maxell et al. 1998)."

Available information indicates that, although boreal toads likely were once common in suitable habitat on the BTNF, their distribution and abundance has declined, substantially in places. Because boreal toads only recently began to be monitored on the BTNF and because there is too little historical data to assess trends, it is not clear when populations declined on the BTNF, how quickly they declined, and how precipitous the declines have been. A compilation of all available location data for boreal toads on the BTNF prepared by W. Estes-Zumpf, Wyoming Natural Diversity Database through the 2013 field season is shown in Map 4, recognizing there are very few known locations of boreal toads prior to Patla's (2000) inventory. Of the locations that were inventoried, boreal toads appear to be rare in or absent from the Greys River, Salt River, and Gros Ventre drainages, and much of the Wind River Range. Except in a small handful of locations (e.g., Blackrock area, parts of the Upper Green watershed), toad densities and reproductive output appear to be low where they presently occur on the BTNF. The current distribution and abundance contrasts with the assessment that boreal toads historically were common to abundant in suitable habitat in their range (Carey et al. 2005, Muths 2005, Keinath and McGee 2005). The likely cumulative impacts of artificial stressors, as summarized in the "Status with Respect to Artificial Stressors on the BTNF" section for both boreal toads and spotted frogs, below, provides an explanation for any declines in distribution and abundance that have occurred on the BTNF.

Furthermore, because some of the precipitous population declines documented in other parts of the Rocky Mountains did not happen until the last 15 years, it is possible that some boreal toad populations in parts of the BTNF may still face such declines. For example, while populations of boreal toads throughout Colorado began declining in the 1970s, Muths et al. (2003) noted that one of the few remaining large populations in Colorado appeared to be healthy in the mid-1990s and went through a precipitous decline, with the population nearing 0 by 1999. No data has been presented to date demonstrating, or even suggesting, that boreal toads (1) were not common or abundant prior to Euro-American settlement, and (2) have not declined substantively in distribution and abundance on the BTNF. They currently are rare to uncommon on the BTNF.

There is no indication that future assessments of the status of boreal toads on BTNF (e.g., assessment of the existing distribution and abundance relative to the pre-alteration distribution and abundance) will be much different than assessments from all other parts of the Rocky Mountains that have been examined.

Factors that appear to have caused or contributed to population declines of boreal toads in the Rocky Mountains are disease, habitat loss, habitat alteration, climate change, increased ultraviolet radiation, acid and mineral pollution from mining, and other pollutants (Patla 2001, Muths 2005, WGFD 2010b, Keinath and McGee 2005). Disease — in particular, chytrid fungus (*Batrachochytrium dendrobatidi*) — appears to have exacerbated population declines. Chytrid fungus is thought to be one of the main causes, likely acting synergistically with other stressors, of mass die-offs in Colorado, Utah, Wyoming, and Montana (Maxell and Hokitt 1999, Muths



Map 4. Presence data (prior to 2012) and presence/absence location data (2012 and 2013) of boreal toads on the Bridger-Teton National Forest, from Wyoming Natural Diversity Database.

2003, Carey et al. 2005, Muths 2005, WGFD 2010b; see the “C.4. Survival as Affected by Disease” section in Part II of this report).

On May 25, 2011, the U.S. Fish and Wildlife Service received a petition requesting the Service list either the Eastern population or Southern Rocky Mountain population of the boreal toad as a threatened or endangered distinct population segment (DPS) under the Endangered Species Act. On April 12, 2012, the U.S. Fish and Wildlife Service published their 90-day finding on the petition in the Federal Register (USFWS 2012). Based on their review, the U.S. Fish and Wildlife Service determined there was sufficient information indicating that listing the Eastern population of the boreal toad as a distinct population segment may be warranted, and to move forward with a 12-month review of this population. However, the agency did not find substantial information that listing the Southern Rocky Mountain population, *as a distinct population segment in and of itself*, may be warranted. Completion of the 12-month review and a decision on whether the Eastern population warrants listing as a threatened or endangered distinct population segment was scheduled for April of 2013, but is now due by September 17, 2014.

Based on a large-scale map in U.S. Fish and Wildlife Service (2012:21923), the Eastern population includes large parts of Colorado and Utah, and small parts of Wyoming (southwestern corner and along the eastern half of the southern border), Idaho (southeastern corner), New Mexico (north-central), and Nevada (along the northern half of the eastern border). In Wyoming, the Eastern population includes boreal toads in all of Lincoln (except in the very northeastern corner) and Uinta Counties, and the southwestern corners of Sublette and Sweetwater counties; and in southern portions Carbon and Albany counties. On the BTNF, the Eastern population appears to include toads on all of the entirety of the Kemmerer Ranger District, all except the far northeastern corner of the Greys River Ranger District, and the southern two-thirds of the Big Piney Ranger District. Also included in the range of the Eastern population is a small portion of the Palisades Ranger District of the Caribou-Targhee National Forest, which is administered by the BTNF (i.e., north of the Snake River).

A conservation measure not included in any “Conservation Actions to Consider” subsections, but that is generally applicable across all habitat and suvival elements, is the reintroduction of boreal toads and spotted frogs into parts of the BTNF where they previously have existed but no longer exist. This would likely not be initiated by the Forest Service, but it has been used for a wide range of sensitive, threatened, and endangered species, including amphibians, and it has been discussed for boreal toads and spotted frogs in several conservation assessments and plans (Loeffler et al. 2001, Hogrefe et al. 2005, Keinath and Patla 2005, Patla and Keinath 2005). It is only identified here as a future possibility, depending on future status on the BTNF and other parts of their range.

Habitat and Ecology

Breeding Habitat

Breeding occurs in still or barely moving water, including ponds, lakes, river backwater channels and oxbow ponds, beaver ponds, flooded meadows, ephemeral pools, and manmade impoundments (Hammerson 1982, Keinath and McGee 2005, Muths 2005). Pierce (2006) added that these sites are normally associated with lodgepole pine and spruce-fir forests. In the Greater Yellowstone ecosystem, breeding sites include shallow-water edges of ponds and lakes (typically in water depths of 4-8 inches), stream and river edges where water is pooled or very slow moving, oxbow ponds, thermal pools and streams, flooded meadows, ephemeral pools, abandoned and active beaver-impounded ponds, and man-made impoundments including reservoirs and quarries (Patla 2001).

Breeding typically begins when snow melts or ice thaws at breeding sites and, therefore, the timing of breeding is variable from year to year and is dependent on elevation (Keinath and McGee 2005). Most breeding takes place between mid-May and mid to late June in the Greater Yellowstone ecosystem, although thermally influenced areas may host earlier breeding (late April) and stream backwater pools may attract late-summer breeding efforts (mid-July or even later); toad tadpoles have been observed in mid-September on the upper Snake River (Patla 2001). Breeding activity at a single area may extend over a few or several weeks, with several peaks of activity. At the large toad breeding site near the Blackrock Ranger District, a site which is not thermally influenced and is not subject to flushing by high water stream flows that could delay breeding, fresh egg strings have been observed between May 17 and June 12 (Patla 2001). Hatching occurs 10-14 days after eggs are laid. Metamorphosis typically happens from late July to late September, but the amount of time from egg laying to metamorphosis is highly variable and depends on water temperature and site conditions. In some cases, metamorphosis may not be completed by winter; it is not known whether non-metamorphosed individuals survive the winter (WGFD 2010b).

Sedges and other emergent vegetation appears to be an important component of breeding habitat, and there appears to be a propensity for toads to lay their eggs in or near the marshy parts of wetlands and possibly in association with willows (Gaughan and Grunae 2005, Hogrefe et al. 2005:9, Keinath and McGee 2005, unpublished amphibian monitoring data of BTNF). Keinath and McGee (2005) assessed that boreal toad eggs are typically deposited within about 6 feet of shore, in marshy areas with emergent sedges or shrubby willows, or even bare substrate in some situations.

Shallow water on northerly shores provides warm water for rapid embryonic and larval development (Bull 2005, Carey et al. 2005,).

Dispersal and Movements

After the breeding season, male boreal toads tend to remain close to breeding sites (e.g., within about 330 yards in studied populations), while females may range as far as 1.5-2.4 miles (Muths 2003, Bartelt et al. 2004, Pierce 2006, Goates et al. 2007). Migration and dispersal distances of boreal toads are discussed in detail in the “Buffer Zones and Levels of Protection” section.

Summer-long Habitat

Adults are primarily terrestrial and inhabit a great variety of habitats, from non-forested to forested and from relatively dry to wet habitats, so long as moist microsites are available, and they typically do not venture far from water. WGFD (2010b, pg. IV-4-1) reported that “Found near water during the day, this toad travels quite some distance from water at night to forage.” Boreal toads can travel long distances, traversing through different types of habitats as they move. They typically appear to concentrate their activities within 10 to 200 yards of water (see the “Why 200 Yards?” subsection of the “Buffer Zones and Levels of Protection” section).

Habitats occupied by boreal toads in summer are diverse, including forested and non-forested wet, moist, and even relatively dry areas. However, they tend to use moist habitats and moist microsites more often than drier habitats and microsites (Bartelt et al. 2004, Brazier and Whelan 2004, Bull 2006, Bull 2009). Eighty-one percent of post-breeding locations in Bull (2006) were terrestrial and 31%, 18%, and 23% were located under rocks, in burrows, and under large woody material, respectively. In a study by Bartelt (2000 as cited in Patla 2001), boreal toads used terrestrial habitats extensively, and they inhabited underground burrows over 26% of the time, according to the radio telemetry study on the Targhee National Forest. Shrub cover (particularly willows), woody debris, and breaks in the shrub or tree canopy layer that allow sunlight to reach the ground appear to be important habitat features. Even though they used terrestrial habitats in this study, most toads did not venture far from water. Some biologists and researchers believe they tend to spend more time in areas such as willows and sedges where the soil is wet or moist (Hammerson 1982, Keinath and McGee 2005). Pierce (2006) stated that adult toads move into high grasses and surrounding forests after breeding, based on Degenhardt et al. (1996) and Loeffler (2001). Particularly when they inhabit drier habitats, they spend a disproportionate amount of time in relatively moist microsites such as under shrubs, woody debris, and in underground burrows, and they tend to remain near moister habitats. Moist microsites in drier habitats provide protection from evaporative water loss and are used to thermo-regulate. Adult boreal toads also thermo-regulate by basking in the sun. After metamorphosing, young toads move away from aquatic habitat and use moist terrestrial habitats where part of their time is spent under the shelter of moist woody debris and underground cavities, and they spend part of their time basking in the sunlight to thermo-regulate (Keinath and McGee 2005).

After metamorphosing, young toads move away from aquatic habitat and use moist terrestrial habitats where part of their time is spent under the shelter of moist woody debris and underground cavities, and they spend part of their time basking in the sunlight to thermoregulate (Keinath and McGee 2005, Bull 2009). Bull (2009) assessed that metamorphs require habitat that is more moist or humid than adults.

Food Habits

As noted by Keinath and McGee (2005:30), "Despite the dominance of [coleopterans and hymenopterans] in boreal toad diets, a wide variety of invertebrates, including ants, beetles, spiders, mosquitoes, grasshoppers, crane flies, stink bugs, damsel bugs, deer flies, wasps, bees, water striders, alder flies, backswimmers, muscid flies, mites, and snails, are taken as prey." Muths (2005:395) noted that "Primary food sources include spiders, worms, ants, moths, beetles, and other arthropods (Campbell, 1970a,c; Barrentine, 1991b; Leonard et al. 1993; Luce et al. 1997," and did not provide any indication of preferences. In some locations, diversity in diets can be low. For example, in the watershed of the Targhee National Forest where Bartelt and Peterson (1997) and Bartelt (2000, as cited by Patla 2001) studied boreal toads, they found that boreal toads fed primarily on ants (75% of diet) and secondarily on beetles (24%), according to scat-content analysis and behavioral observations. Toads are reported to forage primarily during the day although they are also active at night, when they travel overland (Bartelt 2000 as cited in Patla 2001).

Tadpoles appear to be omnivorous, with an apparently large portion of their diet coming from decaying vegetation. They feed on green algae and planktonic material they either filter from the water or scrape from vegetation or sediment; detritus they obtain from the bottom of wetlands; dead tadpoles; and possibly bacteria and dissolved nutrients (Warkentin 1992, Keinath and McGee 2005, Patla and Keinath 2005, Schmutzer et al. 2008).

Winter Habitat

Boreal toads do not hibernate in water like spotted and leopard frogs, nor can they tolerate freezing, as boreal chorus frogs do. Hibernation sites identified by radio-tagging toads on the Targhee National Forest were underground burrows within about 3 feet of a small flowing stream and under slash piles (Bartelt and Peterson 1997 as cited in Patla 2001). Goates et al. (2007) reported on similar hibernation sites. Streamside cavities and old rodent burrows appeared to be the likely overwintering sites for toads observed in mid September along Flat Creek on the National Elk Refuge in Jackson Hole (Patla 2001). In Colorado, toads are reported to overwinter in underground chambers near creeks, ground squirrel burrows, and possibly in beaver lodges and dams where flowing water would keep the air above-freezing (Hammerson 1999 as cited in Patla 2001; Loeffler 2001).

3. STATUS WITH RESPECT TO RISK FACTORS ON THE BTNF

The inventory being conducted by the Forest Service, WNDD, and WGFD, in conjunction with the inventory by Patla (2000) contributes to our understanding of distribution and population status of Columbia spotted frogs and boreal toads on the BTNF, but there currently are no plans to complete an assessment of population status on the BTNF. The population status likely will only identify the current distribution and abundance of spotted frogs and boreal toads without an assessment of the degree to which they have declined or are sustainable over the long term. Viability analyses are expensive and attention is focused on minimum viable populations instead of healthy, functioning populations. Comparisons to an estimated natural, pre-Euro-American distribution and abundance can be helpful, but estimates of natural distribution and abundance are difficult.

Another option for assessing the conservation status of spotted frogs and boreal toads on the BTNF is to go through the following thought process starting with the Forest Service's sensitive species status, state-wide and regional status of both species, and recognition that the U.S. Fish and Wildlife Service is considering listing the eastern clade of boreal toads: (a) is there scientific information demonstrating that climate change, increases in UV-B radiation, and increases in atmospheric nitrogen levels are not negatively impacting spotted frogs and boreal toads on the BTNF?; (b) what does scientific information say about the potential for commercial, recreational, and management activities and facilities on the BTNF to negatively impact these species, particularly in the context of the multiple-stressors concept?; (c) are there management controls that are sufficiently avoiding or mitigating negative impacts? and (d) is there information demonstrating that commercial, recreational, and management activities and facilities are not negatively impacting spotted frogs and boreal toads on the BTNF?

After addressing the potential effects of disease introduction and spread, climate change, increases in UV-B radiation, and increases in atmospheric nitrogen levels on spotted frog and boreal toad distribution and abundance on the BTNF, the remaining summary assessments address the potential ramifications of local artificiall stressors by addressing questions b-d, above.

Based on the large amount of scientific information on the effects of disease, climate change, UV-B radiation, atmospheric nitrogen, roads, motorized use, livestock grazing use, introduced fish, reservoirs, and other stressors (see pertinent sections of this report and Appendix A) it is highly likely these stressors have and continue to cumulatively impacted spotted frogs and boreal toads on the BTNF. The following synopsis is based on scientific information referenced in pertinent sections of this report and in Appendix A.

a. <u>Disease Introduction and Spread</u>

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows that diseases such as chitrid fungus and ranavirus have been major contributing factors in reduced abundance and distribution of boreal toads and, to a lesser degree, spotted frogs (see literature cited in the "C.4. Survival as Affected by Disease" section). Chitrid fungus appears to pose the largest threat on the BTNF and negative impacts have shown to be exacerbated where other stressors (e.g., b-j, below) are affecting populations. Some metapopulations on the BTNF may have already succumbed to the effects of either chitrid fungs by itself or in combination with other stressors. With possible reductions of about 5–7%/year in existing metapopulations of boreal toads infected by chitrid fungus on the BTNF (Pilliod et al. 2010) and assuming that increased mortality due to chitrid fungus does not itself lead to extinction of metapopulations, the stage is set for combinations of other stressors — which may have not caused population declines in the absence of chitrid fungus — for some metapopulations to trend toward extinction (Corn 2003, Forson and Storfer 2006, Gray et al. 2007, Gray et al. 2009, Gahl and Calhoun 2010, Groner 2012, Adams et al. 2013, Gallana et al. 2013, Reeve et al. 2013).
- *Existing Controls on the BTNF* — There currently are no controls (e.g., specific Forest Plan standards or prescriptions) that protect against further increases in the distribution and prevalence of chitrid fungus and the introduction of other infectious diseases. Although there are no requirements, however, seasonal crews that inventory and monitor amphibians on the BTNF take protective measures to minimize the potential for spreading chitrid fungus.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that nonnative diseases are not impacting spotted frogs and boreal toads on the BTNF or that they are only having minimal effects (i.e., there is no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that (1) the introduction and spread of chitrid fungus has not resulted in or contributed to reductions in the distribution of spotted frogs and boreal toads on the BTNF; and (2) the wide range of other artificial and natural stressors, in combination, has not made worse the effects of chitrid fungus on boreal toads and spotted frogs.
- *Synopsis of Situation on the BTNF* — Available scientific information, combined with preliminary results of data collection on the occurrence of chitrid fungus and the effects of a range of artificial stressors on spotted frogs and boreal toads, indicate a high potential for substantial impacts on these species on the BTNF.

b. <u>Climate Change and UV Radiation</u>

- *What the Scientific Information Indicates* — Available information indicates that climate change will result in increasingly warmer temperatures and drier conditions in this part of the Rocky Mountains, and that UV-B radiation is increasing (see literature cited in the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section). To the degree that warming and drying happens, wetlands will have lesser amounts of water, wetlands will try quicker, herbaceous production may be lower, potential for desiccation will increase, larger acreages of forestland may burn, and there may be fewer acres of moist forestland. This in turn would reduce tadpole survival for both species and may reduce survival of adult spotted frogs, which has the potential to contribute to population declines. A range of studies indicate that increases in UV radiation and synergistic effects of UV radiation with other factors such as acidification, shallower waters, certain pathogens, lowered pH, fire retardant, and a polycyclic aromatic hydrocarbon have contributed to amphibian population declines.

- *Existing Controls on the BTNF* — There currently are no definitive controls (e.g., specific Forest Plan standards or prescriptions) that protect against climate change and further increases in UV radiation. Climate change and UV radiation are being addressed at much larger scales than the BTNF.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that the impacts of climate change and increases in UV radiation on spotted frogs and boreal toads are not occuring on the BTNF or only have minimal effects (i.e., no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that (1) climate change has not resulted in or contributed to declining wetland conditions on the BTNF or reductions in the distribution and abundance of spotted frogs and boreal toads on the BTNF; and (2) increases in UV radiation has not reduced survival of tadpoles on the BTNF; and (3) the wide range of other artificial and natural stressors, in combination, has not made worse the effects of climate change and increased UV radiation on boreal toads and spotted frogs.
- *Synopsis of Situation on the BTNF* — Available scientific information indicate a high potential for climate change to contribute to reduced survival of tadpoles and possible reductions in the survival of juvenile and adult spotted frogs, and possible contributions of increased UV radiation to reduced survival of tadpoles. There are no management controls to mitigate these effects and there is no information showing these factors are not negatively affecting spotted frogs and boreal toads on the BTNF.

c. Atmospheric Nitrogen

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows that nitrate and ammonia concentrations in lakes, ponds, and wetlands are increasing on at least parts of the BTNF (as they are throughout the intermountain west), and that tadpoles of spotted frogs and boreal toads are negatively affected elevated concentrations of nitrate and ammonia (see the “B.1. Water Quality” section). Available information also indicates that, while atmospheric inputs may not elevate nitrate and ammonia sufficiently to negatively affect tadpoles, it increases the potential for the addition of other nitrogen inputs (e.g., from urinating and defeccating livestock in and near breeding sites) to negatively affect tadpole survival.
- *Existing Controls on the BTNF* — Objective 1.3(b) and the Water Quality Standard of the Forest Plan require that current State water quality standards be met, at a minimum, in perennial and intermittent streams, ephemeral waters, and isolated waters. However, tadpoles can be adversely impacted when and where the objective and standard are met for some contaminents such as nitrate. The upper allowable concentration of nitrate according to Wyoming Water Quality Standards is 10 mg/L, but tadpoles can experience altered behavior and physiology and increased mortality at 2.5-5.0 mg/L (see “Water Quality” section of Appendix A). In other words, existing controls are somewhat inadequate.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information showing that increases in atmospheric nitrogen and increases in nitrogen in water bodies, due in part to increased atmospheric nitrogen levels, are not negatively impacting tadpole survival on the BTNF.
- *Synopsis of Situation on the BTNF* — Available scientific information indicate that nitrate and ammonia concentrations are increasing in lakes, ponds, and wetlands in at least parts of the BTNF due in part to increases in atmospheric nitrogen. An important implication is that elevated nitrate and ammonia concentrations increase the probability of less-than-suitable water quality being produced by livestock grazing use.

d. Motor-Vehicle Routes, Motorized Use, and Dispersed Roadside Camping

- *What the Scientific Information Indicates* **—** A large volume of scientific information, some of which is summarized in this report, shows definitive negative impacts of roads, motor-vehicle trails, and motorized use on survival rates due to crushing and increased potential for desiccation, reductions in habitat connectivity, altered hydrology, and reduction in water quality (see literature cited in the "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat," "A.6. Habitat Connectivity," "B.1. Water Quality," and "C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)" sections). Patla (2001) and Bull (2009) show that national forest roads **—** similar to situations on the BTNF **—** have a reasonably high potential to increase mortality and reduce habitat connectivity, particularly where roads and motor-vehicle trails are near breeding wetlands.
- *Existing Controls on the BTNF* **—** The only applicable definitive control on the BTNF is the Forest Plan's Streamside Road Standard (USFS 1990b), but (1) there are no criteria in the standard to protect spotted frogs and boreal toads or their habitat; (2) new roads have been constructed or widened within riparian areas since 1990; and (3) there currently are a large number of roads within riparian areas, including within 1/3 mile of breeding sites and within1½ mile of breeding sites. Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species provides general controls.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* **—** There is no known information indicating that the impacts of roads, motor-vehicle trails, motorized use, and associated camping documented in the scientific literature for a wide range of areas and situations, including situations similar to the BTNF, do not occur on the BTNF or only have minimal effects (i.e., there is no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that roads, motor-vehicle trails, motorized-use, and associated camping have not resulted in and are not resulting in (1) moderate to major increases in mortality of metamorphs, juveniles, and adults in metapopulations where roads, authorized and unauthorized motor-vehicle trails, and/or dispersed camping occur; and (2) metapopulation-level impacts where roads reduce the amount of accessible summer habitat and breeding wetlands.
- *Synopsis of Situation on the BTNF* **—** Available scientific information indicates that roads, motor-vehicle trails, motorized use, and dispersed roadside camping likely has contributed to negative impacts on spotted frog metapopulations on the BTNF, even though little or no documentation of impacts exists for the BTNF, and that they continue to contribute to impacts on some metapopulations.

e. Livestock Grazing Use

- *What the Scientific Information Indicates* **—** A large volume of scientific information, some of which is summarized in this report, shows definitive negative impacts of several aspects of livestock grazing use, including reduced survival due to trampling and lowered water quality, negative impacts on herbaceous habitat (humid microsites, hiding/escape cover, insect habitat), lowered water tables, altered plant species composition, accelerated water-level declines, and reductions in the prevalence of burrows (see literature cited in the "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat," "A.4. Herbaceous Species Composition," "B.1. Water Quality," "B.2. Surface-Water Duration in Small Pools," "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter," and "C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)" sections, and Appendix A). While livestock grazing use can **—** in wetlands with extensive stands of tall, dense emergent vegetation **—** create openings beneficial to tadpoles, metamorphs, and adults ("B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section), this one potential benefit is outweighed by the much larger number of negative effects. Trampling may have the largest potential to affect populations. A recent conservation assessment on Yosemite toads (Brown et al. 2015) identified livestock grazing use, including trampling, as one of two high priority risk factors.

- *Existing Controls on the BTNF* — There are no applicable definitive controls on the BTNF for ensuring that livestock grazing use is controlled sufficient to retain suitable habitat conditions and to sufficiently minimize impacts on survival. Objectives 3.3(a) and 4.7(d); Sensitive Species Management Standard; and the Fish, Wildlife, and Threatened, Endangered, and Sensitive Species Standard provide direction for this, but as yet there are no definitive, quantifiable controls based on this direction to maintain sufficient control over livestock grazing use. No such controls existed in the past. Identification of such controls is the purpose of the analysis in Appendix A.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that the impacts of various aspects of livestock grazing use documented extensively in the scientific literature for a wide range of areas and situations, including situations similar to the BTNF, do not occur on the BTNF or only have minimal effects (i.e., there is no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that livestock grazing use has not or is not impacting metapopulations due to (1) reduced survival due to trampling and lowered water quality; (2) reductions in humid microsites, hiding/escape cover, and insect habitat; (3) lowered water tables; (4) altered plant species composition; (5) accelerated water-level declines; and (6) reductions in the prevalence of burrows.
- *Synopsis of Situation on the BTNF* — In part due to the high maximum-use levels allowed under the Forest Plan (e.g., 60-65% use of key forage species in riparian areas) and the lack of sufficient controls over livestock grazing to address spotted frogs and boreal toads, a large amount of scientific information (see Appendix A) indicates that livestock grazing use has contributed to impacts on spotted frog metapopulations on the BTNF and that they continue to contribute to negative impacts on some metapopulations.

f. Introduced Fish

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows negative impacts of introduced trout on the distribution and abundance of spotted frogs and boreal toads (see literature cited in the "C.3. Habitat Effectiveness and Survival with Respect to Fish" section). Low abundance and absence of spotted frogs, related species of frogs, and toads in otherwise suitable habitat has been linked to the introduction of non-native fish into formerly fishless lakes that supported amphibian breeding.
- *Existing Controls on the BTNF* — There currently are no definitive controls (e.g., specific Forest Plan standards or prescriptions) that protect spotted frogs and boreal toads from stocked fish, aside from Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that the impacts of introduced trout documented in the scientific literature, including situations similar to the BTNF, do not occur on the BTNF or only have minimal effects (i.e., there is no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that introduced trout did not result in or contribute to reductions in the distribution of spotted frogs and boreal toads on the BTNF.
- *Synopsis of Situation on the BTNF* — Available scientific information, combined with preliminary results of inventories, indicate that that the introduction of trout into formerly fishless lakes and ponds appears to have caused or contributed to reductions in the distribution of spotted frogs and boreal toads on the BTNF (e.g., parts of the Wind River Range), including the loss of some metapopulations.

g. Distribution and Extent of Beaver Pond Complexes

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows that (1) reductions in the distribution of beaver pond complexes can contribute to lower distribution and abundance of spotted frogs and boreal toads; and (2) reductions in the occurrence and spread of fires can negatively impact spotted frogs and boreal toads to through reductions in non-forested habitat (e.g., moist meadows, willow communities), reductions in spring flows which can affect duration of water in breeding wetlands, shading of breeding pools, and reductions in the distribution and abundance of aspen (see literature cited in the “A.2. Mix of Succession Stages in Forests” and “A.3. Occurrence and Extent of Beaver Pond Complexes” sections). Reductions in the distribution and abundance of aspen is a likely contributor to reductions in the distribution of beaver pond complexes.

- *Existing Controls on the BTNF* — There currently are no definitive controls (e.g., specific Forest Plan standards or prescriptions) that protect spotted frogs and boreal toads from fire suppression, removal of beavers and/or beaver dams, or beaver trapping, aside from Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that the impacts of a reduced distribution of beaver pond complexes and of altered fire-return intervals documented in the scientific literature do not occur on the BTNF or only have minimal effects (i.e., no information showing that the situation on the BTNF is somehow unique).
- *Synopsis of Situation on the BTNF* — Available scientific and ecological information indicate there continues to be (1) a lower distribution of beaver pond complexes than existed prior to Euro-American settlement; and (2) reduced occurrence and extent of fires, which likely contributes on the BTNF to lower amounts of non-forested habitat, reduced spring flows which has the potential to reduce the duration of water in some breeding wetlands, increased shading of some breeding pools, and reductions in the distribution and abundance of aspen. All of these likely are contributing to reduced distribution and abundance of spotted frogs and boreal toads on the BTNF.

h. Artificial Reservoirs and Other Water Developments

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows that large reservoirs and many smaller reservoirs eliminate riparian and wetland habitat (replacing them with large bodies of water typically with unsuitable shoreline habitat) and impact habitat connectivity, and that spring developments can reduce breeding and summer habitat (see literature cited in the “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” and “A.6. Habitat Connectivity” sections).
- *Existing Controls on the BTNF* — There currently are no definitive controls (e.g., specific Forest Plan standards or prescriptions) that protect spotted frogs and boreal toads from the construction and maintenance of reservoirs and the development of springs, aside from Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* — There is no known information indicating that the impacts of large reservoirs and spring-development documented in the scientific literature do not occur on the BTNF or only have minimal effects (i.e., no information showing that the situation on the BTNF is somehow unique). In particular, there is no known information indicating that large reservoirs and spring developments have not contributed to reductions in the distribution of spotted frogs and boreal toads on the BTNF.
- *Synopsis of Situation on the BTNF* — Available scientific information indicate that large reservoirs appear to have contributed to reductions in the distribution of spotted frogs and boreal toads on the BTNF. Also, there likely are breeding wetlands and summer habitat that is negatively affected by spring developments.

i. Pesticides

- *What the Scientific Information Indicates* — Scientific information, some of which is summarized in this report, shows that rotenone has the potential to have major negative impacts on tadpoles. To the extent rotenone has been used in waters of the BTNF where and when breeding by spotted frogs and/or boreal toads for breeding occured (see the “B.1. Water Quality” section).

- *Existing Controls on the BTNF* **—** Aside from Objective 3.3(a), which calls for the protection of sensitive species to ensure that activities do not contribute to long-term or further declines in populations, and aside related direction in the Forest Service Manual, there do not appear to be protective measures that specifically apply to the effects of pesticides on amphibians.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* **—** There is no known information indicating that the impacts of rotenone documented in the scientific literature do not occur on the BTNF or only have minimal effects.
- *Synopsis of Situation on the BTNF* **—** An investigation was not undertaken to determine the past use rotenone on the BTNF or potential future uses.

j. Overrepresentation of Late-Seral Conditions

- *What the Scientific Information Indicates* **—** Scientific information, some of which is summarized in this report, shows that overrepresentation of late-seral forestland has a range of negative effects, including:
    - Reduced water flow volumes and altered timing of flows.
    - Reduced distribution and abundance of beaver pond complexes.
    - Reduced quality and acreage of meadow, willow, and aspen communities.
    - Increased shading of breeding pools.
    - Lack of recently burned habitat.
    - Reduced shrub and herbaceous cover.

  Scientific information shows these to have negative effects on spotted frogs and boreal toads (see the “A.2. Mix of Succession Stages in Forests” section). On the other hand, benefits of conifer forestland include overstory canopy cover, large woody material, and maintenance of suitable water quality.
- *Existing Controls on the BTNF* **—** Objective 3.3(a), Objectives 4.3(b-c), and the Prescribed Fire Guideline provides general direction for restoring habitat conditions, including the use of prescribed burning to enhance or provided habitat for sensitive species, but no specific direction if provided for reducing the amount of late-seral forestland or for addressing conifer expansion into meadows, willows, and aspen.
- *Information Showing that Impacts have no more than Minimal Effects on the BTNF* **—** There is no known information indicating that overrepresentation of late-seral forestland has not had or will not have negative effects on spotted frog and/or boreal toad populations on the BTNF.
- *Synopsis of Situation on the BTNF* **—** Many parts of the BTNF have an overrepresentation of late-seral forestland and scientific information provides sufficient information that negative effects are occurring.

All of the artificial stressors summarized above, in combination with natural stressors, have high potential to be the cause of reductions in the distribution and abundance of spotted frogs and boreal toads on the BTNF. The preponderance of information indicates that chitrid fungus is the leading cause of reductions in the distribution and abundance of boreal toads and possibly spotted frogs throughout most of the BTNF and that the range of artificial stressors summarized above has worsened or compounded the effects of chitrid fungus. However, it is not possible to tweeze out the relative contributions of each stressor in compounding the effects of chitrid fungus. In some parts of the BTNF, non-disease stressors appear to have been drivers in reductions in the abundance of spotted frogs and boreal toads (e.g., introduction of trout into waters of the Wind River Range).

Together, the preponderance of scientific information on the effects of stressors and the status of Columbia spotted frogs and boreal toads in Region 4 of the Forest Service (i.e., sensitive species status) and in Wyoming (i.e., NSS Cell rating of NSS4 and S3 rating in the Wyo. Natural Heritage Program for spotted frogs, and NSS Cell rating of NSS1 and S1 rating in the Wyo. Natural Heritage Program for boreal toads) indicates that the combination of habitat conditions and survival elements are at levels that spotted frogs and boreal toads have and will likely continue to be negatively affected. At a minimum, the combination of artificial stressors outlined above reduce the chances that some spotted frog and boreal toad metapopulations will be able to persist in the event of catastrophic events in addition to the introduction of chitrid fungus.

4. MODELED CAPABLE HABITAT

Capable Frog and Toad Habitat

Capable breeding, summer, and migration habitat of spotted frogs and boreal toads was modeled (Maps 5 and 6). Modeled capable habitat for spotted frogs and boreal toads was modeled together, except for summer habitat. Modeled capable habitat is only presented in two maps to avoid overlap in locations of spotted frog and boreal toad locations. Habitat was modeled as follows:

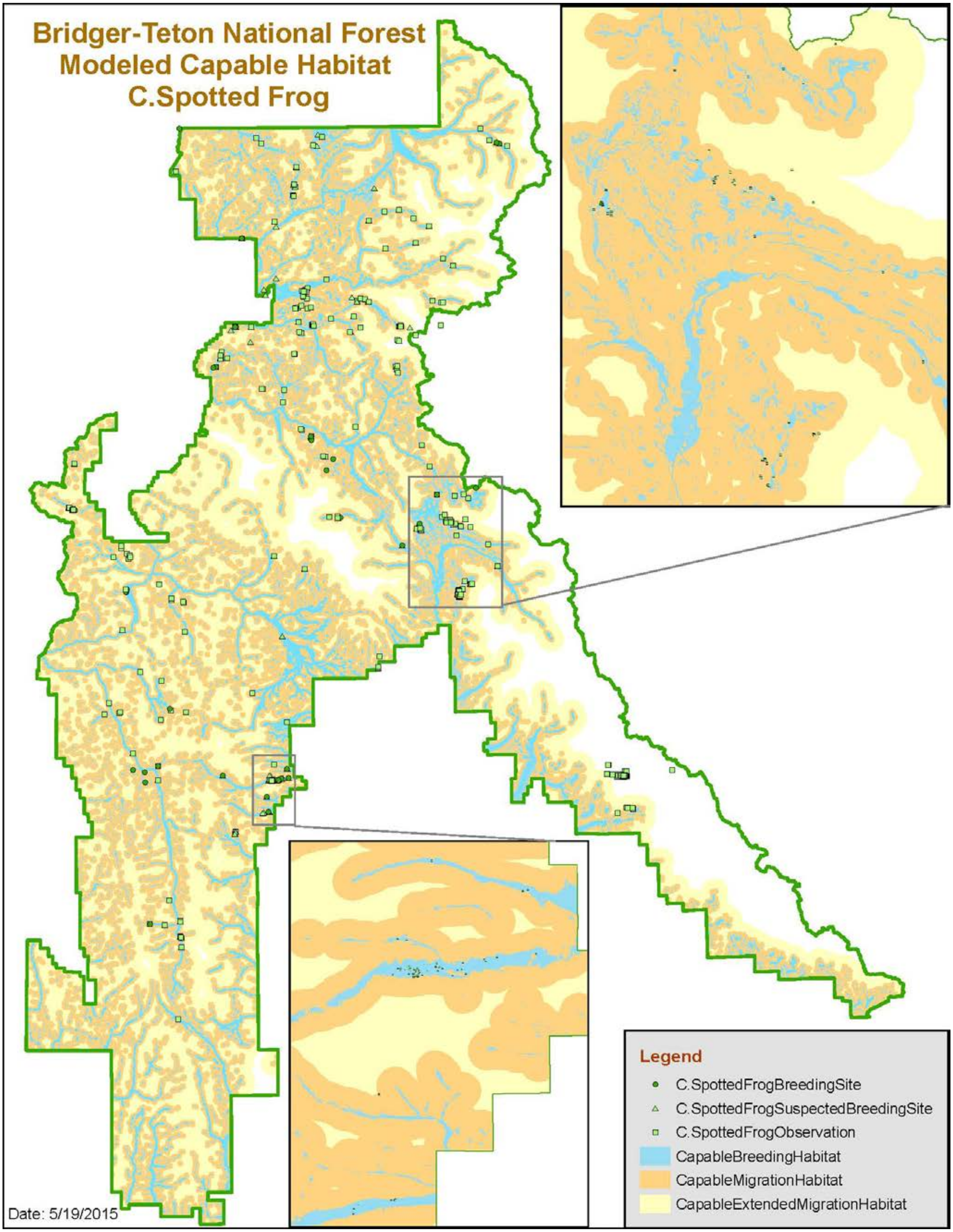
1. *Breeding Habitat for Spotted Frogs and Boreal Toads (and Summer Habitat for Spotted Frogs)* — This consists of all aquatic habitat (water layer for the BTNF, aquatic habitat in the 2007 vegetation layer, National Wetland Inventory map, only including stream habitat of ≤2% gradient) and willow, cottonwood, and riparian herbland types from the 2007 vegetation layer below 9,000 feet. The three riparian vegetation types were included because small unmapped aquatic habitat exists within these types and locations can shift over time. For example, beaver ponds in willow habitat and oxbow wetlands change over time. It is recognized that only a small portion of the three riparian vegetation types provide aquatic habitat that is capable for breeding, but they provide a reasonable representation of where capable aquatic breeding habitat exists. This zone also encompasses capable habitat for spotted frogs during summer months.

   Maps 5 and 6 show the locations of known existing boreal toad and spotted frog breeding sites on the BTNF, indicating that (1) modeled capable breeding habitat encompasses the landscape attributes that make habitat capable for breeding, with a few minor exceptions; and (2) there is more capable breeding habitat than currently is being used by spotted frogs and boreal toads. This can be more readilty observed in the inserts of Maps 5 and 6. Results of capable habitat modeling depicted in Maps 5 and 6 are coarse scale and it is recognized that each species likely favors a certain set of conditions that may only be found within a subset of the conditions represented by modeled capable breeding habitat.

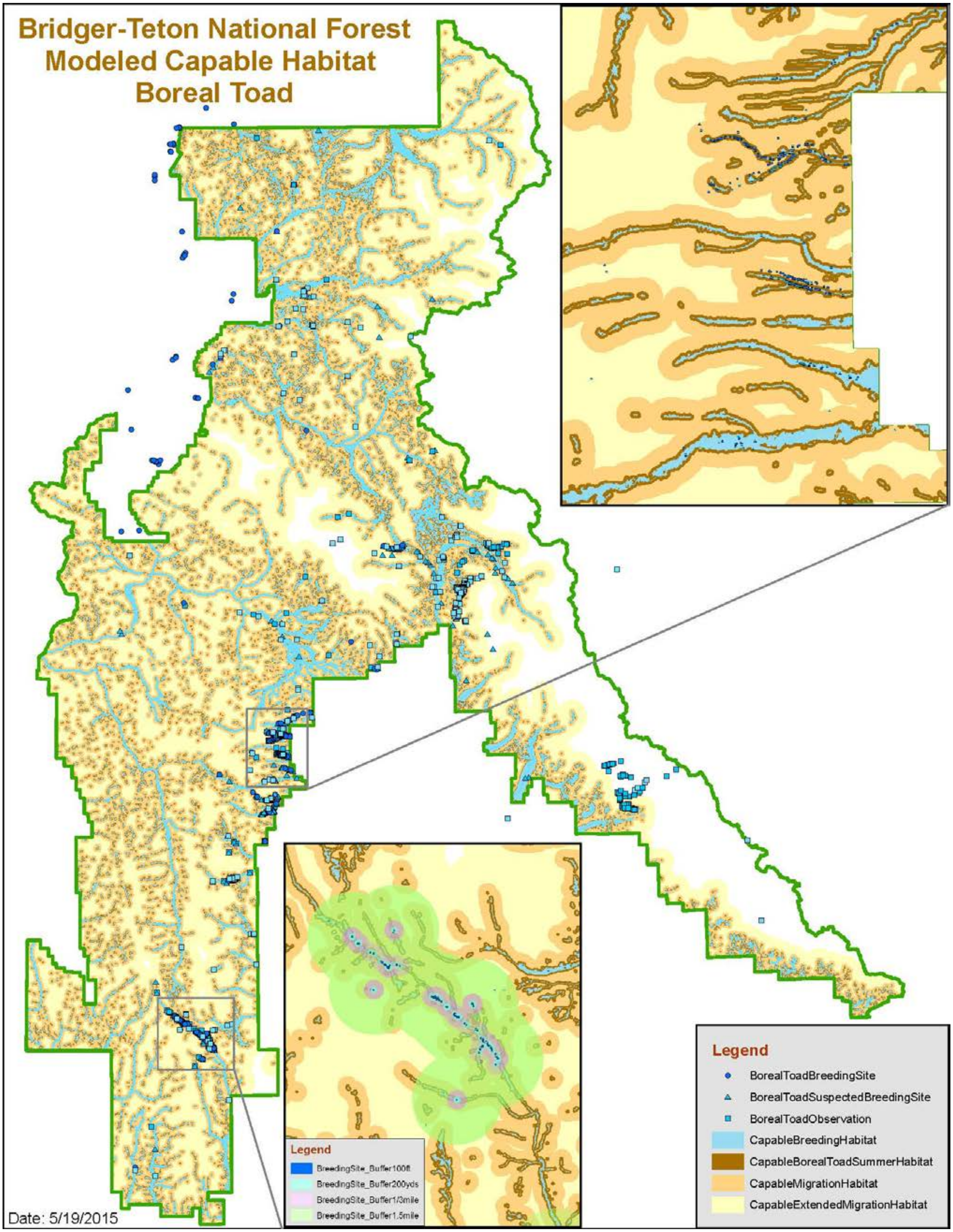
2. *Summer Habitat for Boreal Toads* — While boreal toads can forage and venture further from riparian zones than 100 yards, a large majority of adult and juvenile toads remain within about 100 yards of surface water, not including during migration when they can move much further from water (see "F. Buffer Zones and Levels of Protection" for discussion and citations). Although boreal toads tend to avoid using closed-canopied conifer forestland, conifer forestland with high percent canopy cover were not excluded given the narrowness of the 'summer habitat' band (100 yards) and the likelihood they would use the edges of these stands. (Map 6)

   Summer habitat also includes riparian habitat and, therefore, ecompasses much of the modeled breeding habitat (above). Other habitats used during this period range from silver sagebrush and shrubby cinquefoil (riparian habitat not included in capable breeding habitat) to mountain big sagebrush and mountain shrubland to aspen to open conifer habitat.

3. *Migration Habitat* — A relatively large proportion of spotted frogs and boreal toads have been found, in a range of studies, to migrate as far as 1½ miles (and further) between breeding sites and summer habitat (see "F. Buffer Zones and Levels of Protection" for further discussion and citations). Because they tend



Map 5. Modeled capable habitat for Columbia spotted frogs on the Bridger-Teton National Forest; GIS and mapping were done by Ashley Egan, Lead Wildlife Technician, Greys River and Kemmerer Ranger Districts.



Map 6. Modeled capable habitat for boreal toads on the Bridger-Teton National Forest; GIS and mapping were done by Ashley Egan, Lead Wildlife Technician, Greys River and Kemmerer Ranger Districts.

to remain closer to water and because a majority remain within 1/3 mile of breeding sites, migration habitat in Maps 5 and 6 is split between “Migration Habitat” (≤1/3 mile from capable breeding habitat) and “Extended Migration Habitat” (≤1½ miles from capable breeding habitat). Migration habitat within 1/3 mile of capable breeding habitat is more important that between 1/3 mile and 1½ miles. Migration habitat currently includes all cover types. Future revisions will include eliminating high elevation cliffs, talus slopes, and similar areas.

These zones also encompass habitat that can be used for emigration, and they also encompass uplands that contribute sediment to streams and wetlands.

Modeled capable habitat will be refined, for example, by removing high elevation areas like complexes of cliffs and talus slopes, high elevation areas of high bare ground, and interiors of reservoirs.

Riparian Habitat within Capable Grazing Lands

A previous modeling effort (USFS 2009) took a similar approach for modeling capable habitat for spotted frogs and boreal toads, but incorportated different vegetation types of the 2007 vegetation layer for the BTNF, it used a different buffer zone width, and it only included capable grazing lands within active livestock allotments. The 2009 modeling effort for spotted frogs and boreal toads included two categories, recognizing that information in the “F.Buffer Zones and Levels of Protection” section of this report demonstrate shortcomings of this earlier modeling effort. Nonetheless, it provides general information on acreages of riparian and aquatic habitat within lands that are capable for livestock grazing within active livestock allotments. This information will need to be recalculated when the capable habitat modeling effort (previous section) is completed.

1. *Riparian and Aquatic Habitat* — This included all of the riparian vegetation types (including silver sagebrush and shrubby cinquefoil), perennial streams, and lakes and ponds in the 2007 vegetation layer for the BTNF. This is where much of the capable breeding habitat for both species and summer habitat for spotted frogs exists, where a portion of boreal toad summer habitat exists, and where a portion of migration habitat exists. In the 2009 effort, this zone was referenced as “Actual and Potential Primary Amphibian Habitat, but it was changed to “Riparian and Aquatic Habitat” in this report since capable breeding habitat has been refined (see previous section).

Table 1. Estimated acres of important habitat for spotted frogs and boreal toads in livestock allotments of the Bridger-Teton National Forest, including lands that have the potential to influence water quality of wetland habitat used for breeding.

Geographic Scope	Riparian and Aquatic Habitat	Adjoining 1/4-mile (Watershed Area)
Cattle Allotments		
Total Acres throughout Allotments	77,626	757,083
Acres on Capable Cattle Grazing Lands	50,681	232,652
Sheep Allotments		
Total Acres throughout Allotments	31,422	425,483
Acres on Capable Sheep Grazing Lands	18,784	115,361

2. *Adjoining 1/4-mile Upland Habitat* — This delineation likely encompassed a majority of upland habitat actually and potentially used by spotted frogs and boreal toads. See the “Within 200 Yards of Breeding Wetlands and Streams” subsection of the “Buffer Zones and Levels of Protection” section, below.

   The delineation in Table 1 titled “Adjoining 1/4-mile (Watershed Area)” was set at 1/4-mile in part to encompass actual and potential upland habitat used by spotted frogs and boreal toads, but was also set at 1/4- mile in recognition that the effects of up-gradient watershed conditions can affect the suitability of amphibian breeding sites through erosion and sedimentation.

E. DEFINITIONS

1. COARSE-FILTER AND FINE-FILTER

Coarse-filter **—** In general, "Strategies for setting biodiversity planning goals based on providing an appropriate mix of ecological communities across a planning landscape…" (Haufler 1999a:19) and on providing an appropriate composition and structure within these communities, rather than focusing on the needs of specific species (see explanation below). In particular, for the purposes of this report, a coarse-filter approach is founded on restoring/maintaining natural conditions or conditions within the natural range of variability (Applet and Keeton 1999, Haufler 1999a, and Haufler 1999b, and section 12.14 of WO Amendment 1909.12-2015-1).

Fine-filter **—** "Strategies for setting biodiversity planning goals based on the needs of individual species or guilds of species, thus providing for the needs of those species or guilds" (Haufler 1999a:19).

Coarse-scale **—** "A level of resolution or grain size used in determining or mapping data based on larger units, such as a large pixel size or large grain" (Haufler 1999a:19).

Fine-scale **—** A level of resolution or grain size used in mapping or measuring data based on units such as small grain size or small pixel size" (Haufler 1999a:19).

Haufler's (1999a) definition of coarse-filter was expanded to fill the gap of not having the definition of coarse-filter or fine-filter address within-community composition and structure. The coarse-filter approach can be viewed as meeting the needs of entire wildlife communities, with the recognition that approximating the conditions under which a native wildlife-community formed is the best that can be done to meet the needs of the community as a whole (Reid and Miller 1989, Keystone 1991, Noss and Cooperider 1994, Hunter 1996, Aplet and Keeton 1999, Everett and Lehmkuhl 1999, Haufler 1999a, USFS 2012). As such, adding within-community composition and structure to the definition of coarse-filter is a fine-tuning of the definition. The fine-filter approach clearly is limited to meeting the needs of individual species or guilds, and adding within-community composition and structure would conflict with the original definition.

2. WETLANDS

Wetland **—** In general, wetlands are "transitional areas between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is cover by shallow water;" they are lands where saturation of soils with water is the dominant factor determining soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979, Laubhan et al. 2012). As noted by Laubhan et al. (2012:98), "The Cowardin et al. (1979) definition captures the dynamic nature of wetlands and identifies the importance of hydrology" and is still applicable today. The Clean Water Act defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions…" To be suitable for breeding amphibians, wetlands must have standing water during the breeding season, and wetland types range from ponds/lakes, to very small pools, to wet meadows with little visible open water, so long as there is sufficient openings to provide for sun exposure (Bull 2005, Carey et al. 2005, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, Reaser and Pilliod 2005). Surface water many times is seasonal in wetlands used by frogs and toads. After the breeding season, wetland habitats used by spotted frogs and boreal toads are more encompassing, including those with no surface water but with saturated soils.

Isolated Basin Wetland **—** A wetland that is situated in a topographic depression outside of a riparian zone (i.e., isolated from riparian areas). An isolated basin wetland, for the purposes of this report, is a type of palustrine wetland, which have the following characteristics: situated in a topographic depression, <20 acres, absence of wave-formed or bedrock shoreline, <6.6 ft. water depth at deepest point in low water, and many times have emergent vegetation, shrubs, and/or trees (but this latter characteristic is not a requirement) (Cowardin et al. 1979).

Riverine Wetland **—** These wetlands occur within a channel (Cowardin et al. 1979), and include rivers, streams, and creeks.

Beaver ponds and other basin wetlands (i.e., those in a geographic depression) within riparian zones are included in discussions of riparian habitat. Both of these types of wetlands technically fall within the scope of palustrine wetlands, but they are distinguished from “isolated basin wetlands” by their inclusion within riparian zones and not “isolated” from riparian areas.

3. BREEDING SITES

Breeding sites are defined in two ways for the purposes of this report: (1) what constitutes a breeding site with respect to signs of breeding activity (the first definition below), and (2) what constitutes breeding sites with respect to existing/historic status and known/unknown status (all other definitions, below):

Existing Breeding Site **—** A wetland or wetland complex used for breeding by spotted frogs or boreal toads on the BTNF, regardless of whether their use as a breeding site is known. To be consistent with other definitions, for the purposes of suitable condition statements, existing sites are those that exist during the period 1999-present, until 2015, when it will shift to a 10-year period (see next definition).

Documented Breeding Site **—** For a wetland or wetland complex to be documented as a breeding site, one or more of the following must be documented for the wetland(s): (1) presence of eggs, (2) presence of tadpoles, (3) presence of individuals that are metamorphosing or have recently been metamorphosed (Patla et al. 2008).

Known Existing Breeding Site **—** For the purposes of objectives, this refers to all breeding sites on the BTNF that currently exist and that are known (at least one documented occurrence of breeding from 1999 through 2015). After 2015, “existing,” for the purpose of suitable condition statements and objectives, will shift to “at least one record of breeding within a 10-year period,” assuming that sites were surveyed at least 5 times during the 10-year period. Otherwise, the “known existing” status[D] would be retained until there is sufficient information to demonstrate a given site is no longer being used for breeding. The year 1999 is used as a cutoff because 1999-present data represents the current effort to locate breeding sites on the BTNF. Patla (2000) did her first survey work on the BTNF in 1999, but not all of the sites she located have been revisited since then. This means that many of the yet-to-be-revisited sites could still have breeding activity. Until all sites have been revisited, we need to assume they are being used for breeding until data shows they are not.

Also included in this category are historic breeding sites for which juvenile frogs or toads are found within about 1/3-mile of a historic breeding site (possibly up to 1½ miles if capable wetland is sparse) even if no recent records of breeding activity exist at the historic breeding site; distances of 1/3 mile to 1½ miles will need to be evaluated). Most juvenile spotted frogs and toads typically remain within 1/3 mile of breeding sites, but some can venture further. Follow-up surveys should be conducted to determine breeding status of the historic site. Additionally, locations of juvenile boreal toads can be treated as a proxy for ‘breeding site’ until a breeding site is found if there are no known existing or historic breeding sites within about 1/3 mile. Boreal toads are treated in this way given their status and because so few breeding sites have been found on the BTNF.

[D] Only as used in suitable condition statements and objectives. This would not be used in assessing trends based on monitoring of breeding presence/absence.

Known Historic Breeding Site — All breeding sites on the BTNF for which there is documentation of breeding activity prior to 1999, but for which there are no records of breeding occurring after 1999. After 2015, "historic" will shift to "prior to 10 years of the current year."

Known Historic Breeding Site having Capable amphibian wetland habitat — This refers to all *Known Historic Breeding Sites* that have documented existence of capable amphibian wetland habitat (see below for criteria for capable amphibian wetland habitat). This distinction is made because conditions of some known historic breeding sites may have naturally changed to the point they no longer have the capability to support spotted frog or boreal toad breeding.

Capable Amphibian Habitat — All perennial streams, riparian habitat, and wetlands in the BTNF corporate database and National Wetland Inventory, and all habitat within 1/3-mile of streams, riparian habitat, and wetlands (vs. 1/4 mile in USFS 2009). In combination, the habitats within this area encompass known and unknown breeding sites, historic breeding sites no longer used, potential future breeding sites, the majority of historic and existing migration and summer-use habitat, and potential future migration and summer-use habitat. It also incorporates some of the upslope watersheds that affects water quality, the sedimentation (filling-in) of wetlands, and water flow volumes and timing of water flows. A 1/3-mile buffer encompasses only a small portion of the lands that affect these latter habitat elements, but it provides some representation of them. If habitat is assessed at smaller scales on the BTNF, consideration should be given to mapping watershed functions that affect breeding, migration, and summer habitats. See the "Buffer Zones and Levels of Protection" section, below, for the basis of 1/3 mile.

If suitable condition statements and objectives were to only apply to known breeding sites and associated habitat (e.g., habitat within 1/3 mile or 1½ mile, depending on the suitable condition statement), this could easily lead to continued declines in spotted frog and boreal toad distribution and abundance. Capable amphibian habitat is referenced in some suitable condition statements because there are many existing and historic breeding sites that are not "known" and, therefore, would otherwise not be protected.

Capable Amphibian Wetland Habitat — Wetland habitat that is capable of supporting breeding, summer use, or migration habitat by spotted frogs or boreal toads. At a basic level, such wetlands meet the following criteria (based on information cited earlier): (1) a wet area that meets the definition of a wetland (see definition in the "Habitat and Ecology" discussion for Columbia spotted frogs, previously in this report); (2) gradual slope and the existence of shallow surface water (e.g., roughly about 3-10 inches); (3) surface water that meets criteria 2 from the period of snowmelt at least through sometime in June (low elevation) or July (high elevation); and (4) existence of emergent vegetation.

F. BUFFER ZONES AND LEVELS OF PROTECTION

An important part of managing activities to minimize adverse effects on spotted frogs and boreal toads is the use of buffer zones (Keinath and McGee 2005, Patla and Keinath 2005, Goates et al. 2007). Buffer zones do not provide complete protection from human-related activities, but rather constitute "areas of closely managed activity," as characterized by WDEQ (2004:19), although interior buffer zones could very well be designated as full protection (Semlitsch and Bodie 2003). Semlitsch and Bodie (2003) recommended three different buffer widths to address different natural history needs of amphibians and reptiles around core wetlands. Goates et al. (2007) evaluated the standard 100-ft. buffer width using boreal toads as a case study, but they only considered the use of one buffer width to cover the range of natural history requirements of toads and the multitude of human-related activities that can affect them.

Several authors have questioned the width of buffer zones currently in use around breeding wetlands (Wind and Dupuis 2002, Bull 2009, Browne and Paszkowski 2010). Also, given the different natural history requirements of the two species and the widely varying levels of effects of human-related activities and facilities, more than one buffer widths is needed. The width of buffer zones depends on the habitat resources to be protected, the human-related activity being addressed, the level of protection, and the time of year.

The different widths of buffers — ranging from 100 ft. to 1½ miles — provide different utilities depending on the specific aspect of resources needing management or protection and the human-related activity being evaluated. Three general rules apply: as distance from breeding wetlands increases, (1) the density of frogs and toads decreases, especially after 1/3-mile; (2) the potential for individual frogs and toads to be negatively impacted declines; and (3) movement corridors and use areas of frogs and toads become increasingly linear, especially after 1/3-mile (e.g., within several hundred yards of breeding sites, frog and toad movement and use patterns are more scattered, but after about 1/3-mile, usually only a small number of "spokes" of use extend outward, typically associated with riparian zones (Turner 1960, Pilliod et al. 2002, Muths 2003, Bartelt et al. 2004, Pierce 2006). In combination, these general rules mean that (1) wider buffer zones are needed for activities with proportionately greater levels of potential impact (e.g., a wider buffer zone would be needed for an oil and gas development than for a small group of trucks/camping trailers); (2) higher levels of protection are needed closer to breeding sites, especially within 1/3 mile; and (3) protective measures need to focus increasingly on riparian zones, immediately-adjoining uplands, and wetlands further from breeding sites (e.g., beyond 1/3 mile).

Important note: This section only sets the stage for identifying buffers for particular activities and facilities, to summarize natural history information of spotted frogs and boreal toads related to distances from breeding sites, and to outline basic principles and concepts related to buffer widths. In part, a purpose of this section is to provide this information in one place and to avoid repeating the same information in many different parts o this report. This section does not provide a review of the scientific literature, nor does it identify specific recommendations for buffering specific activities and facilities.

1. WITHIN 100 FEET OF BREEDING WETLANDS (AND RIPARIAN AREAS)

The main purpose of this buffer zone is to protect the integrity of breeding wetlands and to help protect spotted frogs and boreal toads when they inhabit breeding sites, not when they move beyond these areas. Additionally, when applied to riparian zones, the purpose is to protect the integrity of riparian systems and secondarily to help protect spotted frogs and boreal toads when they inhabit riparian zones.

Why 100 Feet?

A buffer zone of 100 feet from riparian zones and wetlands is common in resource management and was primarily established to protect water quality and aquatic resources, not the species associated with riparian areas or wetlands (see Goates et al. 2007 for supporting literature). In their literature review, deMaynadier and Hunter (1995) said recommended buffer strips for riparian areas range from about 100 ft. to 110 yards. The Logging in Riparian Area Standard of the Forest Plan (USFS 1990b:133) requires that no logging activities take place within 100 feet of riparian zones to protect water quality. Also to protect water quality as well as to protect riparian habitat, one of the best management practices of the State of Wyoming for protecting riparian zones from roads and logging activities is to "closely manage" timber harvest and road construction within 50 ft. (or height of mature trees) of riparian zones where slopes are less than 35% and 100 ft. where slopes are greater than 35% (WDEQ 2004). In their "ideal" category for several forest types (i.e., where meeting the needs of amphibians is a primary focus of management), PARC (2008) recommended maintaining forestland conditions within 50-330 feet of wetlands to maintain cooler, moister conditions near streams and wetlands, and to sustain recruitment of litter and large woody debris; and maintaining large woody debris and standing trees and snags for future large woody debris. Semlitsch and Bodie (2003) recommended full protection within 100-200 ft. of core amphibian wetlands to protect water resources and to provide a buffer to protect the aquatic habitat.

Of all parts of spotted frog and boreal toad habitat, breeding wetlands are the most important and this is where the highest levels of negative impacts can occur as a result of human activities (Maxell 2000, Bull 2005, Carey et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Reaser and Pilliod 2005, Schmutzer et al. 2008, Bull 2009, USFWS 2011). Thus, of any part of their habitat, it is imperative to maintain breeding wetlands and maintain suitable conditions in breeding wetlands, which may require full and complete protection for many human-related activities. It is also important to afford full protection to the greatest extent possible, to a buffer zone around breeding wetlands. The absolute minimum recommended width is 100 feet (deMaynadier and Hunter

1995, Semlitsch and Bodie 2003, Goates et al. 2007), except that PARC (2008) provided a range of 50 ft. to 330 feet. No studies have identified a recommended buffer zone around breeding wetlands that would protect individual frogs and toads from being crushed or otherwise disturbed. Setting the buffer zone at 100 ft. around breeding wetlands should, if activities are properly limited within this area, provide adequate protection to eggs, tadpoles, metamorphs, and adults while they are attending breeding wetlands.

A 100 ft. buffer zone around breeding sites does not include pre- and post-breeding movements, dispersal, summer habitat use, and hibernation habitat. Goates et al. (2007:480) found that “The standard method of creating 30.5m [100 ft.] buffers [around all aquatic habitat, not just breeding sites] does not protect all critical habitats for boreal toads… Toads moved up to 100 m into upland areas, more commonly in late July and August.” Goates et al. (2007:478, 481) also found that “…important portions of breeding sites, overland dispersal routes, upland habitats frequented by toads, and small unmapped streams and seeps used for hibernation were still not covered by the current [100 ft.] buffer zones at six of the seven sites,” and that “…ground truthing and implementation of a 30.5m buffer will not necessarily include all habitats used.” Their results indicate that buffers larger than 100 ft. are needed for boreal toads. Goates et al. (2007) stressed the importance of ground-truthing to make sure all breeding wetlands, perennial streams, and seeps are taken into account when setting buffers for particular activities since they found that seeps and some perennial streams did not show up on GIS layers.

The main habitat elements and vegetation types that are important to spotted frogs and boreal toads at breeding sites and in riparian areas include the following:

- The wetland itself.
- The shoreline area, which includes a small portion of the area’s wet meadow, moist meadow, silver sagebrush-cinquefoil, willow, and forest types.
- Riparian habitat, with the most important types of habitat including wetlands, streams, wet meadow, moist meadow, silver sagebrush-cinquefoil, and willow types.

Pertinent Activities and Facilities

Objectives, suitable condition statements, and recommended management constraints that includes a 100 ft. buffer zone around breeding wetlands or along riparian zones range from carefully controlled (e.g., livestock grazing and recreation), highly restrictive (e.g., roads along riparian areas) exclusionary, (e.g., roads adjacent to breeding wetlands, timber harvest).

The degree of habitat suitability that needs to be restored or maintained and the degree to which activities need to be managed within the 100-ft. buffer depends on the activity and whether it occurs in the vicinity of breeding wetlands or along riparian areas. The following provides a summary of why the different activities may be addressed differently within this zone, but does not provide the basis for restricting each of the respective activities. Additional details and citations are found later in the report.

- <u>Roads and Motor-Vehicle Trails</u> — Given the major adverse effects of roads and motorized vehicle use on several aspects of frog and toad ecology and survival, especially as the distance between roads/motor-vehicle trails and breeding sites declines, restrictions on roads, motor-vehicle trails, and motorized use (including camping) is highest in the 100-ft. zone. Impacts from roads, motor-vehicle trails, and associated use includes road construction, road widening (including incremental increases in width over time), and increases in traffic volumes or changes in the timing of traffic volume. Moving roads out of this zone should be seriously evaluated and considered, especially for boreal toads given their higher conservation concern.
- <u>Oil, Gas, and Mineral Development</u> — Similar to roads, oil, gas, and mineral development has the potential to have major adverse effects on frog and toad ecology and survival when located close to breeding sites and, therefore, restrictions are most applicable within 100 feet of breeding sites.

- Fish Stocking — The main concern with respect to past and present fish stocking is the impacts it has on reproductive success, and this occurs at this geographic scale (i.e., within 100 feet of breeding sites).

- Recreation — Although not as intensive as roads and oil/gas developments, recreation (e.g., campgrounds, dispersed camping, off-trail motorized use) can have major adverse effects on frogs and toads at breeding sites. In some aspects, impacts have the potential to be greater, for example, if people were to camp on the shoreline of a breeding pool and if trucks or ATVs were to drive through or “mud-bog” in breeding wetlands. The BTNF currently does not allow, by a special order, dispersed camping within 100 ft. of streams and lakes. The main reason for the special order is to protect water quality and to protect the integrity of aquatic systems. To the extent it is obeyed, this restriction would also reduce the impacts to spotted frogs and boreal toads that are in the general area, but it does not cover breeding sites in smaller systems like small ponds and wet meadows.

- Livestock Grazing — Of all places to restrict livestock grazing use to protect spotted frogs and boreal toads, the most important is at breeding sites due to the wide range of potential effects of cattle and sheep grazing use at wetlands and the magnitude of these potential effects. Many amphibian experts recommend excluding livestock from breeding wetlands, which provides a default starting point. However, if suitable habitat conditions can be retained (including retention of suitable hiding and escape, shade, humidity at ground level, water quality, water volume, tadpole forage, invertebrate habitat), and if trampling of egg masses, tadpoles, metamorphs, and adults can be kept to a bare minimum, livestock grazing can be accommodated in this zone. While most habitat changes only last until the next growing season, these habitat changes occur every year. Additionally, livestock grazing has the potential to impact the integrity of breeding sites, meaning that long-term factors like species composition and hydrology need to be considered.

- Timber Harvest and Mechanical Treatment — The Logging in Riparian Area Standard does not allow timber harvest activities within 100 feet of riparian habitat (USFS 1990b:133), which is similar to silvicultureal best management practices identified by the Wyoming Department of Environmental Quality (2004). Not allowing logging and mechanical treatment (except possibly cutting with chainsaws and leaving lay in some situations) within riparian areas, as well as within 100 feet of breeding sites, would help protect the integrity of these areas, and it would protect individual frogs and toads from being crushed by heavy equipment, protect against soil compaction and elimination of burrows, and would avoid other impacts. While timber harvest practices and mechanical treatments on any given site typically only occur once every several decades, habitat changes resulting from these activities can last many decades, depending on the habitat component. deMaynadier and Hunter (1995) recommended a no cutting zone along riparian areas of at least 33-82.5 feet, with a wider “light partial cutting” zone outside of this. The suggested determining this width based on stream width, intensity of adjacent harvest, and slope.

- Fire — Fire is not addressed at this scale for several reasons, including that (1) managing fire is imprecise, at the other end of the spectrum from timber harvest; (2) fire is a natural process that periodically directly and indirectly affects many breeding sites, and it is a process that the area’s amphibian community evolved to withstand; (3) fire burns the immediate vicinity of breeding sites infrequently (e.g., on average every 30-50 years at the high end, to every 300 years or more at the low end); and (4) fire tends not to burn into wetland complexes and riparian areas on the BTNF. Also, there are several aspects of fire upon which frog and toad habitat depend, including the period rejuvenation of aspen stands which in turn is needed to maintain beaver pond complexes in some drainages, and reduced conifer canopy cover allows for greater discharge volumes of some springs. For wetland sites where there is a reason to keep fire away from the breeding sites, the 100-ft. buffer zone may provide an option, although the 200-yard buffer zone would provide more protection to the wetland site and shoreline. Small encroachments of fire into the 200 yard buffer would be proportionally narrower than would occur with a 100 ft. buffer.

2. WITHIN 200 YARDS OF BREEDING WETLANDS AND STREAMS/LAKES

The main purposes of this buffer zone (between 100 ft. and 200 yards from breeding wetlands) is to protect the movements of spotted frogs and boreal toads to and from breeding wetlands, to minimize or prevent artificial lighting and artificial noise that can disrupt breeding, tadpole growth, or survival, and secondarily to conserve suitable summer-habitat conditions.

Also, as a separate issue, habitat within 200 yards of perennial streams and riparian areas is important to both species, especially boreal toads since spotted frogs typically do not appear to venture this far from riparian areas except during migration. This corridor is most important within about 1/3 mile of breeding wetlands (see the "Within 1/3 Miles of Breeding Wetlands" section) and 1½ mile of breeding wetlands (see the "Within 1½ Miles of Breeding Wetlands" section).

Why 200 Yards?

From Breeding Wetlands

A buffer of 200 yards would encompass a relatively large proportion of the use area of individual populations, and would encompass important habitats used for movements to and from breeding sites and would minimize effects of artificial lights (e.g., at least those associated with buildings and camping) and artificial noises (e.g., at least those associated with camping and other typical activities on national forests) in the immediate vicinity of wetlands. A buffer of 200 yards serves as way to manage uses and facilities at a geographic scale that is just above that of the breeding wetlands but below the 1/3 mile buffer.

In a review of studies of amphibians and reptiles, Semlitsch and Bodie (2003) found that core terrestrial habitat for amphibians surrounding wetlands ranged from about 175 to 315 yards, based on studies on 19 species of frogs and 13 species of salamanders. For frogs only, they found core terrestrial habitat to range from about 225 to 400 yards. The latter is approaching 1/3 mile (587 yards), which is addressed next. Based on 166 journal articles on amphibian movements, Smith and Green (2005) found that about 30% of amphibians studied in these articles moved a maximum distance of about 220 yards (200 m). For anuran frogs, it was about 18% based on 102 journal articles (salamanders had shorter maximum distances). These are maximum distances moved and they were analyzing data in the context of genetic interchange with adjoining metapopulations, so while this information is insightful, it does not address 'core' habitat.

In a study by Pilliod et al. (2002), the average distance traveled by male spotted frogs between breeding sites and summering habitat was typically less than 200 yards, but average distances among years for females was 480-590 yards, or just over 1/4 mile. About 60% of the locations of male and female boreal toads during spring and summer were within about 220 yards of breeding pools in Bartelt et al's. (2004) study, but this information was only based on toads at one breeding wetland. Based on his results, Bartelt et al. (2004) recommended a buffer zone of about 165-220 yards, which he felt would protect 75% of all (primarily male) movements. In Muths' study in Rocky Mountain National Park, more than half of boreal toad locations during spring and summer were within about 200-225 yards of breeding sites.

Funk et al. (2005) found that about 75% of juvenile spotted frogs in a northern Montana study area remained within about 220 yards of the breeding pond and about 96% of adults remained within about 220 yards of the breeding pond. This appears to be more typical of Great Basin populations in which adults typically remain close to breeding wetlands.

From Perennial Streams and Lakes within 1/3-mile or 1½-mile of Breeding Sites

In studies in which researchers assessed locations of boreal toads relative to water sources, average and maximum distances varied from study to study, but most toads appeared to focus their activities within about 200 yards. Goates et al. (2007) found on the Fishlake National Forest that males appeared to prefer staying near water sources (e.g., within 30 ft.) and that, although females ventured further from water, most stayed within about 330 feet. Brazier and Whelan (2004) said that one of the most important findings of the study reported upon by Goates et al. (2007) was the importance of small (< 1 ft. wide) perennial streams for boreal toad use, particularly in late summer. Long and Prepas (2012) found that male and female toads established their refugia 409 ± 167 and 428 ± 114 feet, respectively from surface-water features (range = 3 – 1,687 feet, or 1 – 622 yards).

Bull (2009) mapped the locations of metamorph and juvenile boreal toads associated with three breeding sites in northeastern Oregon. Nearly all metamorphs and juveniles shown dispersing from one breeding site (Figure 3 in her publication) appeared to remain within 200 yards of streams, although it is not clear how far she looked for metamorphs and juveniles beyond 200 yards from streams and breeding wetlands. At the other breeding site, shown in Figure 3 of her paper, a fairly large proportion of metamorphs and juveniles were further from streams and the breeding site, but most were within about 200 yards of riparian habitat. A small proportion of metamorphs ventured into open forestland and a fairly large proportion of juveniles did. In Schmetterling and Young's (2008) study, relatively large numbers of boreal toads used riparian corridors for travel; 82% of radio-tagged toads were located in riparian areas or in water, and only about 18% were located in upland sites.

In a study by Browne and Paszkowksi (2010) on boreal toad hibernation sites, 30% of sites were within about 110 yards of water; but they did not identify the number or proportion that hibernated beyond about 110 yards and within 200 yards (or any other buffer beyond 110 yards). The percentage within 200 yards presumably was higher than 30% and likely was a fair bit higher than this. Based on other studies, it is likely that most boreal toads did not hibernate far beyond 200 yards from water. As such, compared to the rest of the landscape, habitat within 200 yards provided a disproportionate amount of hibernation sites.

Other studies showed use of uplands by spotted frogs and boreal toads (Pilliod et al. 2002, and possibly Bartelt et al. 2004), with most uplands used by these species occurring relatively close to riparian areas, perennial streams, and wetlands.

While a 200 yard buffer recognizes the importance of upland habitat close to riparian zones and perennial streams, it needs to be recognized that uplands further from riparian zones and perennial streams provide habitat for spotted frogs and boreal toads. Pilliod et al. (2002), for example, documenting several male spotted frogs traveling as far as nearly 1 mile between lakes that had no riparian corridor. Bull (2009) had similar findings for boreal toads.

Pertinent Activities and Facilities

Only five human-related activities and facilities are addressed at this scale. The following provides a summary of why the different activities may be addressed differently within this zone, but does not provide the basis for restricting each of the respective activities. Additional details and citations are found later in the report.

- Roads — Given the potential for roads to limit movements of spotted frogs and boreal toads to and from breeding wetlands and the high potential to increase mortality of spotted frogs and boreal toads as they move to and from breeding wetlands, restrictions on roads, motor-vehicle trails, and motorized use (including camping) is applicable in the 200-yard zone. Activities associated with roads, motor-vehicle trails, and motorized use that cause impacts includes road construction, road widening (including incremental increases over time), and increases in traffic volumes and changes in the timing of traffic volume.

- Oil, Gas, and Mineral Development — These developments have the potential to act as barriers to movements of frogs and toads, impact breeding and survival due to artificial lighting and artificial noises near breeding pools, and to eliminate summer habitat within 200 yards of breeding wetlands. Therefore, the 200-yard buffer width provides an opportunity to manage this use sufficiently to minimize or avoid adverse impacts.

- Timber Harvest and Mechanical Treatment — Timber harvest and mechanical treatment at this scale (between 100 feet and 200 yards of breeding sites and riparian areas) can reduce water quality through elevated sedimentation rates, reduction in moist/humid microsites for frogs and toads, and possibly crushing of amphibians by heavy equipment, depending on timing.

- Recreation — While impacts are less than would occur when dispersed camping sites exist within 100 feet of breeding sites, dispersed camping within 200 yards of breeding sites can have particularly high impacts to reproductive success and to the survival of metamorphs and adults using this zone for migration and summering habitat. Potential impacts include reduced water quality in summer-habitat wetlands, soil compaction and reductions in plant species composition, damage to streambanks, reductions in water quality, elevated mortality rates due to crushing by motorized vehicles, horses, and people.
- Fire — If there were a reason for keeping fire away from a particular breeding site, the 200-yard buffer zone may provide a good option since it is large enough to provide some "room to work" as compared to the 100-ft. buffer zone.

3. WITHIN 1/3 MILE OF BREEDING WETLANDS

The main purpose of this buffer zone is to conserve habitat and manage uses — in what constitutes the core of spotted frog and boreal toad year-round habitat of local populations — in ways that (1) allows the integrity and health of riparian areas and watersheds to be maintained and, if degraded, restored; (2) allows suitable habitat conditions to be retained in wetlands, riparian, and meadow vegetation types; (3) does not disrupt or inhibit frog and toad movements; and (4) minimizes the extent to which survival, reproduction, and growth are directly impacted.

Why 1/3 Mile?

Spotted frogs and boreal toads use a variety of habitats during spring, summer, and fall months and this involves inhabiting favored habitat for extended periods and movement through and between favored habitats. There are several habitat and other elements within 1/3-mile of breeding wetlands that make it the most important habitat for existing local populations of spotted frogs and boreal toads, as summarized in the following three bullets. These bullets summarize information outlined in the "Spotted Frog" and "Boreal Toad" subsections that follow.

- The 1/3-mile buffer zone encompasses the summer habitat for a large majority of spotted frogs and, in some areas, boreal toads in local populations, and likely contains winter habitat for most spotted frogs. Results of most movement studies summarized below in the "Columbia Spotted Frog" subsection support this distance: (1) there was considerable use by spotted frogs out to about 1/4 to 1/3 mile from breeding wetlands; (2) there were no apparent, consistent major reductions in use levels between about 100 feet and 1/4 – 1/3 mile from breeding wetlands; and (3) 75-100% of spotted frogs remained within about 1/3 mile of breeding sites in all studies (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001,Pilliod et al. 2002). Results of some movement studies summarized below in the "Boreal Toad" subsection support this distance: (1) there was considerable use by boreal toads out to about 1/3 mile from breeding wetlands; (2) there were no apparent, consistent major reductions in use levels between about 100 feet 1/3 mile from breeding wetlands; and (3) 75-100% of boreal toads remained within about 1/3 mile of breeding sites in two studies (Muths 2003, Bartelt et al. 2004), although >50% of boreal toads moved beyond 1/3 mile in four studies (Bull 2006, Schmetterling & Young 2008, Bull 2009, Browne and Paszkowski 2010). As such, adequacy of 1/3-mile for boreal toads will depend on the purpose of the buffer.
- Within 1/3-mile of breeding wetlands, frogs and toads are relatively scattered (including in some upland habitats) compared to beyond 1/3-mile where their distribution tends to be concentrated in a small number of riparian corridors radiating out from the core area and immediately adjoining uplands.
- Additionally, if new breeding sites are established by the local population, there is a reasonable chance they would be established relatively close to the existing breeding sites, compared to further distances.

The outside perimeter of core habitat and terrestrial buffer recommended by Semlitsch and Bodie (2003) for amphibians was about 370 yards (289 + 50 meters), but this was limited to "core habitat" which they did not define. The studies summarized below support the contention that a protection buffer of 370 yards would be substantially better than 200 yards for some activities and facilities, but it does not encompass the majority of the habitat used by spotted frogs and boreal toads, as described below. Their recommendations were for amphibians in general, were based on averages among species, and they did not address toads. For frogs alone, the distance would be about 1/4 mile when combining the mean maximum core terrestrial habitat (about 400 yards) and the 55 yard buffer zone beyond this. Going beyond the recommendation by Semlitsch and Bodie (2003) is needed to encompass important habitats of spotted frogs and boreal toads.

Based on 166 journal articles on amphibian movements, Smith and Green (2005) found that about 57% of amphibians studied in these articles moved a maximum distance of about 660 yards (0.375 miles). For anuran frogs, it was about 44% based on 102 journal articles (salamanders had shorter maximum distances). These are maximum distances moved and they were analyzing data in the context of genetic interchange with adjoining metapopulations, so while this information is one piece of information, it is not directly applicable.

The following information is presented in two subsections because there is a substantial amount of information on each species with respect to the geographic scale addressed in this section (“Within 1/3 Mile of Breeding Wetlands”). The post-breeding biology of both species is important in establishing buffers at this geographic scale.

Columbia Spotted Frog

After breeding and for the remainder of the summer and fall, adult spotted frogs move to seasonally ephemeral and permanent pools in meadows and forests, beaver ponds, lake margins, riparian zones, streams, and marshes (Pilliod et al. 2002, Patla and Keinath 2005). Wetland habitat is preferred as summer habitat, but they can travel relatively long distances between breeding sites and summer habitat, with these migrations typically beginning in May and June (Turner 1960) to early July (Pilliod et al. 2002). After dispersal from breeding sites, some individuals follow riparian zones when available, but others make fairly linear migrations across meadows and upland habitats such as big sagebrush communities and forestland. Even for spotted frogs that are moving, the tendency is to occupy small areas for a period of time, followed by short periods of movement (Turner 1960, Patla 1997).

Migrations across dry land pose particular problems for frogs. Bodies of frogs have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist. They regulate skin moisture through the microsites they inhabit. Dumas (1964) reported that relative humidity of 65% at about 78 °F is lethal to adult spotted frogs in approximately two hours. Therefore, for those that migrate from their breeding site when humidity is low and/or temperatures are high, survival may depend on migration habitat that retains higher humidity/moisture at ground level and protection from the sun and predators (e.g., herbaceous and shrub cover) or that provides microsites with these qualities. This may be particularly important for adults that migrate between mid June and early July and juveniles that migrate away from the temporary waters of some breeding sites during late July through mid September (when temperatures are highest, relative humidity is lowest, and rain events may be widely spaced). However, Pilliod et al. (2002) found that some frogs migrated through subalpine fir and lodgepole pine with sparse whortleberry and bear grass, but seeps, springs, and other water sources were available along the way (8,000-8,500 ft. elevation with an easterly aspect).

Studies have shown that a large majority (roughly three-quarters up to 100%) of spotted frogs in individual populations remain within approximately 1/3 mile (587 yards) of breeding sites. While some populations of spotted frogs (e.g., those in the Great Basin) typically do no venture far from water after breeding, other populations have a fairly high proportion of individuals that travel as far as about 450-675 yards (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001, Pilliod et al. 2002) and up to 2/3 mile or more (females) between breeding sites and summer foraging habitat and as far as 1¼ mile for males (Pilliod et al. 2002). In a study of a small number of marked Columbia spotted frogs in Oregon, Dumas (1964:179) reported that “…the farthest that any marked pre-tiosa moved during the studies was 350 yards.” In the study by Pilliod et al. (2002), the average distance traveled by male frogs between breeding sites and summering habitat was typically less than 200 yards, but average distances among years for females was 480-590 yards, or just over 1/4 mile to 1/3 mile. None of the juveniles tracked by Pilliod et al. (2002) traveled further than 350 yards from breeding sites. According to Pilliod et al. (2002), “Hollenbeck (1974) reported annual movements to and from breeding areas ranging from 40 to 550 m [600 yards] in a population of R. luteiventris at 2070 m [about 6,770 ft.] elevation near Hyalite Reservoir in south-central Montana.” Turner’s study was conducted in Yellowstone National Park, Bull and Hayes’ study was conducted in northeastern Oregon, Engle’s study was in southwest Idaho, and Pilliod’s study was conducted in the mountains of central Idaho.

Juvenile spotted frogs moved markedly further distances in a population in northern Montana. Funk found that while about 96% of adults remained within about 200 yards of breeding wetlands, 75% of juveniles stayed within 220 yards from breeding wetlands and about 86% stayed within about 0.62 miles. This means that about 11% moved beyond about 220 yards but did not go beyond about 0.62 miles. Likely a large percentage of these likely remained within 1/3 mile of breeding wetlands. The authors did not provide any additional information to determine the percentage that remained within 1/3-mile.

While the Owyhee Mountain subpopulation is technically part of the Great Basin population, 35% of adult Columbia spotted frogs in Engle’s (2001) study moved more than 100 yards from breeding pools, with 25% moving 100-400 yards and 10% moving more than 400 yards.

Travel distances appear to be consistent with at least some populations in the BTNF; for example, in the Little Greys River drainage (e.g., McCain Meadow and Blind Trail Creek area), some of the ephemeral pools in which spotted frogs were observed during the breeding season were roughly 1/4 to 1/3 mile (440 -587 yards) from the nearest permanent water (DeLong 2009b). Although movements of spotted frogs were not tracked to verify these possible movement distances, they correspond to distances found in studies summarized above.

Based on their research, Pilliod et al. (2002) recommended protecting groups of diverse water bodies and surrounding uplands within about 2/3-mile of breeding ponds. Although this is a larger buffer zone than 1/3 mile, most studies have shown that a large majority of spotted frogs remain within 1/3 mile of breeding sites and the 1½-mile buffer zone also offers some protections as well (see the “Within 1½ Miles of Breeding Wetlands” section, below). Patla and Keinath (2005) also recommended protecting migration habitat.

Movements by juvenile spotted frogs have been shown to be considerably shorter than adults (Pilliod et al. 2002). However, because some of the breeding sites used by spotted frogs go dry, they must move to permanent wetlands and streams which can be as far as 1/4 to 1/3 mile or more away. This necessitates overland travel. Pilliod et al (2002) reported migrations of juveniles to winter habitat occurring in September and October. However, if breeding pools dry shortly after metamorphosis (e.g., mid-July or August), survival would depend on overland movement to more permanent water prior to September.

Boreal Toads

After metamorphosing, young toads move away from aquatic habitat and use moist terrestrial habitats where part of their time is spent under the shelter of moist woody debris and underground cavities, and they spend part of their time basking in the sunlight to thermregulate (Keinath and McGee 2005). Adults are primarily terrestrial and inhabit a great variety of habitats, from non-forested to forested and from dry to wet. Carey et al. (2005) assessed that boreal toads tend to stay relatively close to breeding sites through the summer when suitable wetlands exist near the breeding site, but move further when wetland habitat is more limited. They can travel long distances, traversing through different types of habitats as they move. Hammerson (1982) reported on a study where toads sometimes stayed in the same spot for several days but occasionally moved as far as 165 feet per day between such stays. Some biologists and researchers believe they tend to spend more time in areas such as willows and sedges where the soil is wet or moist (Hammerson 1982, Keith and McGee 2005). Pierce (2006) stated that adult toads move into high grasses and surrounding forests after breeding. Particularly when they inhabit drier habitats, they spend a disproportionate amount of time in relatively moist microsites such as under shrubs, woody debris, and in underground burrows, and they tend to remain near moister habitats. Moist microsites in drier habitats provide protection from evaporative water loss and are used to thermoregulate (supporting literature can be found in the “Mix of Succession Stages in Forests” section (in the discussion of large woody material) and in Appendix A (“Humidity Retention, Temperature Moderation, and Protection from the Sun” section). Adult boreal toads also thermoregulate by basking in the sun.

Some studies of movements in boreal and western toads have shown a tendency by males to remain close to breeding sites (e.g., within about 330-550 yards), but Bull (2006) found that most (71%) males stayed within about 1,100 yards of breeding sites and Schmetterling and Young (2008) found that about two-thirds of adults moved beyond 1/3 mile (they did not distinguish between males and females). These studies showed that females range as far as 1.5-2.4 miles in three studies (Bartelt et al. 2004, Muths 2003, Pierce 2006) and as far as 3.9 miles in a study by Bull (2006). Carey et al. (2005) reported that several adult boreal toads PIT-tagged at one location in northern Colorado were found about 5 miles downstream 1-2 years later.

In a study by Long and Prepas (2012), in which they followed 16 male and 19 female boreal toads, 100% of male toads remained within approximately 570 yards (i.e., < 1/3 mile) through August and the average distance from breeding sites for females was about 780 yards in August (it was about 316 yards in July and about 150 yards in June). The standard error bar for females in August was at about 780 yards, which is approximately 0.45 miles. However, Long and Prepas (2012) did not document distances traveled by September, which may be important because distances had increased substantively between June and July and between July and August; males and females had only moved an average of approximately 30 yards and 150 yards, respectively, in June.

In two studies, a large majority (75-100%) of boreal toads remained within approximately 1/3 mile (587 yards) of breeding sites (Muths 2003, Bartelt et al. 2004), but in two other studies, a majority of toads moved beyond 1/3 mile of breeding sites (Bull 2006, Schmetterling and Young 2008). In Muths' (2003) study in Rocky Mountain National Park, nearly 100% of the locations of male toads were within about 570 yards of breeding pools, and there was a relatively large proportion of locations occurred between about 330 and 570 yards. Approximately 75% of the locations of female toads were within about 570 yards of breeding sites, with a fairly large proportion of locations between about 330 and 570 yards. In Bartelt et al's. (2004) study on the Caribou-Targhee National Forest, about 60% of the locations of male and female boreal toads were within about 220 yards of the breeding pool, and all locations were within 660 yards except for two females (2 of 18 toads, or 11%). In this study, female boreal toads moved as far as 440-660 yards or more from breeding pools, with the average home range size for males as large as about 180 acres. If home ranges were circular (which they are not), the radius would be about 525 yards. Home range sizes of females were smaller, but they were linear. Bull (2006) found that 71% of males stayed within about 0.6 miles (nearly 1,100 yards) of breeding sites, but they did not disclose proportions of males that remained within closer distances like 1/3 mile. Also, about 89% of females moved more than about 1 mile from breeding sites (i.e., substantially further than 1/3 mile).

Schmetterling and Young (2008) found that 34% and 36% of radio-tagged boreal toads in two study areas were re-located within about 0.4 miles of where they were originally captured, meaning that roughly one-third probably were within 1/3 mile. The remaining two-thirds were spread fairly evenly up to as far as about 2 miles. Adams et al. (2005), in the same study area, found that some boreal toads moved downstream as much as 0.3 miles in a single day; this was accomplished in part by floating downstream.

Some researchers have concluded that juveniles move shorter distances than adults, but this is not always the case. As reported by Bull (2009:244), "Muths and Nanjappa (2005) stated that toadlets may remain along the border of their natal wetland to overwinter or may move to nearby terrestrial sites or wetlands. In Colorado, reintroduced *A. boreas* toadlets had dispersed 350–600 m by July and August from the reintroduction area where tadpoles were released (Scherff-Norris. 1999. Final report: Experimental reintroduction of Boreal Toads, *Bufo boreas boreas*. Colorado Division of Wildlife, Denver, Colorado, USA)." Bull (2009), however, found that metamorphs and juveniles moved distances comparable to adults. She did not provide information on the number or proportion of metamorph and juvenile boreal toads that remained within certain distances of breeding wetlands, but illustrations showed (1) that marked metamorphs at one breeding stayed within about 300 yards of the breeding site, and marked juveniles were fairly evenly distributed from near the breeding site to as far as 0.7 miles from the breeding site; and (2) marked metamorphs and juveniles at another breeding site were fairly evenly distributed from near the breeding site to about 1.7 miles. In their study, a substantial number of metamorphs and juveniles moved well beyond 1/3 mile; i.e., in some situations on the BTNF, a buffer of 1/3 mile may not be sufficient for some management issues for some breeding populations.

Patla (2001) and Keinath and McGee (2005) recommended protecting important habitat — not only breeding sites but also the network of upland habitat and migration corridors — from natural and human-caused disturbances that could threaten the survival of boreal toads. Both authors recommended protecting habitat within a 1½ mile radius of breeding sites. Although their recommendation is considerably larger than a 1/3 mile buffer zone, a large majority of toads in 2 of 3 studies remained within 1/3 mile of breeding sites and the third study was conducted on western toads in northeast Oregon. Additionally, the 1½-mile buffer zone also offers some protections as well (see the "Within 1½ Miles of Breeding Wetlands" section, below).

Minimum suitable retention levels of herbaceous vegetation[E] applied to suitable plant communities and wetlands within 1/3 mile of breeding sites would likely encompass distributions of all or nearly all male toads and would encompass suitable habitat for a large portion of female toads. Additionally, (1) limiting cattle utilization within 1/3 mile of breeding would moderate cattle utilization levels surrounding this zone, and (2) the greater the distance from breeding sites, the lower the likelihood that any apparently-suitable habitat would be used by female boreal toads. Because sheep typically do not graze in willow and sedge habitat, they likely have few direct impacts on this vegetation.

Pertinent Activities and Facilities

The following identifies the human-related activities that need to be managed within the 1/3-mile buffer zone and briefly summarizes reasons for differentially addressing the activities within this zone, but the discussion does not provide the basis for restricting each of the respective activities. Additional details and supporting literature are found later in the report.

- Roads — Of all human-related activities and facilities at this scale, roads (e.g., new roads, road widening, maintenance of existing roads, decisions to close/obliterate roads) and changes in traffic volumes may be the most important to the ability to achieve Objective 3.3(a) of the Forest Plan. Roads at this geographic scale can act as barriers to annual movements, dispersal, and emigrations, can reduce the amount of riparian and wetland habitat, and can elevate mortality levels for frogs and toads that do attempt to cross roads.

- Oil, Gas, and Mineral Development — Besides roads (addressed above) and compared to developments located close to breeding wetlands (also addressed above), the main ways in which oil, gas, and mineral developments can potentially hinder the achievement of Objective 3.3(a) is through reductions in reproductive success (e.g., as a result of artificial lights and artificial noise close enough to affect reproduction) and reductions in important summer habitat and winter habitat.

- Fish Stocking — Secondary to the effects of past and present stocking on reproductive success in known existing breeding wetlands, is the past and present effects of stocking on re-initiation of breeding in previously-used breeding wetlands and in other capable habitat. It is likely that breeding would be re-initiated in previously used breeding wetlands and other capable wetlands where frog and toad concentrations are the highest (i.e., within 1/3-mile of breeding sites).

- Recreation — Recreation should be generally addressed at this geographic scale and mostly from the standpoint of the effects of unmanaged motorized use on sedimentation rates in wetlands and streams; elevated mortality rates due to crushing by motorized vehicles; effects of expanding dispersed motorized-vehicle-based camping on plant species composition, soil compaction, and crushing by various means. Within the 1/3-mile buffer zone, recreation is concentrated in the same zone inhabited by amphibians; i.e., the riparian/wetland zone, although camping does not venture into wet meadow and wet willow types while standing water exists. Recreation is annually occurring in the areas that it happens and many times takes place throughout the summer.

- Livestock Grazing — While the primary concern with livestock grazing use is the effects it causes at frog and toad breeding sites (i.e., 100-ft. buffer zone), of concern also are (1) the effects of livestock grazing

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[E] This refers to the proportion or amount of herbaceous vegetation that is retained through the livestock grazing season, typically expressed as a percent of the annual production by dry-weight.

use on factors beyond the 100-ft. boundary that can affect reproductive success (e.g., sedimentation from uplands with low ground cover), and (2) effects of livestock grazing on migration and summer habitat (e.g., changes in plant species composition, soil compaction, reduced humidity retention and shading, reduced invertebrate diversity, collapsing of burrows) and survival (e.g., increased mortality due to trampling, disease transmission). Livestock, especially cattle, typically concentrate in the same vegetation types inhabited by frogs and toads within 1/3-mile of breeding sites (e.g., wetlands, wet and moist meadows, willow, silver sagebrush-cinquefoil types). While herbaceous vegetation grows back every year, livestock grazing reduces it every year.

- Timber Harvest — The 1/3-mile buffer zone is large enough to manage the mix of succession stages within this zone independent of the mix of succession stages on the larger landscape. These and associated effects (e.g., increased water yields, aspen rejuvenation, benefits to beavers) last over the long-term, typically lasting several to many decades. From the standpoint of short-term effects (e.g., crushing by vehicles, reduced water quality in short term), the 1/3-mile buffer zone is of secondary importance to the 100-ft. buffer zone with respect to adverse effects of timber harvest and mechanical treatments because of the lower densities of frogs and toads, ability to mitigate impacts through timing of treatments, relatively small size of treatments if they were to occur, highly controlled nature of management of treatments, and because these effects would occur no more than once every several decades.

- Fire — The 1/3-mile buffer zone is large enough to be able to manage prescribed fire at somewhat of a coarse scale and, to a much lesser extent, fire-use fire and wildfire. At this scale, the benefits of fire could be provided while at the same time minimizing adverse impacts. (See “Fire” under the 100-ft. buffer for more discussion.)

4. WITHIN 1½ MILES OF BREEDING WETLANDS

The main purpose of this buffer zone is to manage uses — in what constitutes the periphery of spotted frog and boreal toad year-round habitat of local populations (i.e., metapopuations) — in ways that generally maintains the integrity and health of riparian zones and watersheds; retains suitable habitat conditions in riparian areas and wetlands used by frogs and toads; and minimizes barriers to movements along riparian corridors, especially as it can affect interchange with adjoining metapopulations. Where riparian area or watershed conditions are less than suitable, a focus should be on restoring these conditions.

Why 1½ Miles?

Although a large majority of spotted frogs and boreal toads do not venture beyond about 1/3-mile from breeding sites in many locations, with only a relatively small proportion of frogs and toads moving beyond this distance, other studies have found a substantial proportion of boreal toads moving beyond 1/3 mile, but generally less than 1½ mile from breeding sites. Important summer, migration, and winter habitat exists between 1/3 mile and 1½ miles from breeding sites. Additionally, providing suitable habitat conditions for spotted frogs and toads between 1/3-mile and 1½ miles of breeding sites will foster dispersal and emigration, which likely will be important in the long term conservation of these species and the ability to achieve Objective 3.3(a) of the Forest Plan with respect to these species (see the “Multiple Stressors and Viability” section). Genetic interchange has been found to occur across large areas for both spotted frogs and boreal toads (Funk et al. 2005, Murrell 2013), further emphasizing the importance of long-distance dispersal corridors.

Patla (2001) and Keinath and McGee (2005) recommended protecting important habitat — not only breeding sites but also the network of upland habitat and migration corridors — from natural and human-caused disturbances that could threaten the survival of boreal toads. Both authors recommended protecting habitat within a 1.5 mile radius of breeding sites. Increasing recognition is being given to conservation efforts being directed at maintaining the capability for periodic emigration from one metapopulation to adjoining or nearby metapopulations. Based on 166 journal articles on amphibian movements, Smith and Green (2005) found that about 84% of amphibians studied in these articles moved a maximum distance of about 1.5 miles. For anuran frogs, it was about 79% based on 102 journal articles. Although 1.5 miles is shorter than the maximum distances traveled by a portion of amphibians — including spotted frogs and boreal toads (Engle 2001, Peirce 2006) — taking appropriate management actions within this distance of known breeding sites, combined with the recognition that additional actions may be needed beyond this zone on a case-by-case basis, would contribute to the ability of individuals from any given metapopulations to emigrate to nearby metapopulations.

While frog and toad habitat should be conserved within 1½ miles of breeding sites, vast acreages of land exist between the 1/3-mile and 1½-mile perimeters (about 4,300 acres), compared to the 223 acres that exists within a 1/3 mile radius, and frogs and toads likely only use a small fraction of the 4,300 acres. Although capable habitat includes riparian areas, wetlands, moist and wet meadows, willow stands, and silver sagebrush, aspen stands, open conifer forestland, and the edges of big sagebrush and dense conifer forestland are also important habitats of boreal toads (Bartelt et al. 2004, Keinath and McGee 2005, Patla and Keinath 2005, Pierce 2006), and spotted frogs also use a range of upland habitat types during migration (Pilliod et al. 2002). Upland habitats are more difficult to map. There are several aspects of habitat, frog and toad ecology, and human-relative activities and facilities within 1½ miles of breeding wetlands, but beyond 1/3 mile, that need to be considered in restoring, conserving, and protecting habitat and managing human-related activities and facilities:

- Riparian areas provide the main corridors of movement to and from key frog and toad habitats and riparian areas provide important summer habitat (Turner 1960, Pilliod et al. 2002, Muths 2003, Goates et al. 2007). Pilliod et al. (2002) recommended protecting groups of diverse water bodies and surrounding uplands within about 2/3-mile of breeding ponds, but this would not protect habitat used by spotted frogs and boreal toads out as far as that recommended by Patla (2001) and Keinath and McGee (2005).

- It is not uncommon for boreal toads to move beyond 1/3-mile and a majority move beyond 1/3-mile in some areas (Bull 2006, Schmetterling and Young 2008, Bull 2009, Browne and Paszkowski 2010). Furthermore, approximately 10 to 25% of boreal toads moved beyond 1½ miles in 3 of 6 movement studies on boreal toads (Bull 2006, Schmetterling and Young 2008, Bull 2009).

- Watershed conditions, including the mix of succession stages, influences wetland and stream habitat conditions, as well as the number and distribution of wetlands. See previous paragraph regarding “surrounding uplands.”

- Facilities that impede migrations and other movements can affect survival, reproductive success, successful establishment of new breeding sites, and emigration.

- Human-related activities and facilities that do not necessarily detract from frog and toad habitat can reduce survival, growth, and reproductive success.

Spotted Frog

In a study in eastern Idaho, Pilliod et al. (2002) found that females traveled as far as 2/3 mile or more from breeding sites and that males traveled as far as 1¼ miles from breeding sites. In a study in southwestern Idaho, a small portion of adult male and female frogs traveled (either as one way trips or as return trips) distances of 1 to 1¼ miles, and one subadult traveled about 4 miles downstream (Engle 2001). In a study by Funk et al. (2005) in northern Montana, about 99% of adult spotted frogs stayed within about 1.24 miles of breeding wetlands, but about 95% stayed within about 220 yards; and about 91% of juveniles stayed within about 1.24 miles, but about 75% stayed within about 220 yards (only about 5% of juveniles and 1% of adults moved beyond about 0.62 miles but not beyond 1.24 miles. In other studies, distances did not exceed about 1/3 mile (e.g., Turner 1960).

Boreal Toad

In most movement studies, a large majority of boreal toads remained within about 1½ miles of breeding sites. In Muths’ (2003) study in Rocky Mountain National Park, Colorado, nearly 25% of locations of female boreal toads were between 2/3 and 1½ miles from breeding sites. Males did not travel beyond about 0.6 miles. At one breeding site on the Caribou-Targhee National Forest, one female boreal toad traveled about 1½ miles from the wetland and one male traveled nearly 0.6 miles (Bartelt et al. 2004), and movements of both appeared to be associated with riparian areas and nearby uplands. Two of 18 toads (about 11%) traveled beyond 660 yards. Wind and Dupuis (2002) reported on the results of a study in Colorado. In this study, female boreal toads moved as far as 440-660 yards or more from breeding pools. Peirce (2006) stated that female boreal toads can range as far as about 1.5 to 2.5 miles. Each study only radio-tagged a small proportion of boreal toads in the populations studied, meaning that the small number of toads traveling 1/3 mile to 1½ miles or more from breeding sites represent larger numbers of toads. Some of the riparian zones beyond 1/3 mile likely provide important habitat for boreal toad populations.

Bull (2006) found that 89% of female western toads moved more than about 1 mile from breeding sites, but it was not possible to determine the proportion that remained within 1½ miles; it appears that 25% or more moved beyond 1½ miles. Only 29% of males moved beyond about 0.6 miles from breeding sites, and at least one moved as far as 0.7 miles, at least one moved as far as 1.4 miles, and at least one moved as far as 2.4 miles (but results were not reported in a way that allowed proportions to be ascertained; each male represents 3.5% of sample size).

Bull (2009) did not provide information on the number or proportion of juvenile boreal toads that remained within certain distances of breeding wetlands, but illustrations showed (1) that marked metamorphs at one breeding stayed within about 300 yards of the breeding site, and marked juveniles were fairly evenly distributed from near the breeding site to as far as 0.7 miles from the breeding site; and (2) marked metamorphs and juveniles at another breeding site were fairly evenly distributed from near the breeding site to about 1.7 miles.

On the other hand, in Schmetterling and Young's (2008) study, 49% and 55% of radio-tagged boreal toads in two study areas, respectively, moved between 0.41 and 1.5 miles from where they were originally captured. Only 9% and 17% of the radio-tagged toads in each study area, respectively, moved beyond about 1.5 miles. These results generally support 1½ miles as a buffer and it increases the importance of this buffer zone for some uses.

Pertinent Activities and Facilities

The following identifies the human-related activities that need to be managed within the 1½-mile buffer zone and briefly summarizes reasons for differentially addressing the activities within this zone, but the discussion does not provide the basis for restricting each of the respective activities. Additional details and supporting literature are found later in the report.

- Roads — At this geographic scale (1½-mile zone), roads (e.g., new roads, road widening, maintenance of existing roads, decisions to close/obliterate roads) and changes in traffic volumes can impair migrations and dispersal, reduce the amount of riparian and wetland habitat, increase sedimentation in wetlands and streams, and increase mortality.

- Oil, Gas, and Mineral Development — Besides new or widened roads and increases in traffic volumes, the greatest potential for impacts of these developments, at this geographic scale, is the reduction in reproductive success (e.g., as a result of artificial lights and artificial noise close enough to affect reproduction).

- Recreation — Effects of recreation at this geographic scale include increased sedimentation in wetlands and streams due to unmanaged motorized use, elevated mortality rates due to crushing by motorized vehicles; reduced plant species composition, soil compaction, and loss of habitat due to dispersed recreation; and crushing by various means.

- Livestock Grazing — At this geographic scale, the main potential effects include reduced humidity retention, hiding cover, shading, and invertebrate habitat in riparian areas; elevated sedimentation rates due to lowered ground cover in uplands and unstable streambanks in riparian areas, especially vegetation types used by frogs and toads; and direct reductions in water quality in wetlands used by frogs or toads.

- Timber Harvest — The main concern at this scale is timber harvest and mechanical treatments that occur near riparian areas that are or may be used by boreal toads. The main potential for adverse effects are increased sedimentation due to timber harvest activities and increased mortality due to heavy equipment operation.

Part II — Suitable Conditions, Risk Factors, and Conservation Actions

The sections of this part of the report (Part II) are arranged by habitat/survival element, rather than by risk factor, in order to focus on achieving and maintaining suitable conditions for the two species, which includes conditions that do not contribute substantively to increased mortality. Forest Plan direction (Objective 3.3(a) and 4.7(d) and Sensitive Species Management Standard) and higher-level direction (e.g., FSM 2670.32.3, FSM 2672.1) focus on the protection of sensitive species from activities that may cause harm and the provision of suitable conditions. This approach places the spotlight on the "near-ultimate" target of management (i.e., provision of suitable conditions on the ground) since the agency does not directly control the ultimate target (i.e., healthy, sustainable, and viable populations of sensitive species on the BTNF). The identification and resolution of risk factors is a crucial part of meeting direction for sensitive species, but they do not provide a "target" for management; rather, they essentially stand in the way of hitting the target and need to be managed accordingly.

The first group ('A') encompasses habitat elements that are long-developing and that address health and functionality of wetlands, riparian areas, rangelands, and forests. In addition to having merit on their own accord (in terms of directly providing/affecting frog and toad habitat), they provide the foundation for providing suitable conditions for habitat/survival elements in the second and third groups ('B' and 'C'). Group 'B' addresses habitat elements that change or can change in the short term, particularly as affected by human activities, and Group 'C' addresses survival and habitat-effectiveness elements that change or can change in the short term as affected by human activities.

A. Long-term, Health / Functionality Elements
   1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat
   2. Mix of Succession Stages in Forests
   3. Occurrence and Extent of Beaver Ponds
   4. Herbaceous Species Composition
   5. Canopy Cover and Health of Willow Communities
   6. Habitat Connectivity

B. Short-term (e.g., Annual) Habitat Elements
   1. Water Quality
   2. Surface-Water Duration in Small Pools (Retention of Water into Mid and Late Summer)
   3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter
   4. Soil Looseness and Maintenance of Overhanging Banks

C. Habitat Effectiveness and Survival Elements Affected by Human Activities
   1. Survival, as Affected by Vehicles, Heavy Equipment, and Livestock
   2. Reproduction and Survival, as Affected by Lights and Noise
   3. Habitat Effectiveness and Survival, as Affected by Fish
   4. Survival, as Affected by Disease
   5. Survival and Reproduction as Affected by Climate Change and UV Radiation

While the section of this report focus on suitable conditions for habitat and survival elements, management is most directly involved with resolve risk factors to the extent possible and practical, and addressing multiple stressors is central to success in attaining and maintaining suitable conditions.

Any changes in the distribution and abundance of spotted frogs and boreal toads on the BTNF likely are a consequence of the culmination of a variety of factors (multiple stressors), rather than just one or two individual factors (Table 2, and see “Multiple Stressors” section in Part I). Some of the factors affecting habitat and survival elements may independently have no more than negligible or minor effects, but together with a large number of risk factors have the potential to cumulatively have considerable impacts on these species. The number of factors affecting any given metapopulation of amphibians likely ranges from a small to large number and the set of factors affecting one population may be substantially different than the set affecting another population.

Factors that may have contributed to reduced distribution and abundance of spotted frogs and boreal toads on the BTNF and that continue to exert stress on populations include , introduction and spread of disease, habitat loss and fragmentation due to roads and trails, mortality from motorized vehicles, trampling by livestock, reductions in herbaceous hiding and thermal cover due to grazing, conversion of wet-meadow communities to moist or dry meadow communities dominated by nonnative grass species due to overgrazing and lowered water tables, accelerated sedimentation of breeding sites due to erosion in historically overgrazed uplands and from roads and motorized trails, reductions in water quality due to defecation and urination by livestock and wildlife, reductions in the proportion of early-seral forest communities and expansion of conifer into non-forest types like meadows, reduction in the amount of water in small breeding pools due to advanced succession and drinking by large numbers of livestock, historic beaver trapping and their recovery, fish stocking in ponds and lakes that did not naturally support trout, increases in atmospheric nitrogen, and climate change and increased UV radiation (Patla 2000, USFS 2009; and Keinath and McGee 2005, Patla and Keinath 2005, PARC 2008; and the large number of citations throughout Part II). Aside from the introduction and spread of diseases, livestock grazing, roads, and motorized use are the factors that have the greatest potential to have affected the distribution and abundance of spotted frogs and boreal toads on the BTNF.

Interestingly, a very recent conservation assessment on Yosemite toads (Brown et al. 2015) identified 16 risk factors, and it identified all of the risk factors summarized on the top of Table 2, except Brown et al. (2015) did not identify oil and gas development, reduced distribution of beaver pond complexes, and noxious weeds as risk factors. Livestock grazing and recreation were identified as the two high priority risk factors (Brown et al. 2015). Apparently, there is no potential for oil and gas development within the range of Yosemite toads.

Table 2. Habitat and other environmental elements and the factors that affect their suitability for boreal toads and spotted frogs. These assessments are based on reviews of information examined in pertinent sections of the report. Elements were not weighted to reflect relative important, so the figures at the bottom of the table are merely summations of columns.

	Factors With Potential to Affect Habitat and Environmental Elements												
Habitat and Other Environmental Elements	Roads, Motor-Vehicle Trails, and Motorized Use	Camping and Associated Activities	Oil, Gas, and Mineral Development	Livestock Grazing	Timber Harvest and Mechanical Treatment	Prescribed Fire, Fire Use, and Wildfire	Reduced Fire-Return Intervals and Fire Suppr.	Reduced Distribution of Beaver Pond Complexes	Artificial Reservoirs & Other Water Developments	Introduced Fish	Noxious Weeds	Pesticides and Other Chemicals	Disease Intro. & Spread
A. Elev. of Water Table and Extent (Width) of Riparian Habitat	N	N	N	N				N					
B. Occurrence and Extent of Beaver Ponds	N				P	P	N	n	N			n	
C. Soil Looseness and Bank Integrity	N	N		N									
D. Water Quality	n/N	n/N	n/N	n/N	n	n		n/N	N		N	n	
E. Retention of Wetland, Stream, and Riparian Habitat	N	N	N	N	N	N	N	N	N				
F. Surface-Water Duration in Small Pools	N	n		n/N	P	P	N	N	N				
G. Canopy Cover and Health of Willow Communities				N		P	N	N/p				n	
H. Herb Species Composition		N		N	P	P	N				N	P	
I. Height and Structure of Herbaceous Vegetation[A]		n		n		n					N	P	
J. Mix of Succession Stages in Forests					P	P	N						
K. Survival as Affected by Trampling by Vehicles and Livestock	n	n	n	n	n								
L. Survival as Affected by Disease	N	N		N	N					N			N
M. Habitat Connectivity	N	N	N						N				
N. Habitat Effectiveness and Survival as Affected by Fish									N	N			
Total P's and p's	0	0	0	0	3	5	0	1	0	0	0	2	0
Total N's and n's	8	9	4	10	4	2	6	6	6	2	3	2	1

P = potential to positively affect (long-term); p = potential to positively affect (short-term or annually).

N = potential to negatively affect (long-term); n = potential to negatively affect (short-term or annually).

[A] This refers only to seasonal effects and effects of plant vigor on height and structure. It does not include effects of plant species composition on height and structure.

A. LONG-TERM HEALTH / FUNCTIONALITY ELEMENTS

Approximating natural conditions and restoring/maintaining healthy conditions for elements in this major section are central to meeting Objective 3.3(a) and other direction with respect to spotted frogs and boreal toads. Together, they form the foundation of conserving these species over the long term. Because these conditions are central to maintaining native wildlife-communities as a whole, the importance of these conditions to spotted frogs and boreal toads is only a small part of the importance of approximating natural conditions and restoring and maintaining healthy conditions. Furthermore, restoring and maintaining healthy, properly-functioning conditions of many of the elements addressed in this section are important for providing for a range of other resources, including water on and off National Forest System lands (e.g., for agricultural irrigation water, domestic supplies), long-term forage for livestock, long-term timber supplies, fuels management, and long-term recreation opportunities. Thus, even if these conditions were not needed for spotted frogs and toads, they are generally needed for a wide range of other resources and uses.

The conditions outlined in this section form the foundation of attaining other suitable conditions and objectives identified in section B.

A.1. DISTRIBUTION AND AMOUNT OF WETLAND AND WET/MOIST RIPARIAN HABITAT

Introduction and Background

This habitat element is highly important because riparian areas, streams, and isolated basin wetlands are the cornerstones of breeding, summer-long, and hibernation habitat for spotted frogs and boreal toads (Maxell 2000, Loeffler et al. 2001, Hogrefe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Goates et al. 2007), and there are many Forest Service-controlled or -influenced activities and developments that have caused or have the potential to cause the loss of riparian and basin wetland habitat on the BTNF. Thus, the distribution and amount of wetland and wet/moist riparian habitat, in combination, plays a central role in meeting Objective 3.3(a) and the Sensitive Species Management Standard with respect to these species.

The distribution and amount of wetland and wet/moist riparian habitat is affected by five major categories of factors. The first four of these are addressed in this section:

1. *Stream Channel Integrity* — The importance of maintaining riparian areas in healthy condition (which necessarily includes relatively high stream channel integrity) has been identified in conservation assessments, plans, and other documents for spotted frogs and boreal toads (Munger et al. 1996, Engle 2001, Loeffler et al. 2001, Keinath and McGee 2005, Patla and Keinath 2005). As an example, Munger et al. (1996) "…found one significant trend: sites with spotted frogs tended to be found in areas relatively low amounts of sagebrush [sic], which would be expected to invade streamsides of heavily degraded streams for which the water table has fallen. In addition, no spotted frogs were found in areas identified as downcut…" Their study encompassed 168 sites.

   The amount of riparian habitat is discussed in terms of the extent of riparian habitat across any given valley bottom or bottom of a shallow draw (valley bottom). The major determinant of the extent of riparian vegetation and wetlands in valley bottoms is the elevation of the water table relative to the elevation of the valley bottom, including the seasonal fluctuation of water tables (Youngblood et al. 1985, Thurow 1991, Ohmart 1996, Shafroth et al. 2000, Ridolfi et al. 2006, Hammersmark et al. 2009), as illustrated in Prichard (1998:13, 17, 90, 91). As the elevation of a water table drops over the long term, the extent of riparian vegetation declines and remaining riparian habitat becomes drier. For example, oxbow wetlands and wetlands in natural depressions shift to wet meadow or moist meadow habitat, wet meadow habitat commonly shifts to moist meadow habitat, and moist meadow habitat can be lost to nonnative bluegrass communities or upland habitat such as mountain big sagebrush (Kauffman and Krueger 1984, Youngblood et al. 1985, Schulz and Leininger 1990, Kovalchik and Elmore 1991). Presence and persistence of small wetlands (e.g., water retained within oxbows and natural depressions in riparian zones) and wet meadows are particularly important to amphibians. Laubhan et al. (2012) assessed that the hydroperiod is the single most important factor controlling the establishment and maintenance of specific wetlands and wetland processes. To the extent that valley bottoms provide drier habitat on the BTNF (USFS 1997, USFS 2004a), fewer wetlands, and wetland habitat for shorter duration into the summer, the lower the quality of the habitat for boreal toads and spotted frogs.

Stream channel integrity has a large influence on water table levels (Ohmart 1996, Rosgen 1996, Prichard et al. 1998; see also Leffert 2005 for supporting references). USFWS (2011) identified lowered water tables and corresponding effects on riparian wetlands and plant communities as one of the biggest threats to spotted frogs in Idaho, Oregon, and Nevada (the geographic scope of their assessment). Stream channel integrity in turn is primarily driven by streambank stability in low-gradient streams which in turn is driven primarily by the composition of deep-rooted sedges and willows (Kovalchik and Elmore 1991, Ohmart 1996, Prichard et al. 1998). Stream channels with accelerated lateral cutting can cut at a downward angle, depending on geomorphology of riparian areas, which can lead to lowering of the water table. Herbaceous species composition and ground cover in uplands can affect stream channel integrity because reduced composition and ground cover can ultimately contribute to higher peak flows, which can contribute to higher erosion of stream channels (Thurow 1991, Satturlund and Adams 1992, National Research Council 1994, USFS 1997).

Although the elevation of the water table relative to the elevation of the valley bottom is not a criterion in assessing proper functioning condition, elevation of the water table is clearly depicted in documents describing proper functioning condition as having a major influence on valley bottom vegetation (Prichard 1998:13, 17, 90, 91).

Down-cutting of trails in riparian areas and non-riparian meadows can have similar effects on the drying of riparian and moist/wet meadow habitat and conversion to non-riparian/non-meadow types. This occurs to the extent that water tables are lowered or water is otherwise drained from affected portions of riparian areas and meadows.

2. *Encroachment by Roads and Other Facilities* **—** Human-related activities and developments that can result in the direct loss of wetland and riparian habitats include placement of roads, reservoirs, and oil and gas developments within wetland and riparian habitat (Satturlund and Adams 1992, Forman et al. 2003, Laubhan et al. 2012). Campgrounds and dispersed camping areas can seriously erode the quality of riparian habitat for spotted frogs and boreal toads.

3. *Altered Hydrology due to Facility Placement* **—** Facilities and other developments that can result in altered hydrologic patterns of springs, streams, and wetlands.

4. *Accelerated Sedimentation* **—** Human-related activities and developments that can result in reduced longevity of wetlands (i.e., accelerated loss of wetland habitat) include placement of roads, reservoirs, and oil and gas developments; diversion of water from springs and streams; elevated sedimentation rates from historic and existing livestock grazing; and elevated sedimentation from roads, trails, recently logged units, and recently burned areas. Reduced longevity of wetlands results in reductions in wetland habitat available to spotted frogs and boreal toads. In her study of the effects of sediment loading on western toads, Wood (2005:37) assessed that "…In the long run, the greater impact of sediment loading on pond-breeding species is likely through pond filling which may alter the hydroperiod and leave little suitable habitat for grazing or refugia."

5. *Occurrence and Extent of Beaver Pond Complexes* **—** This is addressed in the section entitled "A.3. Occurrence and Extent of Beaver Pond Complexes."

The facilities, other developments, and activities that have the potential to affect this habitat element are discussed further in the "Risk Factors and Restoration Factors" subsection, below.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of law, executive orders, and the Forest Plan requires the Forest Service to maintain riparian areas in a healthy, properly-functioning condition, and to protect against the loss of wetlands and riparian habitat to roads and other facilities and, to a somewhat lesser degree, against the premature filling in of wetlands through excessive sedimentation. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to wetlands and riparian areas.

> ***Section 404 of the Clean Water Act (1972, and amendments in 1977) —*** Protection of wetlands. This Act established a major federal program regulating activities in wetlands. Jointly charges the U.S. Army Corps of Engineers and the Environmental Protection Agency with regulating discharge of dredge or fill material into "waters of the United States," which includes wetlands.
>
> ***Executive Order 11990 (1977) —*** Protection of wetlands. This executive order stresses the avoidance, to the extent possible, of long- and short-term adverse impacts associated with the destruction and modification of wetlands, and the avoidance of direct or indirect support of new construction in wetlands wherever there is a practicable alternative.
>
> ***Executive Order 11988 (1977) —*** Floodplain management. Each federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by floodplains.
>
> ***Goal 4.1 (Forest Plan) —*** "Road management preserves wildlife security, soil, visual resource, and water-quality values."
>
>> ***Objective 4.1(a) —*** "Minimize new road building and downgrade or close existing roads and motorized access trails to maintain or increase wildlife security."
>>
>> ***Objective 4.1(b) —*** "Design roads and structures to retain soil, visual resource, and water-quality values."
>
> ***Goal 4.3 (Forest Plan) —*** "Overall diversity of [forestland] and riparian habitats within the Bridger-Teton National Forest are enhanced as timber is removed."
>
>> ***Objective 4.3(c) —*** "Protect and rehabilitate riparian areas to retain and improve their value for fisheries, aquatic habitat, wildlife, and water quality."
>
> ***Goal 4.7 (Forest Plan) —*** "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreation values or experiences."
>
>> ***Objective 4.7(b) —*** "Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present."
>
> The Forest Challenge Statement for minimizing impacts of livestock grazing is as follows: "Overuse of the range by livestock, including pack and saddle stock, can cause unacceptable loss of other resources. The challenge is to manage the levels and locations of grazing livestock to maintain or enhance resource values. If the challenge is not met, resources valuable to the livestock industry and other National Forest users will be lost" (USFS 1990b:82).

> ***Livestock Grazing of Riparian Areas Standard (Forest Plan)*** — "Livestock grazing in riparian areas will be managed to protect streambanks. This may be achieved through the use of gravel crossings, tree-debris barriers, fencing, riparian pastures, development of alternative watering sites out of the riparian area, longer allotment rests, or improved livestock distribution..."
>
> ***Streambank Stability Guideline (Forest Plan)*** — "At least 90 percent of the natural bank stability of streams that support a fishery, particularly Threatened, Endangered, and Sensitive species, and all trout species, should be maintained. Streambank vegetation should be maintained at 80 percent of its potential natural condition or an HCI rating of 85% or greater. Streambank stability vegetation and fish numbers and biomass should be managed by stream type."
>
> ***Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan)*** — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."
>
> ***Restoring Stream Channel Guideline (Forest Plan)*** — "Areas where human activities have resulted in adverse impacts such as channel widening, aggradation, or lowering of the water table should be restored."
>
> ***Streamside Roads Standard (Forest Plan)*** — "Wherever possible, roads will avoid riparian areas or drainageways. Where riparian areas or drainageways cannot be avoided, location and design of roads will apply sediment-reduction practices to prevent degradation of riparian or stream quality. Roads presently within riparian areas will be relocated outside riparian areas where possible."
>
> ***Road Maintenance in Riparian Area Standard (Forest Plan)*** — "Maintenance, improvement, and repair of roads within riparian zones would mitigate impacts of the road to water quality, but would not avoid impacts because erosion and sedimentation would continue, albeit at a lower rate, and roads would continue to be a source of contaminants."
>
> ***Executive Order 13186 —*** requires that all federal agencies must, to the extent permitted by law and agency missions: "…(1) support the conservation intent of migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities…; (2) restore and enhance the habitat of migratory birds, as practicable;… (4) design migratory bird habitat and population conservation principles, measures, and practices into agency plans and planning processes… as practicable…; (5) ...[several qualifiers]… ensure that agency plans and actions promote programs and recommendations of comprehensive migratory bird planning efforts such as Partners-in-Flight, U.S. National Shorebird Plan, North American Waterfowl Management Plan, North American Colonial Waterbird Plan, and other planning efforts, as well as guidance from other sources...," among other requirements. Migratory bird conservation plans point strongly in the direction of restoring and maintaining riparian habitat.

Given the degree to which loss of riparian habitat from roads can impact spotted frogs and boreal toads (see "Risk Factors and Restoration Factors," below), Objective 3.3(a) is an important source of direction for maintaining riparian habitat in healthy condition, for limiting the placement of roads and other facilities in wetlands and riparian areas, and for avoiding and correcting sources of sedimentation that can prematurely fill wetlands where they can impact these species.

Estimated Natural Conditions

Natural conditions for his element constitute the distribution and amount of wetlands and riparian habitat that would exist when streams and springs, streams, riparian areas, and uplands are functioning naturally, as supplemented by a natural distribution and abundance of beaver pond complexes (addressed in another section), and that would exist in the absence of any roads, reservoirs, and any other facilities and developments. This necessarily includes water tables at their natural potential elevations relative to elevations of valley bottoms. "Potential" condition, as shown in State A of Figure 2 and Appendix A, State E of Figures 3 and 4 in Prichard et al. (1998), equate to natural conditions. While the range of natural conditions for this element do not encompass the entirety of suitable conditions for spotted frogs and boreal toads, they encompass a large part of what constitutes suitable conditions for these species since (1) these are the conditions under which amphibian communities formed or developed in this area, and (2) any deviations from these conditions typically result in either less wetland or riparian habitat or drier habitats within riparian zones, which are all contrary to the needs of frogs and toads.

No attempt was made to characterize (e.g., using GIS), either precisely or approximately, the distribution and amount of wetland, stream, and riparian habitat that would exist today under natural conditions.

There are three main reasons why natural conditions in riparian zones and isolated basin wetland habitat provide suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, riparian areas, streams, and isolated basin wetlands are the cornerstones of breeding, summer-long, and hibernation habitat for spotted frogs and boreal toads in this part of the Rocky Mountains (Maxell 2000, Pilliod et al. 2002, Bartelt et al. 2004, Keinath and McGee 2005, Patla and Keinath 2005, Goates et al. 2007). Wetlands in riparian areas (e.g., oxbow wetlands, off-channel wetlands, springs, beaver ponds), streams, and isolated basin wetlands, at a coarse scale, are the only wet habitats in this part of the Rocky Mountains — other than lakes and reservoirs which are typically too deep — that provide breeding habitat for the two species and summering habitat for spotted frogs, except that lakes can provide summer habitat for spotted. Riparian areas are a key component of summer habitat for boreal toads (Bartelt et al. 2004, Keinath and McGee 2005, Goates et al. 2007), are central to migration and possibly emigration and immigration of both species, and are important as hibernation habitat (Keinath and McGee 2005, Patla and Keinath 2005).

Second, riparian habitat and wetlands in healthy, fully-functioning *natural* condition represent the largest amount and widest distribution of riparian and wetland habitat that can possibly be produced across the landscape given the area’s elevation, geologic history, geomorphology, and climate conditions, and assuming a natural distribution and abundance of beavers. In other words, if natural wetland and riparian conditions on the BTNF are less-than-suitable for spotted frogs and boreal toads, it would be impossible to provide suitable conditions on the BTNF. Human-related factors that affect wetland and riparian habitat in nearly all or all cases result in incrementally lesser amounts of these habitats (Chaney et al. 1993, Prichard et al. 1998, Wyaman et al. 2006).

Third, riparian and wetland habitat in healthy, fully-functioning natural condition provide for wetter and moister habitat conditions, than are provided in lower ecological conditions. This is primarily due to higher water tables, elevations of water tables that do not decline as rapidly through the summer, and taller and denser vegetation that helps maintain moisture and humidity (Ohmart 1996, Prichard et al. 1998), and because riparian habitat in healthy condition tend to better support beaver dam complexes. These conditions are important because spotted frogs and boreal toads have a strong dependency on wet and moist environments and the vast majority of the landscape is too dry for them.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural distribution and amount/extent of wetland, riparian, and non-riparian meadow habitat — including particular riparian plant communities according to what naturally would occur on particular sites — in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This in recognizing the importance of beavers in many riparian systems, which is addressed in the “A.3. Occurrence and Extent of Beaver Ponds” section.

There is no need for fine-filter adjustments — i.e., to target greater or lesser extents or amounts of wetland, stream, or riparian habitat than existed under natural condition — because (1) the natural distribution, amount, and characteristics of wetland, stream, and riparian habitat represents conditions under which amphibian communities formed or developed in the BTNF area; (2) the provision of natural conditions, compared to existing conditions, would benefit spotted frogs and boreal toads; (3) improved conditions for spotted frogs and boreal toads, compared to natural conditions, would entail a larger-than-natural amount of wetland and riparian habitat, which is far from realistic and not ecologically defensible; (4) a lower-than-natural amount of wetland and riparian habitat would negatively affect spotted frogs and boreal toads, compared to natural conditions, meaning there is no need, from the standpoint of either species, to provide lesser amounts of their habitat than the land is capable of supporting; and (5) spotted frogs and boreal toads would not be adversely affected by increasing the amount of wetland, stream, and riparian habitat compared to existing conditions. In short, a lower-than-natural amount of wetland and riparian habitat in healthy, fully-functioning condition represents a negative impact and a larger-than-natural amount is not feasible.

One possible exception to the assessment that no adjustments are needed to meet the needs of spotted frogs and boreal toads is that, given the multitude of factors that negatively currently affect these species, along with strong indications of reduced population levels at the BTNF scale and likely disappearance of local populations, a larger-than-natural distribution and abundance of riparian habitat may offset some of these other impacts. However, this would not be feasible. Regaining a natural distribution and abundance of beaver pond complexes would be difficult enough.

Deviations from Estimated Natural Conditions to Accommodate other Uses

Extent of Riparian Habitat Relative to Stream Channel Integrity

It may not be possible to restore and maintain stream channel integrity levels and streambank stability that existed prior to Euro-American settlement given the range of factors currently affecting streambank stability (see “Risk Factors and Restoration Factors,” below) and given the multiple-use mandates of the Forest Service, which in turn means that it would not be possible to fully restore and maintain natural distribution and amount of wetlands and the natural extents of riparian habitat across valley bottoms without eliminating livestock grazing, roads, recreation, and other uses and facilities.

Central to sustaining suitable extents of riparian habitat across valley bottoms is maintaining high stream channel integrity, which depends on stable streambanks, which in turn is greatly influenced by streambank vegetation, particularly in low-gradient streams (Chaney et al. 1993, Elmore and Kaufman 1994, Ohmart 1996, Wyaman et al. 2006). Fisheries biologists on the BTNF identified suitable streambank stability as falling in the range of 75-85% for most stream types (Table 3). They obtained these percentages from Leffert (2005). Leffert had combined local information with Rosgen’s (1996, as cited by Anderson and Fogle 2013) assessment of sensitivity to bank erosion. Anderson and Fogle (2013) provide additional basis for defining suitable streambank stability. The streambank stabilities identified in Table 3 allow for a small amount deviation from natural conditions in order to accommodate livestock grazing, grazing by horses, and other uses.

Table 3. Suitable bank stability based on Rosgen channel type (Adopted from Table 3 in Anderson and Fogle 2013).

	Rosgen Channel Type		
	A1, A2, A6, B1, B2, B3, C1, C2, E3, E4, E5, E6, F1, F2, G1, G2	A3, A4, A5, B4, B5, B6, F3	C3, C4, C5, C6, D3, D4, D5, D6, DA4, DA5, DA6, F4, F5, F6, G3, G4, G5, G6
Bank Stability Objective	85%	80%	75%

These are similar to draft streambank objectives the Forest Hydrologist (Ronna Simon) for the BTNF had developed, in support of the Streambanks Stability Guideline, for cattle allotments in the Gros Ventre River drainage: 80-100% of the length of the banks of B channels are stable; 75-100% of the length of the banks of C channels are stable; and 85-100% of the length of the banks of E channels are stable. These draft objectives were subsequently pulled in as draft objectives for allotment management planning on the Greys River Ranger District. These streambank stability objectives were developed to meet the Streambank Stability Guideline of the Forest Plan (USFS 1990b:126), which calls for a minimum of 90% of the natural streambank stability. By allowing for a

10% reduction from natural bank stability, the “90% of natural” bank stability builds in a certain amount of use by livestock and other uses. Based on the Streambank Stability Guideline, Simon (2008) came up with a minimum streambank stability of 80% (i.e., ≥80% of the length of streambanks is stable) for unclassified streams. For classified streams, she identified the following: ≥80% of the length of B channels are stable, 75-100% of the length of C channels are stable, and 85-100% of the length of E channels are stable. This would result in only minor instances of banks caving in.

Simon (2008) also based her draft objectives on recommended guidelines in the *Caribou National Forest Riparian Grazing Implementation Guide Version 1-2,* Leffert 2005 (Simon 2008:4). Leffert (2005:23) concluded that “It appears that inherent, undisturbed bank stability of channels functioning at full potential ranges from about 70 percent to near 100 percent, depending on the type of channel and streamside vegetation.” The following is an excerpt from the portion of his literature review that identified percentages:

> “The Beaverhead National Forest found a correlation between vegetation communities and inherent stability. Stream types are used in the determination of Sensitivity Levels. Using their information, desirable deeprooted carex and salix communities can be 80-100 percent stable under unimpaired conditions. Overton et al (1995) found A, B, and C reference channel types to be 97 percent, 87 percent and 85 percent stable respectively within the study area. Observations by Leffert (2005) found that if an adjustable channel is more than about 20-30 percent disturbed, channel adjustment processes begin to occur. This is not an ‘instantaneous’ or specific threshold-induced adjustment, rather it initiates a more continuous series of channel adjustments over time to accommodate changes in channel dimension, sediment loading and/or flow changes (Rosgen 1996).” (Leffert 2005:23)

Simon (2008:4-7) also summarized a large number of research papers and existing guidelines and standards used by other national forests regarding minimum streambank stability. A small proportion identified a minimum of 70% streambank stability, but most identified a minimum of 80% streambank stability and a few identified 85% or 90% as the minimum.

Suitable streambank stability outlined in Table 3 are consistent with the recommendation in Keinath and McGee (2005:44), for conserving boreal toad habitat, that a “minimum of 75 percent of the streambank or shoreline should be maintained in stable condition with adequate vegetation or rock/channel characteristics to prevent erosion.

Central to maintaining and restoring streambank stability in most or all of the stream types identified in Table 3 is having satisfactory canopy cover of sedges on streambanks where streambank vegetation is not otherwise dominated by willows or other streambank plant species. Alma Winward (Personal Comm. 2011) stated that 85% of green-lines along low-gradient streams should be dominated by sedges and other strong, deep rooted plants, except where willows limit production of these plants. This is consistent with Platts and Meehan’s (1977, *as cited in Leffert 2005*); they suggested a guideline that most streambank surfaces should have 80 percent or more canopy cover to prevent unacceptable water temperatures, although this is a different measure (temperature vs. bank stability). These percentages are also consistent with estimated relatively-natural sedge canopy cover in riparian systems (see the “Deviations from Estimated Natural Conditions to Accommodate Other Uses” subsection of the section entitled “4. Herbaceous Species Composition in Wetlands, Riparian Areas, and Rangelands”).

The properly functioning condition (PFC) assessment technique provides a way to place “relatively-natural conditions” on a standardized scale (Prichard et al. 1998) that is being fairly widely applied to federal lands. However, it is important to recognize that riparian areas determined to be at “proper functioning condition” can range in condition from potential natural community and late-seral conditions (States “A” and “B” in Figure 2 and States “E” and “D” in Figure 4 of Prichard et al. 1998) to a relatively altered condition with substantially lowered water tables and greatly reduced width of riparian vegetation (States “E” and “F” in Figure 2 and State “C” in Figure 4 of Prichard et al. 1998). Proper functioning condition allows for substantial deviation from natural conditions as a result of human uses so long as major functions of riparian systems (e.g., dissipation of energy, capturing of sediments, floodplain development, flood-water retention, root mass protection of streambanks) are adequately maintained (Prichard et al. 1998). Riparian areas at the lower threshold of proper functioning condition likely do not provide suitable habitat for spotted frogs and boreal toads in many situations because it involves substantial deviation from potential natural community and fully functioning conditions, as depicted in Figures 2, 3, and 4 of Prichard et al. (1998:13,16, 17). Proper functioning conditions near the low-end threshold results in a greatly reduced width of wet and moist riparian vegetation, reduced surface soil moisture and near-ground humidity levels, reduced potential for off-channel wetlands to be filled, and quicker drying of off-channel wetlands. Where willow stands persist (e.g., on terraces) in riparian areas at the proper functioning condition, soil moisture and near-ground humidity levels after early summer may be substantially reduced, particularly if cattle grazing is prevalent under willow canopies.

Using Figures 2 and 4 of Prichard (1998:16, 17), suitable riparian conditions range from potential natural community (State “A” in Figure 2 and State “E” in Figure 4) down to late-seral conditions (State “B” in Figure 2 and State “D” in Figure 4). This allows for some deterioration of stream channel integrity and riparian functionality that appears to be consistent with the Forest Plan Streambank Stability Guideline, which allows for up to a 15% reduction in streambank stability and streambank vegetation compared to natural conditions. At a mid-seral stage (State “C” in Figure 4 of Prichard 1998:17), streambank stability would need to be less than 85% of natural for channel and riparian conditions to reach this stage. Suitable conditions for fisheries in Figure 3 of Prichard et al. (1998:16) range from roughly the midpoint of mid-seral stage through potential natural community, meaning that conditions at or near the PFC threshold are less than suitable. Compared to fish, spotted frogs and boreal toads depend more on water tables being near that of natural conditions (e.g., to facilitate the filling of off-channel wetlands in high flows, slow the decline of water in off-channel wetlands), larger expanses of wet meadow communities, and larger expanses of moist meadow communities. These are several reasons why the lower limit of suitable conditions in riparian areas is late-seral and not mid-seral.

Amount and Distribution of Wetland and Riparian Habitat with Respect to Facilities and Sedimentation

For a variety of reasons, it will be necessary to accommodate most of the existing roads, reservoirs, and other facilities that currently occupy riparian and wetland habitat. Roads are central to providing a wide range of uses such as many of recreational uses, livestock grazing, timber harvest, and access to private lands. It may also be necessary to accommodate additional roads and other facilities in the future, but the benefits need to be carefully weighed against further detriments to spotted frogs, boreal toads, and other riparian/wetland wildlife. Accommodation of these uses will continue to contribute to the populations of boreal toads and spotted frogs that are below the natural distribution and abundance of these species.

A central question here is “how far down can the lower limit of suitability be drawn to accommodate facilities (e.g., roads, reservoirs) while still assuredly meeting Objective 3.3(a), and the Sensitive Species Management Standard, and higher-level direction for sensitive species?”

No attempt was made to determine or model the amount of riparian and wetland habitat that is needed to maintain natural population levels or healthy, well distributed populations of spotted frogs and boreal toads on the BTNF. However, in the process of accommodating roads and other facilities and activities that directly or indirectly contribute to or that cause the direct loss of wetland or riparian habitat while at the same avoiding any further declines in spotted frog or boreal toad populations and to facilitate recovery of some sub-populations, it may very well be necessary to relocate portions of roads and other facilities or to close and decommission others, especially within the current distribution of these amphibian species. The Forest Plan’s Streamside Road Standard clearly requires that future roads avoid riparian areas to the greatest extent possible and that roads currently located in riparian areas will be relocated outside riparian areas where possible.

Based on the importance of riparian habitat to both species, the range of negative impacts of roads on these species, riparian habitat that has already been lost to roads and other facilities, and considering the Streamside Roads Standard and Road Maintenance in Riparian Area Standard, the low-end threshold of suitable conditions for this habitat element includes (1) the existing amount of fully-functioning or near fully-functioning riparian habitat within 1½ miles of known existing breeding sites, at a bare minimum (i.e., no net loss); (2) recovery of as much riparian and wetland habitat as possible, of the acreage that was previously lost to roads and other facilities; and (3) minimize, to the extent practical and in balance with protecting other resources, erosion of soil from roads and motor-vehicle trails into wetlands used by spotted frogs and boreal toads. Because the existing and suitable acreages of riparian and wetland habitat in fully functioning or near fully-functioning condition are not available, suitable conditions need to be stated in these vague terms until a more thorough analysis can be completed. An important part of future work on this habitat component is identifying roads, motor-vehicle trails, and other facilities that are unduly impacting spotted frogs and/or boreal toads.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages, including "deviations from estimated natural conditions to accommodate other uses," and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions were developed in lieu of identifying the minimum acreage of wetland and/or riparian habitat needed within 1½ miles of breeding sites, as this has not been ascertained in the literature and likely depend on a large number of variables.

Extent of Riparian Habitat Relative to Stream Channel Integrity

1. Within capable amphibian riparian habitat[F], riparian plant communities exist across the full extent of valley bottoms on the BTNF as would occur when stream channels and soil moisture patterns in meadows are in relatively-natural conditions, which generally equates to late seral to potential natural community, as shown in Figures 3 and 4 of Prichard (1998:16, 17). Monitoring the extent of riparian habitat would be difficult to undertake, and it in large part will be dictated by the extent to which suitable streambank stability is restored and maintained over the long term. Therefore, suitable condition statement 2, below, would be the main focal point of assessing the degree to which this suitable condition is being met or will be met in the future.

2. Bank stability on streams is maintained according to the values found in Table 3 unless the stream has been determined by a hydrologist, geomorphologist, or fish biologist to be unable to acquire the minimum specified level of stability due to natural geomorphic conditions; in these cases, the minimum streambank stability level will be determined by one of the identified disciplines based on pertinent factors (e.g., driven by to natural geomorphic conditions).

3. Within capable amphibian habitat areas outside of riparian zones, non-riparian wet/moist meadow habitat exists across the full extent of shallow draws and shallow depressions, at or near which would occur under natural conditions.

4. Within riparian habitat and non-riparian wet/moist meadows, a natural mix of vegetation and wetland types is approximated, which generally corresponds to riparian areas being in late-seral condition as defined in Prichard et al. (1998) and does not fully encompass the range of proper functioning conditions (PFC). As an example, where sedge marshes naturally existed, it is important to approximate these conditions (i.e., moist meadow or silver sagebrush communities in their place, due to lowered water tables, provide fewer benefits). As with the extent of riparian habitat across valley bottoms (above), the extent to which a natural distribution and abundance of particular plant communities is approximated in riparian zones is driven by streambank stability over the long term (see '2', above).

Capable amphibian habitat is used as the geographic scope because it likely encompasses a large majority of known existing breeding sites, as well as a large majority of unknown existing breeding sites, historic breeding sites, existing and historic migration and summer habitat, and potential future breeding, migration, and summer

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[F] Capable amphibian habitat of spotted frogs and boreal toads essentially encompasses all riparian vegetation types, moist/wet meadow types, isolated basin wetlands, and other vegetation types within a yet-to-be-determined distance (e.g., ¼-mile, ½-mile) from these riparian, meadow, and wetland types on the BTNF. Silver sagebrush and shrubby cinquefoil types are included as riparian vegetation types. Capable habitat includes breeding, summering, wintering, and a portion of migration habitat. By including migration habitat, this also includes upland habitat the condition of which can affect sedimentation.

habitat. Also, the conditions outlined in suitable condition statement 2 for streambank stability, above, is already being applied to all fish-inhabited streams BTNF-wide.

Attaining and maintaining suitable bank stability is of paramount importance in providing for (1) sufficiently high water tables to sustain moist to wet habitat conditions across valley bottoms and sustained flows through late summer and fall, according to the natural potential; (2) stream channels that do not erode horizontally in a way that maintains lower-than natural amounts of productive riparian vegetation, (3) streambank erosion rates that are within the natural range of variability, such that water quality is not impacted beyond the range of natural variability; and (4) willow and sedge habitat that provides food and dam-building material for beaver, which in turn provide habitat for frogs and toads.

Amount and Distribution of Wetland and Riparian Habitat with Respect to Facilities and Sedimentation

1. As a starting point, the provision of suitable conditions for this habitat element involves the following:
    a. Existing distribution and amount of wetland habitat; i.e., no net loss of isolated basin wetland habitat (no loss to roads, motor-vehicle trails, camping areas, water developments, oil and gas developments, other developments or activities, or to accelerated sedimentation). This includes soil erosion in uplands above basin wetlands that does not exceed near-natural erosion rates, with some accounting for properly constructed and managed facilities and properly managed activities on the land (e.g., roads, trails, livestock grazing).
    b. Existing distribution and amount of riparian habitat within 1½ miles of known existing breeding sites and known historic breeding sites having capable amphibian wetland habitat; i.e., no net loss of riparian habitat to the greatest extent possible (no loss to roads, motor-vehicle trails, camping areas, water developments, oil and gas developments, other developments or activities).
2. Recognizing the negative effects of reducing the amount of available habitat, suitable conditions for this habitat element includes the following, especially within about 1½ to 2½ miles of known existing breeding sites and historic breeding sites having capable amphibian wetland habitat.
    a. Recover isolated basin wetlands that may have been lost to roads, motor-vehicle trails, camping areas, water developments, oil and gas developments, other developments or activities, or to accelerated sedimentation.
    b. Recover riparian habitat that may have been lost to roads, motor-vehicle trails, camping areas, water developments, oil and gas developments, other developments or activities.
3. Allow additional wetland and riparian habitat to form through natural processes.

Targeting the retention of all existing isolated basin wetlands is consistent with (i.e., required by) current laws, policy, and Forest Plan direction with respect to wetlands, which is a precursor to the definition of any statement of suitable conditions and habitat objectives. “Existing breeding sites and known historic breeding sites having capable amphibian wetland habitat” is identified as the geographic scope because restrictions on developments and activities that would eliminate frog and toad habitat are most critical on the BTNF where spotted frog or boreal toad breeding sites exist, but restrictions can only be imposed around breeding sites that are known. Existing and known historic breeding sites only comprise a portion of the capable amphibian wetland habitat, and applying restrictions across all capable habitat would be overly restrictive. This highlights the importance of conducting thorough pre-development surveys to ascertain whether any existing or capable breeding sites would be affected. Objective 3.3(a) and the requirement to avoid or minimize impacts to sensitive species (FSM 2670.32) must be met regardless of whether locations of breeding sites are known. Pre-development surveys and appropriate changes to any development proposal would account for this.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.2. Mix of Succession Stages — Meeting suitable conditions for the mix of succession stages would help meet suitable conditions for the distribution and amount of wetland and riparian habitat by increasing the amount of water reaching or flowing through these types of habitat, primarily as a result of lower rates of transpiration by conifer trees.

A.3. Occurrence and Extent of Beaver Pond Complexes — Meeting suitable conditions for the occurrence and extent of beaver pond complexes would help meet suitable conditions for the extent and amount of riparian habitat by elevating water tables, in some cases increasing the width of riparian habitat or creating riparian habitat where none existed without beaver pond complexes, and by otherwise maintaining and restoring riparian functioning.

A.4. Herbaceous Species Composition — Meeting suitable conditions for herbaceous species composition would help limit the degree to which stream channels are unnaturally scoured due to excessive overland flows and the extent to which water tables are lowered. Depleted ground cover (especially when less than about 65%) contributes to elevated rates of overland flow, which can contribute to increased scouring of stream channels lower in the watershed, which in turn can result in lowered water tables or a narrower width of productive riparian vegetation; and it can also contribute to higher levels of deposition in other places, including contributions to restoring previously down-cut areas.

Meeting suitable conditions for herbaceous species composition would help limit the extent of erosion in uplands and riparian areas and the degree to which sediments reach wetlands. Depleted ground cover (especially when less than about 65%) contributes to elevated rates of overland flow and erosion.

A.6. Habitat Connectivity and C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts) — To the extent new road and motorized-trail construction is prevented in areas used by spotted frogs and/or boreal toads and to the extent roads and/or motor-vehicle trails are eliminated in areas used by these species (e.g., as a result of A.6 and C.1), conditions outlined in suitable condition statements under A.1, above, will be met to a greater degree.

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Meeting suitable conditions for herbaceous retention in riparian areas would help in the process of restoring and maintaining riparian health, which would translate into water tables reflective more of relatively natural conditions, which in turn would provide for conditions conducive of riparian habitat across valley bottoms.

B.4. Soil Looseness and Maintenance of Overhanging Banks — Meeting suitable conditions for soil looseness in riparian areas would help in the process of restoring and maintaining riparian health, which would translate into water tables reflective more of relatively natural conditions, which in turn would provide for conditions conducive of riparian habitat across valley bottoms.

Risk Factors and Restoration Factors

The following risk factors have altered and/or have the potential to alter the extent of riparian habitat in valley bottoms and to alter wetlands, which in turn limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Extent of Riparian Habitat Relative to Stream Channel Integrity

Heavy Grazing on Streambanks — Heavy grazing on streambanks causes them to erode at unnaturally high levels because sedges, willows, and other streambank plants that are heavily grazed cannot maintain the healthy, robust, and deep roots needed to hold streambanks in place (Kauffman and Krueger 1984, Clary and Webster 1989, Kovalchik and Elmore 1991, Thurow 1991, Kleinfelder et al. 1992, Hall and Bryant 1995, Skinner 1998, Micheli and Kirschner 2002a, Micheli and Kirschner 2002b). Over time, accelerated bank erosion in some stream types results in down-cutting of the stream channel or accelerated lateral cutting which can be accompanied by downward movement of the stream channel (i.e., lateral down-cutting). Down-cutting in turn lowers water tables (Chaney et al. 1993, Elmore and Kauffman 1994, Ohmart 1996, Wyaman et al. 2006). When this happens, sedges and other streambank vegetation eventually become replaced by upland plant species, the roots of which do not have the capacity to hold banks in place nearly to the extent that sedges and willows do (Kovalchik and Elmore 1991, Micheli and Kirschner 2002a, Micheli and Kirschner 2002b). As an example, Micheli and Kirschner (2002a) found that banks without wet meadow vegetation are roughly ten times more susceptible to erosion than banks with wet meadow vegetation.

Depleted Ground Cover in Uplands — Depleted ground cover (especially when less than about 60-65%) contributes to elevated rates of overland flow, which can contribute to increased scouring of stream channels lower in the watershed, which in turn can result in lowered water tables (Thurow 1991, Satturlund and Adams 1992, National Research Council 1994, USFS 1997, Holechek et al. 2011). As assessed by USFS (1997:23), “Historically, excessive sheep grazing on the southern end of the forest removed upland vegetation with resulting soil loss and water infiltration reduction… sheep grazing along the driveways created extensive rilling and gullys with the elimination of previous riparian vegetation in headwater areas. In some areas, sheep grazing resulted in a lowering of the stream bed and water table. This caused riparian areas to transform into less stable, drier sites with associated [dry-site plant] species.” This was similarly discussed in USFS (2004a). Riparian habitat comprises a small minority of habitat across the landscape (e.g., <5%), and historic reductions in the amount of moist and wet meadow habitat and small wetlands due to lowered water tables further reduces the amount of this important habitat for amphibians.

Road Effects on Water Tables, Peak Flows, and Water Flow Routes — Roads constructed in riparian areas and close to riparian areas can alter hydrology sufficiently to affect water tables in some situations (Satterlund and Adams 1992, Forman et al. 2003:177-195). In these instances, roads can result in reduced or elimination of flow to wetlands, altered timing of flow, accelerated declines in water level reductions, and conversely, they can result in the creation of wetlands next to roads where the road base impedes surface or subsurface flows. However, creation of wetlands is not a positive effect when this occurs immediately adjacent to a road. Roads in riparian areas and adjacent to riparian areas can also affect peak flows and the routing of water and sediments (Satterlund and Adams 1992, Jones et al. 2000, Forman et al. 2003:177-195).

Reduced Stream Flow Rates — Altered timing and amount of streamflows, including accelerated reductions in flow rates in mid to late summer, contribute to accelerated reductions and larger reductions in water storage and wetland duration in riparian zones. The following are several examples of factors that contribute to altered timing and amount of streamflows, including reduced streamflow rates: water developments, upstream reservoirs, overrepresentation of late-seral conifer forestlands, and expansion of conifer forestlands into non-forest vegetation types (Satterlund and Adams 1992, Sada et al. 2001, Magilligan and Nislow 2005, Graf 2006). Water developments and reservoirs alter the timing and amount of stream flows (Magilligan and Nislow 2005, Graf 2006).

The large increases in the abundance and canopy cover of conifer trees — both in terms of advanced succession throughout conifer forestland types and in terms of increasing abundance and canopy cover of conifers in non-forest vegetation types — reduces stream flows (Bosch and Hewlett 1982, Satterlund and Adams 1992, Pilliod et al. 2003).

Grazing-Induced Headcuts and Down-cut Trails in Meadows — Deep, non-stream channels running the length of some meadows, typically resulting from head-cuts caused by years of heavy or severe grazing or from entrenched recreation and livestock trails, act similarly to agricultural drain ditches that are constructed in areas that would otherwise be too wet to grow agricultural crops. The lowered water table allows crops to be grown that would be adversely affected by too much soil moisture. The same processes hold in native moist to wet meadows. Vegetation that grew in meadows when soil moisture was high is replaced by plant species that are more tolerant of the drier conditions. In combination, reduced moisture levels at the soil surface and reduced height and canopy cover of herbaceous vegetation reduces habitat suitability for spotted frogs and boreal toads. Where native vegetation has been replaced by nonnative bluegrasses or smooth brome, negative impacts to frogs and toads are worse.

Heavy to severe grazing can cause head-cuts to start in meadows and, after a number of years typically create channels that act as drains in at least a portion of the meadow in which they exist. One example of this exists in some of the small meadows intermixed within a lodgepole pine matrix between lower Blind Trail Creek and lower South Fork of the Little Greys River. Most of these meadows have small, intermittent water flows with undefined channels. Head-cuts have formed in many of these meadows and this has resulted in a shift in plant species composition and changes in near-ground moisture levels in mid and late summer (e.g., DeLong 2007). The altered plant communities are easy to see in many situations.

Where down-cutting of trails (including horseback riding trails, hiking trails, cattle trails, and motor-vehicle trails) in meadows is deep enough and where the gradient allows for water to flow down trails, down-cut trails can have similar effects. It is not uncommon for snowmelt and runoff from heavy rains to run down these trails to the point they become heavily eroded. In some situations, where deep trenches have formed, the down-cut trails act similarly to agricultural drain ditches where water tables would otherwise be too high to grow desired agricultural crops. However, the opposite is true for native meadows, where high water tables are needed to maintain native moist meadow and wet meadow communities. To the extent that eroded trails and down-cut intermittent channels (previous paragraph) drain water that otherwise would be retained in the meadow, plant species composition changes to species that can withstand the drier conditions.

Amount and Distribution of Wetland and Riparian Habitat with Respect to Facilities

Direct Loss of Habitat Due to Placement of Roads and Road Widening — The complete elimination of a wetland or a portion of riparian habitat within the distribution of local spotted frog or boreal toad populations can have major adverse effects, especially given the cumulative factors that are affecting populations (Maxell and Hokit 1999, Forman et al. 2003, Keinath and McGee 2005, Patla and Keinath 2005, PARC 2008). Where roads are placed over the top of a wetland or part of a riparian area, these portions of habitats are lost, and this has happened in a wide range of locations across the BTNF.

Loss of riparian habitat acreage due to road construction (including road widening) results from placement of material on top of what previously had supported riparian vegetation in order to build road surfaces, and habitat loss due to creation of two-track and wider roads and motor-vehicle trails results from the compaction and elimination of vegetation in the tracks (Cole and Landres 1995, Douglass et al. 1999, Maxell and Hokit 1999, Patla 2000 and Keinath, Forman et al. 2003). Where road bases have been built up, the width of habitat loss is greater.

Included in this category is the widening of roads, straightening of roads, and re-routing of sections of roads that result in additional loss of riparian habitat. Where road widening, straightening, and/or re-routing results in existing riparian or wetland habitat being covered by road-base or other material, this results in the loss of boreal toad and spotted frog habitat when it is in the vicinity of breeding wetlands and their dispersal areas (i.e., within 1/3 mile to 1-1/2 miles of breeding sites).

ATVs can also cause reductions in the width and amount of riparian habitat, especially in narrow riparian corridors. Meyer (2002) documented how two-track trails in wet areas become braided as riders incrementally pioneer new trails around muddy areas only to have the newly pioneered trails become muddy, prompting riders to create even more trails. On the BTNF, braiding of trails in wet areas occurs in many riparian areas, including narrow riparian corridors with limited riparian habitat, and it contributes to further loss of vegetation in these limited and sensitive habitats.

Direct Loss of Habitat to Oil, Gas, and Mineral Development and Building Complexes — If oil, gas, or mineral development sites or building complexes are located within boreal toad or spotted frog habitat, habitat is lost within the footprint these sites (Loeffler 2001, Keinath and Patla 2005, Patla and Keinath

2005). However, because these types of sites will not be located in riparian areas and will not overlay wetlands, potential impacts to toad and frog populations is less than would occur if sites could be located in riparian areas and on top of wetlands. If oil, gas, or mineral development sites or building complexes are located in the immediate vicinity of breeding sites (e.g., within 100-200 yards), they have the potential to eliminate important summer-long, migration, or winter habitat.

Loss of Habitat to Reservoirs — Existing reservoirs eliminated the riparian and wetland habitats that existed where reservoirs now exist, and in most cases, habitat created by reservoirs is less than suitable for spotted frogs and boreal toads (Maxell 2000; and Brown et al. 2015:65 for Yosemite toads). Existing large reservoirs on the BTNF likely have eliminated frog and toad habitat, but some of the smaller reservoirs may provide habitat that is usable by frogs and toads and, in a small number of situations, may provide suitable habitat. Brown et al. (2015:65) reported that Yosemite toads likely had disappeared in several valleys as a result of reservoirs being constructed.

A constructed reservoir, compared to the habitats that existed prior to its development, can have either positive or negative effects on boreal toads and spotted frogs, depending on the habitats that existed prior to reservoir development, how these habitats were used by toads or frogs, and characteristics of the habitats created including their duration through the summer (Maxell 2000, Patla and Keinath 2005:36,44, PARC 2008). In most cases, creation and maintenance of artificial reservoirs (e.g., water-storage reservoir, stock watering pond) results in a net reduction in habitat quality for boreal toads and spotted frogs and it is not uncommon for creation of artificial reservoirs to eliminate habitat for toads and frogs: (1) reservoirs many times have relatively steep shorelines, (2) water levels rise and fall depending on water demand, and (3) shoreline and emergent vegetation that becomes established many times is heavily grazed and/or trampled due to livestock use (Maxell 2000, Patla and Keinath 2005, PARC 2008).

Alteration of flows below reservoirs can be substantive enough that it eliminates riparian wetlands.

On the other hand, Keinath and McGee (2005:27,41) identified ephemerally flooded parts of reservoirs as providing habitat for boreal toads, and Kindschy (1996) discussed the benefits of small reservoirs for wildlife in general. There is no indication that benefits of reservoirs outweigh negative effects, and differential effects depends on specific situations.

Loss of Habitat to Fire Lines — As explained by Brown et al. (2015:42), “The construction of fire lines or firebreaks by firefighters using hand tools or machinery such as bulldozers may be extensive and result in similar habitat changes as those associated with road and road construction… More than 240 km of 1-10m wide fire line were constructed for a 57,000 ha wildfire in California in 1999 (Ingalsbee and Ambrose 2002).” Fireline construction represents a relatively short-term reduction in habitat and it can also include loss of upland habitat.

Altered Hydrology due to Facility Placement

Loss of Habitat Due to Altered Hydrology Resulting from Placement of Roads and other Facilities — Road construction **—** including construction of roads on top of existing two-track roads and re-routing of sections of road **—** can also alter hydrology, which in turn can lead to the loss of wetlands (Satterlund and Adams 1992, Forman et al. 2003, Andrews et al. 2008). Even when a road is located to the side of a wetland, it is possible for hydrology to be altered enough such that the wetland disappears, declines in size, or is otherwise reduced in suitability for amphibians. Brown et al. (2015:60) cited several studies showing that roads can affect hydrology, with effects including pattern of runoff, surface-water flow, and debris flows.

Water Developments — Depending on how water developments, including diversions, are constructed, they can eliminate spring and/or associated wetland habitat and pools, if the diversion of water is high enough (Kindschy 1996, Maxell 2000, Patla and Keinath 2005, PARC 2008, Brown et al. 2015:65). Even if they do not eliminate spring or wetland habitat, water developments many times adversely affect frogs and toads that used the spring-habitat prior to their development due to alterations in wetland habitat

(Keinath and McGee 2005:38, Patla and Keinath 2005:49). This can be mitigated by protecting the spring source and maintaining sufficient flows in the spring to maintain wetland habitat. Also, in cases in which cattle are impacting a certain spring inhabited by frogs and/or toads, the diversion of some of the water from the spring, if designed properly (including fencing of the source and the return of overflow back to the channel), can mitigate the impacts to some degree (Kindschy 1996, Maxell 2000, Patla and Keinath 2005, PARC 2008).

Amount and Distribution of Wetlands as Affected by Accelerated Sedimentation

Unnaturally high rates of sedimentation can prematurely fill in wetlands, thereby reducing their life span.

Sedimentation of Wetlands, from Less-than-Satisfactory Rangelands — While basin and stream-system wetlands periodically form and disappear as a consequence of soil, geologic, hydrologic processes (in addition to those created by beavers), elevated erosion rates and subsequent sedimentation of down-gradient wetlands have the potential to artificially reduce the lifespan of these wetlands. As discussed in the "Extent of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section, above, and "A.4. Herbaceous Species Composition" section, below, rangelands that have reduced ground cover, especially below 60-65% ground cover, are more prone to have elevated levels of erosion, which translates into elevated levels of sedimentation in down-gradient waters. To the extent this has occurred and is occurring, the net effect would be a reduction in the distribution and abundance of capable amphibian wetland habitat. It is recognized that some sites naturally have <60% ground cover. The section, "A.4. Herbaceous Species Composition" describes the mechanisms for how this occurs. It is unclear the extent to which this may have happened on the BTNF.

Sedimentation of Wetlands, from Burned and Logged Areas — Elevated sedimentation levels, originating from recently burned areas and logging units, have the potential to contribute to a reduced lifespan of wetlands used by spotted frogs or boreal toads. Elevated rates of erosion for one or a few years post-fire is a possible effect of wildfires, fire-use fires, and prescribed burns (Bestcha 1990, McNabb and Swanson 1990, Satturlund and Adams 1992). In some cases, wildfires can result in mass wasting (Bestcha 1990), which if this occurs above a wetland used by frogs or toads especially for breeding, could have a major adverse effect on the local population. It is unclear the extent to which this has happened on the BTNF.

Sedimentation of Wetlands, from Roads and Trails — Elevated sedimentation levels, originating from roads and trails, have the potential to reduce the lifespan of wetlands used by spotted frogs or boreal toads. It is not uncommon for sediments from roads and trails to comprise the largest proportion of sedimentation on a given landscape (Satturlund and Adams 1992, Forman et al. 2003, USFS 2004a). It is unclear the extent to which this is occurring on the BTNF.

Sedimentation of Wetlands, from Constructed Firelines — As noted by Brown et al. (2015:42), "Sedimentation may be the most detrimental road-like effect of firelining on amphibians because unpaved roads are responsible for greater increases in sediment mobility and erosion than either logging or fire per se (Rieman and Clayton 1997). Mechanized equipment is not used in wilderness areas for fire suppression."

***Sedimentation of Wetlands, from Unnaturally High Elk Populations* —** Grazing by unnaturally high population levels and unnatural concentrations of elk likely has altered herbaceous species composition, including a reduction in ground cover, in some parts of the BTNF (see "A.4. Herbaceous Species Composition"), which has potential to contribute to higher rates of sedimentation where affected rangelands are situated above breeding wetlands and other wetlands used by spotted frogs or boreal toads. Differences between natural conditions (including natural population fluctuations of elk) and existing conditions (consistently high numbers of elk) likely have no more than minor effects on sedimentation rates in wetlands, except in limited situations (e.g., adjacent of winter feedgrounds), because even with elevated numbers, elk are substantially more spread out than livestock.

Occurrence and Extent of Beaver Pond Complexes

There are several factors that have impacted the occurrence and extent of beaver pond complexes on the BTNF, and these are listed and discussed in the “A.3. Occurrence and Extent of Beaver Pond Complexes” section, later in this report.

Conservation Actions to Consider

The following conservation actions would contribute to achieving and maintaining suitable conditions outlined above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including deMaynadier and Hunter (1995), Bartelt (2000), Maxell (2000), Patla (2000), Engle (2001), Forman et al. (2003), Holechek et al. (2011), Keinath and McGee (2005), and Patla and Keinath (2005), Shovlain (2006), Andrews et al. (2008), PARC (2008), Schmutzer et al. (2008), and WGFD (2010a,b), as well as other publications cited earlier in this section.

I. General

1. Conduct surveys to locate any existing breeding sites and other capable amphibian wetland habitat that could be lost or otherwise adversely impacted.

II. Grazing by Livestock and Horses on Streambanks

1. Minimum stubble heights can be applied as a means to maintaining (or restoring) streambank stability and stream channel integrity. Typically, if streambanks are in satisfactory condition, a minimum average sedge stubble-height of 4-5 inches is used as a starting point and if streambanks are in unsatisfactory condition, a minimum average sedge stubble-height of 6 inches is used as a starting point (Clary and Webster 1989, Hall and Bryant 1995, Skinner 1998, Clary and Leininger 2000). Some authors have suggested as much as a minimum 8-inch stubble height on sedges (Clary and Leininger 2000, Fraser 2003).

2. Another option is to implement limits on percent of the green-line with hoof prints/slides for the stated purposes. The Forest Hydrologist identified a minimum of 20% of a streambank that can have hoof prints or hoof slide marks (Simon 2008). Above 20%, adverse impacts of hoof action is outside the range of acceptable impacts.

3. Maximum of 30% use of herbaceous vegetation in riparian zones to help maintain proper riparian functioning (Loeffler 2001).

4. Season of livestock use can be adjusted as needed to achieve the objective.

5. Livestock grazing systems can be adjusted. For example, changes from season long grazing to deferred rotation, rest rotation, or other system.

6. Riparian pastures can be created to more closely manage livestock use in riparian areas.

7. More intensive herding, more fences, development of water sources outside of riparian areas, and salt placement can be used to reduce use of streambanks by livestock. However, some of these (more intensive herding and development of water sources) can have adverse impacts on spotted frogs and boreal toads and, therefore, would need to be carefully considered. Place all salt and mineral supplements at least 200 yards from stream, spring, wetland, and riparian habitat (including silver sagebrush).

8. A last resort would be exclusion of livestock from specific habitats of .

III. Livestock- and Recreation-created Channels in Meadows

1. Where cattle trails have eroded downward and act as drains in meadows and where heavy grazing has caused head-cuts to form and work their way up the meadow, actions should be considered to stop or

slow the movement of the head-cut, eliminate the potential for head-cuts to form (e.g., reduced utilization limits), and to fill in channels that have formed (e.g., through a variety of measures, including dropping trees and large woody material into channels). It is imperative that grazing and trailing be managed to avoid reoccurrence of head-cuts being formed and to avoid recovering head-cuts from becoming reactivated.

2. To the extent feasible, eroded and braided trails in meadows should continue to be restored, including methods identified in the previous bullet.

IV. Roads and Motor-Vehicle Trails

1. Avoid any new road construction, any widening of roads, and straightening of roads that would infringe on wetlands and avoid new road construction, widening of roads, designation of motor-vehicle trails, and other alterations of roads and trails that would further reduce riparian habitat within 200 yards of breeding wetlands.

2. Avoid, to the greatest extent possible, construction of new roads, widening of roads, and designation of motor-vehicle trails within or adjacent to riparian areas within 1/3 miles of breeding sites.

3. Consider closing and or re-routing roads and motor-vehicle trails currently within 200 yards of breeding sites.

V. Reservoirs and Other Water Developments

1. Avoid the development of reservoirs and other water developments to the greatest extent possible within areas used by boreal toads and spotted frogs, except where water developments would mitigate impacts of livestock use of springs and other natural water sources. In these cases, water developments would need to be excluded from livestock and horse use.

2. When installing water developments and when applying for water rights for these developments, ensure that sufficient water remains available in the spring area and in down-gradient wetlands the springs may sustain, and ensure that livestock cannot access the spring area and associated wetlands (e.g., through the use of an exclosure).

VI. Oil, Gas, and Mineral Development

1. Ensure that the footprint of oil, gas, and mineral developments are beyond 200 yards of known existing breeding wetlands and historic breeding wetlands with capable habitat and are at least 200 yards from riparian areas when within 1/3 mile of toad and frog breeding sites.

VII. Camping

1. Minimize and, to the extent possible, prevent the establishment of dispersed camping sites and other intensively-used recreation sites in riparian areas and non-riparian meadows within 1/3 mile of boreal toad and spotted frog breeding sites, with special attention of reducing dispersed camping sites within 200 yards of breeding sites.

2. Avoid any developments — including oil, gas, and mineral developments, building complexes, and other similar developments — within 200 yards of breeding sites.

3. To the greatest extent possible, avoid any developments associated with camping within 200 yards of riparian areas when within 1/3-mile of breeding sites.

VIII. Livestock Grazing Effects on Erosion and Sedimentation

1. Ensure that livestock grazing is being managed to meet ground cover and plant species composition objectives reflective of healthy rangelands above breeding wetlands and other wetlands used by spotted

frogs and boreal toads. If existing ground cover and plant species composition are below objective levels for riparian or rangeland health (e.g., see suitable ground cover leves in “A.4. Herbaceous Species Composition”) — and if it can be demonstrated that low ground cover levels are natural — take proper action to ensure appropriate adjustments are made to livestock management to maintain upward trends.

2. Implement other BMPs pertaining to livestock grazing, as necessary, to minimize excessive erosion.
3. Exclusion of livestock from breeding sites using fences would be a last option.

IX. Vegetation Treatment

1. Adhere to Forest Plan standards and guidelines, National best management practices, and State of Wyoming best management practices with respect to logging and vegetation treatments, as needed, to ensure that logging, mechanical treatments, and prescribed burning to not accelerate erosion above breeding sites and above other ponds used by spotted frogs and boreal toads.

Measures and Indicators

Currently Monitored Elements

The monitoring elements identified in the following short lists are currently being monitored across the BTNF in a range of locations, but the application per district varies, and it may be necessary to review locations relative to the needs of spotted frogs and boreal toads, recognizing that these species are just two of a large number of criteria that need to be considered when selecting monitoring sites.

Where the elevation of water tables is influenced by streambank stability (and ultimately stream channel integrity), the following factors can be used as a proxies of the extent (width) of riparian vegetation in valley bottoms (Burton et al. 2011). Both are being monitored by hydrologists, fisheries biologists, and range management specialists on the BTNF. Amphibian habitat needs should be considered when establishing sites to monitor these elements.

- Streambank Stability
- Stream Channel Integrity

The following is being used in short-term (annual) assessments of whether stable streambanks are expected in the near future or whether upward or downward trends in streambank stability are expected in the near future:

- Retained Stubble Heights on the Green-line – This is an easily-measured indicator of whether stable, upward, or downward trends would be expected in streambank stability. Typically, if streambanks are in satisfactory condition, a minimum average sedge stubble-height of 4-5 inches is used as a starting point and if streambanks are in unsatisfactory condition, a minimum average sedge stubble-height of 6 inches is used as a starting point (Clary and Webster 1989, Hall and Bryant 1995, Skinner 1998, Clary and Leininger 2000). Some authors have suggested as much as a minimum 8-inch stubble height on sedges (Clary and Leininger 2000, Fraser 2003). Use of stubble height for limiting adverse impacts to streambanks caused by livestock use is different than using stubble height as a measure or assessment of the suitability of herbaceous vegetation for spotted frogs and boreal toads. An average stubble height of 4 inches is less-than-suitable and an average of 6 inches probably is not suitable either (Appendix A). Because stubble height is measured only along the green-line, the less-than-suitable habitat along this thin linear corridor is of little consequence so long as suitable habitat is provided as discussed in B.3 Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter.
- Streambank Shearing on the Green-line – Use of streambank shearing as a short-term indicator of whether stable, upward, or downward trends in streambank stability will be expected was initiated recently on the BTNF (Simon 2008). It is a more indirect indicator than stubble height because stubble height of sedges indicates the degree to which sedge roots will hold banks in place and sedge roots are the most important

bank stabilization factor (Chaney et al. 1993, Elmore and Kaufman 1994, Ohmart 1996, Wyaman et al. 2006). However, the extent of streambank shearing also indicates the amount of livestock use. There is no indication that monitoring streambank shearing would indicate the retention of suitable habitat conditions for spotted frogs and boreal toads through the livestock grazing season, except for the potential of maintaining overhanging banks.

The following elements currently being monitored by rangeland management specialists or hydrologists/water-right specialists can be used to assess (i.e., indicate) the potential for erosion in uplands and subsequent elevated sedimentation rates, and changes in water flow from springs. Amphibian habitat should be considered, albeit in limited situations, when establishing sites to monitor the first two elements.

- Ground Cover – This is the main element that is monitored on the BTNF to indicate the extent to which uplands absorb water (e.g., infiltration and percolation) and transport it downslope on the soil surface during and after precipitation events. The lower the ground cover and the greater proportion of the water that flows overland, the greater the potential for erosion and subsequent sedimentation in wetlands and stream systems. Even though rocks >3/4 inches in diameter are counted as ground cover, and even though they protect the soil from the impact of raindrops, they do not facilitate infiltration to the extent that plants and litter/organic matter do (and rocks do not replace many other functions of vegetation they may have replaced as a result of soil loss and reduced cover of herbaceous vegetation). Therefore, the most meaningful part of ground cover for watershed functioning is total ground cover minus rock cover.

- Herbaceous Species Composition – Although herbaceous species composition is secondary to ground cover (minus rock cover) in terms of watershed functioning, it adds substantive information that can be used to assess the extent to which uplands absorb water and transport it downslope on the soil surface during and after precipitation events (see previous paragraph).

- Reductions in Flow Volumes due to Spring Developments and Diversions – Prior to developing each new water source, either as a water source for livestock grazing on the BTNF or for private individuals off of National Forest System lands, the water flow (in terms of cubic-feet-per-second) is currently being assessed relative to the total flow of the spring and the net effects on spring, stream, and/or wetland habitat.

Additional Monitoring Elements to Consider

Where the elevation of water tables is influenced by eroded trails and other created channels that act like drain ditches in meadows and willow-meadow complexes, the first two factors listed below can provide some indication of the elevation and extent of water tables or soil moisture patterns in these habitats. The third factor addresses sedimentation and reduced longevity of wetlands.

- Number and Proportion of the Length of Trails in Meadows that are Down-cut sufficiently to affect soil moisture in adjoining plant communities, including recreational, livestock, and other trails.

- Movement Rates of Head-cuts

- Sedimentation Rates Originating from Roads and Trails

Riparian and wetland habitat retention and loss could be more directly measured in terms of the following:

- Acres of Riparian/Wetland Habitat Retained across the BTNF — This essentially is the acreage of wetland and riparian habitat, by vegetation type, existing at any point in time in the future, and can be ascertained through GIS, recognizing this would take time to complete.

- Acres of Riparian/Wetland Habitat Already Lost — Determining the acres of wetland, riparian, and spring habitat already lost to roads, reservoirs, and other facilities and activities would take substantially more time to complete and would be based on more assumptions.

- Acres of Direct Riparian/Wetland Habitat Loss, by Project — This would apply to new construction of roads; oil, gas, and mineral developments; and other developments.
- Springs Lost or Adversely Impacted, by Project

A.2. MIX OF SUCCESSION STAGES IN FORESTS

Introduction and Background

Increasing attention is being given to the importance of terrestrial habitat in the conservation of amphibian populations (Skelly et al. 1999, Marsh and Trenham 2001). Marsh and Trenham (2001:47), for example, concluded that "Terrestrial habitat may be exceptionally important to the conservation of amphibian populations. Management plans that focus only on preserving ponds or wetlands will probably fail to maintain viable amphibian populations." As an example, in a study of 100 radio-tagged western toads, Bull (2006) found that 81% of post-breeding locations were on land and only 19% were in water. Just as important is that terrestrial areas not used by spotted frogs and boreal toads have large effects on habitats used by them (e.g., water cycling, sedimentation, beaver activity).

The mix of succession stages is a central terrestrial habitat element because the mix of succession stages and the processes that drive this mix (e.g., fire) affects the distribution and abundance of beaver pond complexes; water flow rates of springs (and whether otherwise-capable breeding wetlands contain water and duration of water in some wetlands); level of shading of breeding wetlands; the provision of non-forest habitat near existing and capable breeding wetlands; the provision of healthy aspen, willow, and meadow habitat (i.e., not overtopped by conifers); provision of moist micro-sites and cover; potentially sedimentation and longevity of some wetlands (e.g., due to post-fire accelerated erosion); and possibly post-fire conditions in breeding wetlands, which has potential to substantially affecting occupancy and reproductive output in breeding wetlands. These are all discussed in detail below.

Even though effects of any individual factor identified in the previous paragraph may not affect spotted frog or boreal toad populations across the BTNF to any appreciable degree, individual factors have the potential to have relatively large effects on local populations. For example, large effects can occur if all or most ponds in a given drainage have disappeared due to lack of beavers, if several key breeding wetlands are impacted by greatly reduced spring output due to expansion of conifer forestland, or if tadpole survival is reduced due to premature drying caused by reduced spring output and/or shading of breeding pools.

In assessing the effects of an altered mix of succession stages and the ecological processes and management practices to restore a more natural mix, effects need to be viewed in terms of (1) conditions and processes that naturally occurred in amphibian habitat (e.g., periodic fire and the habitat changes this brought), and (2) conditions and processes that spotted frogs and boreal toads did not evolve with (e.g., forest openings with limited large woody material, soil compaction, crushing by heavy equipment). Vegetation treatments can be undertaken in ways that mimic or approximate many of the conditions produced by natural processes like fire. As viewed in terms of coarse-filter conservation, habitat conditions under which the amphibian community of the BTNF evolved or developed are within the range of suitable conditions even though some specific conditions may be somewhat unfavorable. The biggest concerns, then, are (1) a mix of succession stages that is outside the range of natural variability and (2) human activities and human-caused conditions that do not approximate natural conditions or processes and that may reduce reproductive success or survival.

Many factors related to the mix of succession stages and the actions to restore a natural mix of succession stages affect or potentially can affect boreal toads and spotted frogs. As a summary, (1) it appears that the greatly expanded fire return intervals on many parts of the BTNF and the concurrent large overrepresentation of late-seral forestlands are working against the attainment of Objective 3.3(a) and the Sensitive Species Management Standard with respect to boreal toads and spotted frogs, and (2) while timber harvest and mechanical treatment would help increase the amount and distribution of early-seral communities, they have several adverse side effects, including loss of habitat to roads, reductions in large woody material, soil compaction, and crushing by vehicles (on roads) and by heavy equipment (in treatment units).

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction specifically on sensitive species — which generally call for suitable conditions (which for spotted frogs and boreal toads necessarily addresses a mix of succession stages) to be provided — the following provisions of the Forest Plan and an executive order requires the Forest Service to work toward achieving and maintaining a desired mix of succession stages for sensitive species and other wildlife species, and for other resources and uses. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to the mix of succession stages.

The desired mix of succession stages has not yet been defined for the BTNF, despite the very large number and variety of resources and uses dependent on a mix of succession stages. Defining the desired mix will be a multi-disciplinary effort. For wildlife conservation on national forests, the 2012 Planning Rule (USDA 2012) clearly points in the direction of restoring and maintaining a natural or relatively natural mix of succession stages since this is a basic coarse-filter condition in forest systems, recognizing the planning rule may not direct management on the BTNF for several more years.

Wildlife (including amphibians) and Other Resources and Uses

***Goal 4.2 (Forest Plan)* —** “Other resource values are retained or improved as timber is removed from the Bridger-Teton National Forest.”

***Objective 4.2(a)* —** “Apply silvicultural practices to achieve documented, site-specific, multiple-resource objectives on lands suited—scheduled—for timber production.”

***Objective 4.2(b)* —** “Cut or remove timber to meet documented, site-specific recreation, wildlife, visual, or water-production objectives on lands not suited—unscheduled—for timber production.”

These objectives have the potential to support the attainment of a suitable mix of succession stages for spotted frogs and boreal toads, but would require site-specific objectives to be formulated in part for spotted frogs and boreal toads.

***Goal 4.3 (Forest Plan)* —** “Overall diversity of [forestland] and riparian habitats within the Bridger-Teton National Forest are enhanced as timber is removed.”

***Objective 4.3(a)* —** “Provide for vegetative species and age diversity, genetic quality, and forest appearance.”

***Objective 4.3(b)* —** “Provide for diverse habitats to ensure viable populations of management indicator species.” [Note: boreal toads are one of the BTNF’s MIS.]

Vegetation: General Prescription (Forest Plan) — “Whether range or timber, vegetation management activities enhance diversity of plant communities and various successional stages of those plant communities within the Management Areas. For aspen, priority is placed on perpetuating stands being invaded by conifers. Vegetation treatment projects are designed to retain diverse age classes.”

***Vegetation: Timber Prescription (Forest Plan)* —** “A wide range of silvicultural opportunities is used to manage the timber resource consistent with other resource objectives.”

Other Wildlife and Other Resources and Uses

Goal 2.1 (Forest Plan) — Adequate habitat for wildlife, fish, and edible vegetation to help meet human food needs is preserved.

Objective 2.1(a) — Provide suitable and adequate habitat to support the game and fish population objectives established by the WGFD. [A mix of succession stages is a key part of big game habitat.]

Goal 1 (Forest Plan) — "Conserve the Canada lynx."

> ***Objective VEG O1 —*** Manage vegetation to mimic or approximate natural succession and disturbance processes while maintaining habitat components necessary for the conservation of lynx.
>
> ***Objective VEG O3 —*** Conduct fire use activities to restore ecological processes and maintain or improve lynx habitat.

Water Yield Standard (Forest Plan) — "When developing silvicultural prescriptions to increase water yield, preference will be given to the following site conditions and cutting unit specifications: soils with depths greater than two feet, stands with crown closure greater than 50 percent and basal areas greater than 100 square feet, north and east aspects, toe slope or bench locations, less than 10 acres clearcutting size, and cutting unit widths will be five to eight times the average tree height of the adjacent stands."

Executive Order 13186 — requires that all federal agencies must, to the extent permitted by law and agency missions: "…(1) support the conservation intent of migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities…; (2) restore and enhance the habitat of migratory birds, as practicable;… (4) design migratory bird habitat and population conservation principles, measures, and practices into agency plans and planning processes… as practicable…; (5) ...[several qualifiers]… ensure that agency plans and actions promote programs and recommendations of comprehensive migratory bird planning efforts such as Partners-in-Flight, U.S. National Shorebird Plan, North American Waterfowl Management Plan, North American Colonial Waterbird Plan, and other planning efforts, as well as guidance from other sources...," among other requirements. Migratory bird conservation plans, with respect to forestlands, point strongly in the direction of restoring and maintaining a natural mix of succession stages.

In consideration of all resources and uses on the BTNF, amphibians only provide a small part of the reason for providing a mix of succession stages, but they do provide substantive contribution to the reasons for the need to restore and maintain a relatively natural mix of succession stages.

In the process of designing and implementing prescribed burns, mechanical treatments, and timber harvest projects, the Forest Service needs to adhere to the following provisions of Forest Plan, in addition to meeting Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction specifically on sensitive species.

Goal 4.2 (Forest Plan) — "Other resource values are retained or improved as timber is removed from the Bridger-Teton National Forest."

> ***Objective 4.2(c) —*** "Prevent logging or certain logging practices where potential effects on other resource values, including wildlife, Threatened and Endangered species, recreation, soils, air, visual resource, and water-quality values are unnacceptable."

Goal 4.3 (Forest Plan) — "Overall diversity of [forestland] and riparian habitats within the Bridger-Teton National Forest are enhanced as timber is removed."

> ***Objective 4.3(c) —*** "Protect and rehabilitate riparian areas to retain and improve their value for fisheries, aquatic habitat, wildlife, and water quality."

Logging in Riparian Area Standard (Forest Plan) — "The following logging requirements will be used in riparian areas: log landings and decking areas will not be allowed within riparian areas; directional falling of trees away from a stream will be required; logging slash will be removed from riparian areas—the exception is where large woody debris is placed in the streams for habitat improvement projects; and a mature forestland appearance will be maintained within 100 feet of live streams."

Estimated Natural Conditions

There are many interrelated elements related to and affected by the mix of succession stages. Amphibian habitat is affected in many different ways.

Natural Mix of Succession Stages

Natural conditions for his element constitute the mix of succession stages that would exist under a natural disturbance regime (as generally outlined in Table 4), and it includes the immediate effects of natural disturbances. While the range of natural conditions for this element do not encompass the entirety of suitable conditions for spotted frogs and boreal toads, they are encompassed within the range of suitable conditions for these species since these are the conditions under which amphibian communities formed or developed in this area and because a natural mix of succession stages, e.g., compared to existing conditions, provides for a wide range of suitable habitat conditions (e.g., as affected by beaver pond complexes, output of springs). A natural mix of succession stages reflects what can be sustained in the BTNF area in the absence of human-related impacts on fire frequency and spread (e.g., fire suppression) and in the presence of fire and other major disturbances. It likely is impractical to attempt to maintain a larger proportion of late-seral forestland than existed under a natural fire regime because eventually conditions will bring these forests into “balance” and may possibly overshoot the proportion of early succession if attempts are made over the long term to limit the conversion to early succession and to maintain a larger-than-natural proportion of forestland in late succession (Brown 1975, Hessburg and Agee 2003, Hessburg et al. 2005, Lehmkuhl et al. 2007). Domination of much of the BTNF landscape by lodgepole pine, aspen, and big sagebrush types is a strong indicator of relatively frequent fires and a relatively small proportion of the each type in late succession (Brown 1975, Knight 1994, Hessburg and Agee 2003, LANDFIRE 2007). Also, a natural mix of succession stages contributes to proper watershed functioning and to healthy forestland, rangeland, and riparian areas, which is needed to long-term sustainability of spotted frogs and boreal toads.

Table 4. Midpoints of an approximate natural mix of succession stages (age classes) of each major forestland type and the typical number of years post-disturbance for each succession stage, primarily based on LANDFIRE’s (2007) biophysical setting models. The mix of succession stages is based on the span of years that each vegetation type remains in a particular stage and not specific structural attributes at each succession stage.

Vegetation Type	**Early**	**Mid**	**Late**
Aspen	10-40% *(0-10 yrs)*	20-30% *(11-40 yrs)*	40-75% *(>40 yrs)*
Lodgepole Pine (seral)	5% *(0-25 yrs)*	30% *(26-70 yrs)*	65% *(>70 yrs)*
Lodgepole Pine – poor sites	15%	65%	20%
High-Elevation Spruce-fir	10% *(0-40 yrs)*	30% *(41 to 80-110 yrs)*	60% *(>80-110 yrs)*
Douglas-fir (most areas)	10% *(0 to 20-40 yrs)*	20% *(21-41 to 70-140 yrs)*	70% *(>70-140 yrs)*
Douglas-fir (just above sage zone)	20%	15%	65%
Douglas-fir – Dry, south slopes	1%	87%	12%

Unfortunately, LANDFIRE (2007) only identified midpoints or averages, except that a range was derived from their information for the aspen type. To be more useful and biologically meaningful, ranges should be added to this information (i.e., to present a natural range of variability), which may require reviewing additional literature.

Discussions of the mix of succession stages in this report highlight early succession and late succession, recognizing that mid succession also influences habitat suitability of spotted frogs and boreal toads, as well as recognizing that mid succession proceeds from early succession. Early-seral and late-seral forestland each have a range of beneficial and negative effects on spotted frogs and boreal toads. Because there are both positive and negative effects of late-seral and early-seral forest communities, a balance is needed between them. However, no attempt was made to identify an optimum mix of succession stages because there are far too many direct, indirect, cumulative, and possibly synergist effects that would need to be accounted for, not to mention differences in optimum mixes depending on topography, vegetation types, sizes and juxtaposition of these vegetation types, distance to water, and other factors. And furthermore, there likely are differences in optimum conditions for spotted frogs and boreal toads… not to mention the other 130+ vertebrate wildlife species and other uses of the BTNF. For these reasons and for reasons described elsewhere in this report, a key premise is that, as the proportion of late-seral communities increase above the natural range of variability and as the proportion of early-seral communities declines below this range, the net effect on spotted frogs and boreal toads is negative. Support for this line of reasoning is outlined in discussions that follow.

Natural Fire Regime

The amphibian community in the BTNF area developed over time in habitats that were heavily influenced by fire, as recognized by Patla (2001) and Keinath and McGee (2005). Patla (2001:10) prefaced her discussion of the effects of fire on boreal toads with the following assessment: "The fire-adapted nature of forests (conifer and aspen) on the BTNF suggest that natural fire regimes pose no threat to the persistence of native amphibians" (Patla 2001:10). Keinath and McGee (2005:38) prefaced their discussion of the effects of fire on boreal toads with the reality that "Fire is a natural event through which boreal toads have historically survived as a species. Fire suppression may indirectly affect boreal toad habitat by altering the natural succession cycles in forest communities" (Keinath and McGee 2005:38). Pilliod et al. (2008) also recognized that fire is a natural part of amphibian habitat and that amphibian communities that formed in areas with relatively frequent fire return intervals are adapted to this disturbance. PARC (2008) recommended, in their "maximizing compatibility" category of recommendations (i.e., where needs of amphibians are met along with other uses) for several forest types, to manage for a variety of stand ages and types to provide a variety of habitat conditions at the stand and landscape levels. They also noted that western toads (of which boreal toads is a subspecies) may have been adversely affected by years of fire suppression and the contributions this has had to canopy closure in conifer forests. Furthermore, Hossack and Corn (2007) identified possible major benefits of periodic fire to boreal toads.

Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns

With the above considerations in mind, the following subsections outline functions of the most important habitat components associated with late-seral communities and early-seral forest communities, from the standpoint of the habitat needs of spotted frogs and boreal toads. No attempt was made to define natural conditions for each of habitat components described below, mostly because conditions of each are driven by the mix of succession stages. Where information exists, effects of natural conditions of particular components are discussed.

The estimated natural mix of succession stages, especially where aspen occurs near water courses, appears to provide a suitably balanced mix for spotted frogs and boreal toads. It provides a large, well-distributed base of late-seral forestland, which is especially important to boreal toads, and it provides for many of the benefits of early-seral communities, including higher water flow volumes, greater abundance of aspen which can translate into more beaver pond complexes, and short-term increases in large woody material (post-burn). The current overrepresentation of late-seral forestland in most parts of the BTNF likely is exacerbating negative effects of late-seral forestland on spotted frogs and boreal toads. Moving toward a natural mix of succession stages (Table 4) would benefit spotted frogs and boreal toads, as most of the effects of late-seral forestland are negative and most of the effects of early-seral forestland are positive, especially for spotted frogs which do not use forestland habitat. At some point, however, increasing the proportion of early-seral communities beyond natural conditions would detrimentally affect boreal toads and possibly spotted frogs. However, there is little need for exploring this end of the spectrum because it will be difficult enough to increase the proportion of early-seral communities to an approximation of natural conditions.

Two of the following 8 habitat components/functions of late-seral forestland (water quality and density of large woody material) positively affect boreal toads, 1 of the 8 components/functions of late-seral forestland (water quality) positively affects spotted frogs, and 2 of the 8 components/functions of late-seral forestland (shading of breeding pools and other factors affecting wetlands in late-seral forestland, and conifer trees and overstory canopy cover) have mixed effects on boreal toads.

- Evapotranspiration and Water Flow Volumes – The proliferation of conifer trees — both in terms of advanced succession throughout conifer forestland types and in terms of increasing abundance and canopy cover of conifers in big sagebrush, mountain shrubland, aspen, grassland, meadow, and willow communities — has the potential to be reducing water flow of springs and streams (Satterlund and Adams 1992, Pilliod et al. 2003) and may also be accelerating evapotranspiration of surface water in some breeding wetlands which reduces the chance of tadpole survival (Maxell 2000). Reduced water spring and stream flows in turn has the potential to be reducing water inflow (either surface or subterranean flows) into some of the pools, ponds, and other wetlands used by frogs and toads on the BTNF, including some used for breeding. Skelly et al. (1999) found this to be the case in their Michigan study area. They found that incrementally higher levels of tree canopy cover (i.e., a consequence of advancing succession) was inversely related with hydroperiod of breeding ponds, to the point that ponds were drying as much as 2.5 weeks earlier, compared to 20-30 years earlier and lower percent canopy cover of trees, but given similar amounts of rainfall. Skelly et al. (1999) concluded that breeding-pond hydroperiod and tree canopy cover at breeding ponds were the two factors that most influenced amphibian distributions in their study area in Michigan. Pilliod et al. (2003) stated that "Pearson (1994) suggested that possibly the most important effect of fire on wetlands may be the change in frequency and spatial configuration of habitats in the surrounding landscape," and one of the factors involved is the effects of vegetation cover type on evapotranspiration rates that can affect subsurface water.

  A natural proportion of late-seral forestland (and a natural proportion of non-forest vegetation types having a preponderance of conifer trees) would limit, compared to existing conditions, the extent to which evapotranspiration and reduced water flows would negatively impact wetland habitat.

  Just as overrepresentation of late-seral conifer forests has the potential to reduce water flow into wetlands and just as it may accelerate evapotranspiration of surface water, a higher proportion of a forested system in early succession would incrementally alleviate these problems. More water would make it to springs, streams, and wetlands, which would be particularly important if there are situations where water volumes are insufficient to support the initiation of breeding or where wetlands dry before metamorphosis is complete (i.e., if this is being caused by reduced flows caused by high canopy cover of conifer trees).

- Distribution and Abundance of Beaver Pond Complexes – The mix of succession stages in areas where aspen exist near stream channels likely affects the availability of beaver ponds for spotted frogs and boreal toads in many places on the BTNF (this is addressed in the "A.3. Occurrence and Extent of Beaver Ponds" section, above). The prevalence of advanced succession and expanded fire-return intervals on many parts of the BTNF has reduced the prevalence of aspen on the landscape due primarily to increased abundance and canopy cover of conifer (Gruell 1980a, Gruell 1980b, USFS 1997, Loosen et al. 2009). This includes major declines in aspen on some sites formerly occupied by beavers (Gruell 1975), and it is possible that aspen declined in some of these places as a combined effect of conifer expansion and continued harvest of aspen by beavers. This likely is having a major effect on population distribution and abundance of spotted frogs and boreal toads in some drainages of the BTNF (see the "A.3. Occurrence and Extent of Beaver Pond Complexes" section for the basis for this assessment).

  A natural proportion of early-seral forestland, particularly where aspen exists on the landscape, would facilitate the restoration of the distribution and abundance of beaver pond complexes across the BTNF.

  Just as the aging of forests on much of the BNTF's forests has resulted in aspen becoming effectively unavailable to beaver in many drainages, conversions of late-seral conifer forest to early-seral aspen communities in drainages formerly occupied by beaver would, in the long term, facilitate the return of beavers to these drainages. This in turn has the potential to greatly benefit spotted frogs and boreal toads given their dependence on beaver ponds where other wetlands are not available (Maxell 2000, Patla and Keinath 2005, Reaser and Pilliod 2005, Amish 2006, PARC 2008, USFWS 2011).

- Acreage of Meadow, Willow, and Aspen Communities – The abundance and canopy cover of conifers in willow, aspen, and meadow communities is altering plant community composition and structure (e.g., reduced canopy cover of willow and aspen, reduced composition of graminoid species), which could displace spotted frogs and possibly boreal toads (e.g., see the “A.5. Canopy Cover and Health of Willow Stands” section, above). The expansion of conifer trees into willow, aspen, and meadow communities is a natural process (i.e., vegetation succession), but under natural conditions this was counteracted by periodic fire and riparian areas in healthy, fully-functioning condition (e.g., water tables high enough to prevent successful establishment of conifer trees. Where conifer trees have overtopped willow, aspen, and meadow communities, fire and hydrologic functioning that eliminate conifer trees and allow willow, aspen, and meadow communities to return would benefit spotted frogs and boreal toads that would use these habitats if not dominated by conifers. Additionally, the large woody material from the conifer trees would be an added benefit for a period of time in these communities after a fire.

- Shading of Breeding Pools and Other Factors Affecting Wetlands in Late-Seral Forestland – Conifer canopy cover can restrict sunlight into small isolated pools, which may be limiting forage production for tadpoles and can limit growth rates (Maxell 2000, Carey et al. 2005, Reaser and Pilliod 2005). Reaser and Pilliod (2005:563) asserted that “Pooled water with strong sun exposure… are critical components for persistence of Columbia spotted frogs.” Carey et al. (2005) discussed in detail the importance of having water temperatures consistently between about 60 ºF and 85 ºF during long periods each day (especially the upper end of this range) for boreal toad tadpoles to metamorphos before freezing temperatures in the fall; the dense conifer trees adjoining wetlands on the south and southeast shores can limit the extent to which this occurs. Maintenance of late-seral communities in areas occupied by boreal toads in Glacier National Park appears to have maintained low visitation of boreal toads at breeding sites and low reproductive rates (Hossack and Corn 2007) until breeding sites and surround lands burned in wildfires (see further discussion in “Effects of Increases in Early-seral Communities,” below). This has the potential to be affecting boreal toad distribution and abundance on the BTNF given the greatly reduced fire return intervals in most parts of the BTNF.

  Assessments of the effects of fire and logging on breeding ponds and reproductive success are mixed. Some experts view effects of reduced tree canopy cover and altered forest structure next to ponds as detrimental, but no studies in which specific measures of reproductive success were cited to support their assessments with respect to spotted frogs and boreal toads, or close relatives.

  Two studies and one set of observations suggest that fires and logging in the vicinity of breeding pools are beneficial to boreal toad breeding and may be neutral or beneficial to spotted frogs breeding. Hossack and Corn (2007:1407) “…did not find any evidence that suggests that the Moose Fire [in Glacier National Park] negatively affected occupancy or vital rates of the three amphibians we studied.” They found that Columbia spotted frog occupancy of breeding sites appeared to be similar between wetlands inside and outside the fire, and they did not detect any signs of reduced occupancy. In fact, they previously had concluded that occupancy by spotted frogs increased in wetlands that burned, but changed their conclusions after they incorporated detection probabilities into their analysis.

  Hossack and Corn (2007:1408) concluded that “…wildfire seems to create favorable conditions for *B. boreas*, at least in the short term.” They found that 9 burned wetlands were used for breeding in two years immediately after the fire in an area where no breeding had been detected and adults had rarely been seen. Reproduction then declined markedly in the third year, at which time no breeding was detected. However, they continued to observe numerous juvenile toads within the fire perimeter during the years after the fire, indicating there was recruitment from some wetlands in the fire perimeter. They also reported on another fire in Glacier National Park in which boreal toads were found breeding in more than 20 wetlands the year after the wildfire in an area where extensive surveys in 4 years had identified only 3 breeding sites.

  Hossack and Corn (2007) did not identify any clear indication as to why boreal toad use of wetlands increased after being burned. They did not detect any difference in temperature of burned wetlands used for breeding compared to those that were not used for breeding; however, it was not clear whether they compared burned wetlands and those that were unburned. They cited sources showing that boreal toads can fairly quickly respond to disturbances that create early successional habitats. One possibility is increased nutrient loading that can happen for several years after fires (Pilliod et al. 2003).

Semlitsch et al. (2009) found that clearcutting in three study areas in the eastern United States resulted in increases in all measures of reproductive success in leopard frogs (e.g., tadpole survival, mass at metamorphosis) and gray tree frogs (e.g., calling by males, oviposition by females, growth rate of tadpoles). An exception was that several measures of reproduction in wood frogs were negative and none were positive. These results for breeding wetlands contrasted with results for adults and juveniles in forests/clearcut areas for the species studied.

Given the apparent negative effects of too much shading of breeding wetlands for both species and apparent benefits of fire to boreal toad breeding areas, movement toward a greater amount of fire on the landscape and a natural mix of succession stages would likely benefit spotted frogs and boreal toads. Even the mixed results point in the direction of a natural mix of succession stages because, where there are differing results of scientific studies or where there is some question of effects, the best approach is to approximate the conditions under which amphibian communities formed or developed in this area.

- Recently Burned Habitat – Guscio et al. (2007) found that 22 radio-tagged western toads in Glacier National Park selected for sites that were burned the previous summer at a high level of severity. The author did not provide any descriptions or quantifications of habitat (e.g., availability of large woody material, shrubs, herbaceous vegetation) or distances to moist microsites. Nonetheless, however, the strong statistically-significant results demonstrate some level of benefit in some types of habitat. Hossack and Corn (2007) appears to lend some support to this.

- Water Quality – Late-seral forestland mostly has positive effects on water quality, primarily in the form of protecting soils from erosion. This serves to limit the amount of sedimentation, thereby facilitating higher water quality and allowing wetlands to persist longer as a consequence of low sedimentation rates.

  On the other hand, high-severity fires may result in sediment delivery to downstream breeding sites, which can affect tadpole survival (Satturlund and Adams 1992, Maxell 2000, Patla 2001, Pilliod et al. 2003, Keinath and McGee 2005). In some small streams, sedimentation may increase to 10-100 times natural levels for 10 years or more (Pilliod et al. 2003). Sedimentation can also reduced the longevity of wetlands (see "Wetland, Stream, and Riparian Habitat Retention" section), particularly as a consequence of large flushes of sediments which can occur with heavy rains following a severe fire. Another impact to water quality due to fires is an increase in concentrations of nutrients such as soluble reactive phosphorus, ammonium, nitrate, and nitrite in streams and wetlands (Pilliod et al. 2003, citing seven studies in support of this). Some species have been shown to be sensitive to elevated levels of nitrites and nitrates (Pilliod et al. 2003).

  These negative effects of wildfire on water quality, under a natural fire regime, were naturally occurring at a relatively small number of wetlands in the BTNF area at any given time and were relatively short-lived at these wetlands. These low-frequency, short-lived impacts at any given wetland need to be assessed in the context of the large number of benefits associated with a natural mix of succession stages.

- Conifer Trees and Overstory Canopy Cover – The most important functions of mature trees appear to be shading, the retention of moisture on the forest floor where canopy cover is high enough to "hold in" the moisture, and the future provision of large woody material. Forestland typically provides a higher availability of moist microsites, as compared to forest openings and other non-forest communities, for summering boreal toads and for migrating spotted frogs (Bartelt et al. 2004, Keinath and McGee 2005, Rittenhouse et al. 2008), but much of this relies on large woody material (addressed in the next bulleted subsection, below).

  Despite the large amount of large woody material in some mature and old forests and their preference for large woody material, there is no indication that boreal toads preferentially select forestland over other habitats, and they appear to select against closed-canopy forests (Wind and Dupuis 2002, Bartelt et al. 2004, Bull 2006, PARC 2008). Although many closed-canopy forests are moist, they appear to have too much shading and too little solar radiation for toads to be able to maintain a preferred body temperature. Rafael (1988). Wind and Dupuis (2002:12) assessed that "Toads are often found in clearcuts, and may favour these habitats to closed canopy forests in coastal habitats (Raphael 1988, Dupuis 1998, Davis 2000, Matsuda, unpublished data) and interior habitats (Ward and Chapman 1995, Gyug 1996)," and noted that the extensive shading and cool temperatures in mature forestland — with few openings that permit sunlight to hit the ground — appeared to be a limitation to occupancy by western/boreal toads, and that openings created by fire (and timber harvest) may be beneficial. Where radio-tagged western toads used areas with tree cover, Bull (2006) found they selected for sites of lesser tree cover and lesser density of trees than was measured at random locations during the course of two seasons (100 toads were radio-tagged in this study). Thus, epidemics of mountain pine beetles and other insects and disease that increase mortality of conifer trees likely benefit boreal toads.

For reasons described above, most use of forestland habitat by boreal toads occurs along the edge between forestland and non-forestland and in open-canopied forests, with few toads venturing very far into closed-canopied conifer forests (Raphael 1988, Wind and Dupuis 2002, Bartelt et al. 2004, Bull 2006). The importance of edges to a variety of species and the way in which edges benefit wildlife are discussed in Thomas et al. (1979b).

The periodic creation of early-seral plant communities in forests (i.e., following major reductions in conifer canopy cover) is a natural part of forest ecology in this area (Knight 1994, Patla 2001:10, Keinath and McGee (2005:38), LANDFIRE 2007), and recently-burned forestland are within the range of suitable habitat conditions for boreal toads so long as sufficient large woody debris are retained (Raphael 1988, deMaynadier and Hunter 1995, Wind and Dupuis 2002, Bartelt et al. 2004, Bull 2006). Openings that are created by fire likely are favored by boreal toads because they typically contain high densities of large woody material and the amount of large woody material increases over time as additional snags fall, thereby providing moist microsites well into the future. Furthermore, abundance and canopy cover of herbaceous vegetation and shrubs increases substantially following fire in many situations, adding to their favorability by toads (see "Shrub and Herbaceous Cover," below).

Based on a study of radio-tagged western toads in northeastern Oregon, Bull (2006) found that areas recently burned by stand-replacement fires (and that were not subsequently logged) were used by toads in proportion to their occurrence, but other indications in their study and results of all other studies appear to indicate at least some selection for small to medium-size openings in forestland. Bull (2006) found that toads moved shorter distances from breeding sites in burned forests than in green forests, possibly indicating that some elements of habitat are more suitable in burned forests. They also found that areas with no trees and seedlings were used more and older forest stands used less than expected based on availability ($P<0.001$). Furthermore, toads occurred in forest openings >50 ft. in diameter 62% of the time and in forests 38% of the time, compared to 39% of random points in openings and 61% of random points in forests.

A thorough review of forest management practices and their effects on amphibian ecology can be found in deMaynadier and Hunter (1995). Although most studies involved timber harvest practices, effects of reduced forest overstory cover through timber harvest are likely similar to effects of fire, except that higher densities of large woody material and no soil compaction (i.e., greater benefits and fewer negative impacts) would occur with fire. In 18 studies reviewed by deMaynadier and Hunter (1995), they found that anurans as a group were less abundant on 6-month to 40-year-old clearcuts as compared to abundance on uncut control plots. However, in studies in which toads were part of the amphibian community, anurans as a group were more abundant — in three of four studies cited in Table 1 of deMaynadier and Hunter (1995) — in young clearcuts greater than 6-months than in uncut control plots. In fact, the *only* studies showing a greater abundance of amphibians in clearcuts were studies in which toads were part of the amphibian community. Keinath and McGee (2005) noted that boreal toads appear to be less vulnerable to habitat changes following timber harvest than other amphibian species.

Wind and Dupuis (2002) cited five studies indicating that western toads are often found in clearcuts and possibly favoring clearcuts to closed-canopy forests. In a study by Raphael (1988) in Douglas-fir forestland in northwestern California, western toads were substantially more abundant in young clearcuts than in 4 of the 5 other age classes; abundance was similar in 50-150 year-old stands. The clearcut stands had an average of about 36 tons/acre of woody material >3 diameter as well as shrub cover, although the amount of shrub cover was not identified. While Bartelt et al. (2004) found that boreal toads in avoided *young* clearcuts in their eastern Idaho study site, they found that male toads showed greatest selection for meadow, shrub, and 10-year clearcut patch types (i.e., over open-canopy and closed-canopy forests). Bartelt et al. (2004) stated that "…clearcuts had large amounts of solar radiation, but only small amounts of protective cover, which often was concentrated (e.g., slash piles)." Pilliod et al. (2003) also noted the increased solar radiation resulting from fire. This makes large woody debris an important issue. Female toads showed greatest selection for shrub and open-forest patch types.

In research conducted on the Targhee National Forest, by Bartelt (2000, as cited in Patla 2001) found that habitat structure directly affects micro-environmental conditions, which in turn has considerable effects on toad behavior. He felt that excessive cover removal can negatively affect toad habitat because of the drying of micro-habitats, and he found that toads avoided the interior of clearcuts and other regeneration harvest treatment areas. However, leaving a sufficient amount of large woody debris during timber harvest and mechanical treatments would provide suitable microsites for frogs and toads. Increases in shrub cover would add to these microsites (Bartelt 2000, as cited in Patla 2001).

Late-seral forestland is needed to provide for future supplies of large woody material, both in forested habitats and in recently burned forests. Given the many decades that it takes to produce large enough trees to provide large woody material (including the sometimes long period of time it takes for conifers to reestablish on some sites) and given the much shorter duration of logs, a majority of forestland needs to be in late succession.

For reasons discussed above, a natural mix of succession stages — compared to the current overrepresentation of late-seral forestland and underrepresentation of early-seral communities — would benefit spotted frogs and boreal toads. While boreal toads inhabit conifer forestland, they only do so along edges where conifer canopy cover is high and they also inhabit recently burned forestland and a range of non-forested habitats (Muths 2003, Keinath and McGee 2005, Bull 2006).

- <u>Density of Large Woody Material</u> – Large woody material is available to boreal toads in two main situations: in mature to late-seral forestland and in recently burned forestland, including where they immediately surround or adjoin breeding wetlands and summer wetlands. Bartelt et al. (2004) found that large woody material was used regardless of habitat type (for those types in which large woody material is typically available). Results of Bartelt et al. (2004:464) "…suggests that toads selected habitats with available cover, and then used the cover in ways that met their immediate needs for thermoregulation (e.g., basking) or conserving body water (e.g., sitting in underground burrows or shaded, moist soil)." Bull (2006) provided more definitive data showing that western toads select sites with relatively high densities of large woody material, as well as high densities of rocks and burrows, for use as cover and moist microsites. Large woody material likely is only used by spotted frogs during migrations and other movements. The importance of large woody material for amphibians in general as moist microsites is discussed in detail by PARC (2008). Maser et al. (1979) described in detail the log decomposition process and the different micro-habitat functions they serve through each successive class of decomposition.

  When boreal toads inhabit conifer forestland, including open canopied forests and woodlands, large woody debris provides important moist microsites (Raphael 1988, Patla 2001, Bartelt et al. 2004, Keinath and McGee 2005, Bull 2006, PARC 2008, Long and Prepas 2012). In closed-canopied forests, boreal toads likely only use large woody material near the edges of the forest, meaning that large woody material in interior parts of closed-canopied forests are essentially not available to most boreal toads. Therefore, a relatively low acreage of late-seral and old-age forestland, in which logs are prevalent features, actually provides habitat for boreal toads. Soon after a stand-replacing fire in forestland, trees begin to fall and this can continue for several decades, which provides for an abundance of large woody material. Large woody material is especially important in recently burned forestland in areas with capability to be occupied by boreal toads (e.g., for providing moist micro-sites, hiding cover, and for thermoregulation) because of the lack of forest canopy cover (Raphael 1988, Pilliod et al. 2003, Bartelt et al. 2004, Bull 2006).

Another reason why large woody material is important is that it provides nesting substrate for several species of ants that are important in the diets of boreal and western toads (Bull 2006).

The presence of large woody material depends on large trees being produced… and then dying and falling. A natural fire regime and natural proportion of late-seral forestland (and a natural proportion of non-forest vegetation types having a preponderance of conifer trees) would both provide a large supply of large trees and low to high density of large woody material, with high densities provided in localized areas such as after a fire.

- <u>Shrub and Herbaceous Cover</u> – Regardless of type of habitat used, shrubs appear to be important sources of moist microsites and protection from the sun for boreal toads (Bartelt et al. 2004, Keinath and McGee 2005). Shrubs contribute to moist microsites in mid-seral to late-seral forestlands, and may be a more important source of moist microsites in early-seral forestland where the overstory of trees does not contribute to retaining moisture below the canopy. Canopy cover of herbaceous vegetation and shrubs can increase substantially following fire in many situations (Thomas et al. 1979d; Pieper 1990; Riggs et al. 1996; Stam 2008), adding to their favorability by toads. In riparian areas, willows are an important component of boreal toad habitat.

  In vegetation types in which shrubs contribute to micro-sites, shrubs contribute in all successional stages. In these vegetation types, there typically are fewer shrubs in late-seral forests than in early-seral communities, but soil surfaces in late-seral forests typically retain higher moisture levels and large woody material is prevalent. In early-seral communities where shrubs are prevalent, shrub canopies likely allow higher levels of moisture to be retained under logs (e.g., in a post-fire community) than would occur in the absence of shrubs, in addition to providing moist microsites themselves.

  A natural fire regime and natural proportion of late-seral forestland would provide a range of shrub conditions.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

No attempt was made to identify an optimum mix of succession stages for spotted frogs and boreal toads because there are far too many direct, indirect, cumulative, and possibly synergist effects that would need to be accounted for, not to mention differences in optimum mixes depending on topography, vegetation types, sizes and juxtaposition of these vegetation types, distance to water, and other factors.

<u>Landscape Scale</u>

There is no need, from the standpoint of spotted frogs and boreal toads, to make any adjustments to the coarse-filter approach of approximating the natural mix of succession stages and natural fire return-intervals — at a landscape level — in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because the amphibian community in the BTNF area developed over time in habitats that were heavily influenced by fire, as recognized by Patla (2001) and Keinath and McGee (2005). As outlined above in the “Estimated Natural Conditions” section, there would be a net positive effect on spotted frogs and boreal toads from increasing the proportion of early-seral communities, compared to existing conditions. Targeting a natural mix of succession stages at the landscape scale would result in a suitable mix of succession stages for both species.

Despite the net positive effects of early-seral communities, compared to late-seral forestland, it may be difficult to justify targeting a larger-than-natural proportion of early-seral communities at a landscape scale or a fire return-interval that is shorter than what occurred naturally. At some point, as late-seral forestland is converted to early-seral communities, the net benefits of doing this would turn to net negative effects, especially for boreal toads. However, this threshold is not known. Also, it is unrealistic for a larger-than-natural proportion of early-seral communities to be produced across the BTNF or large parts of the BTNF.

Finer Scales

At finer scales than the landscape level, there are several fine-filter adjustments or mitigation measures that need to be addressed either in suitable condition statements or in conservation actions, or both:

- Mix of Succession Stages at the Local Population Scale – Some concern has been expressed in literature reviews and conservation assessments about timber harvest, mechanical treatment, and fires in the vicinity of spotted frog and boreal toad breeding sites and in summer-long habitat of boreal toads and other amphibians (Maxell 2000, Patla 2001, Keinath and McGee 2005, Patla and Keinath 2005, PARC 2008). While most concerns deal with factors other than creation of early-seral habitats (e.g., road construction, crushing), some of the concern deals with a change from late-seral forestland (with an abundance of moist microsites) to early-seral communities, especially if a sufficient amount of large woody debris is not left behind.

  While keeping with the overall coarse-filter mix of succession stages, suitable conditions for this habitat element should be adjusted such that a minimum of 60-70% of the forestland (depending on forest type as shown in Table 4; and depending on part of the BTNF[G]) within 1.5 miles of boreal toad breeding sites remains in late succession, with (1) an emphasis of creating early-seral forestland in areas formerly supporting beavers but not presently supporting beavers due to reductions in aspen and dominance of forestland by conifers, (2) provision of a minimum of 10-15 tons per acre of large woody material and a minimum of 2 live and 2 dead trees per acre in harvest/treatment units, and (3) maintenance of late-seral forestland within 100 feet of breeding wetlands where trees are harvested/treated and to the extent possible in prescribed fire areas. The basis of each part of the above fine-filter adjustments is as follows.

  - Minimum of 60-70% of the Forestland in Late Succession within 1.5 miles of Breeding Sites – This is a precautionary approach since the preponderance of evidence shows there to be a net benefit of conversions to early-seral communities near breeding sites (see items 1-3 in the “Why this Element is Important” section). The 60-70% minimum was derived from Table 4 and applied to the area within 1.5 miles of breeding sites; i.e., it was applied to a small area as a precautionary measure. A reference was added for Table 4. However, given the concerns raised by experts regarding timber harvest and mechanical treatments in the home ranges of spotted frogs and boreal toads, this fine-filter adjustment was added. Given the apparent benefits of fire to boreal toads and spotted frogs, this fine-filter adjustment does not apply to wildfires or to lightning-strike fires managed for resource benefit.
  - An emphasis of Creating Early-seral Forestland in Areas Formerly Supporting Beavers – This is discussed further in the “A.3. Occurrence and Extent of Beaver Pond Complexes” section. When prescribed burns and vegetation treatment projects are being considered, areas that historically supported beavers and that no longer do (as a result of a loss of aspen) should receive emphasis.
  - Maintenance of Late-seral Forestland within 100 feet of Breeding Wetlands – Despite indications that fire and logging in the immediate vicinity of breeding wetlands are neutral to beneficial to spotted frogs and boreal toads (see discussion in “Risk Factors and Restoration Factors,” below), caution should be taken for several years (until this is evaluated in more detail) when implementing timber harvest, mechanical treatment, and prescribed burn projects. In their “ideal” category for several forest

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[G] 60-70% of forestland in late succession, especially at this scale, could very well be an overestimate. For example, there was a much smaller proportion of forestland in the Teton National Forest (Forest Reserve) was in late succession, based on an 1896 survey (D. Deiter, Jackson Ranger District, District Ranger, personal communication).

types (i.e., where meeting the needs of amphibians is a primary focus of management), PARC (2008) recommended maintaining forestland conditions within 50-330 feet of wetlands to maintain cooler, moister conditions near streams and wetlands, and to sustain recruitment of litter and large woody debris; and maintaining large woody debris and standing trees and snags for future large woody debris. This would also help protect the integrity of breeding wetlands and provide connectivity between the wetland and terrestrial habitats (Bartelt et al. 2004). While serving a different purpose in this habitat element (i.e., habitat protection), the 100-foot threshold is consistent with the 100-foot threshold identified in the Logging in Riparian Area Standard of the Forest Plan (1990:133) and with silvicultureal best management practices identified by WDEQ (2004). However, the slope portion of the standard was not included above because incrementally steeper slopes do not impart a need to protect incrementally more habitat.

Fire should be treated differently given the likely benefits of periodic fire to wetlands used by boreal toads and possibly spotted frogs (discussed previously) and the potentially net adverse impacts of attempting to keep fire away from wetlands. Pilliod et al. (2003) concluded that "Allowing fire to burn into riparian forests surrounding wetlands may benefit many wetland species and will likely be less disruptive than fire suppression efforts."

- Shrub Cover – Based on recommendations from Patla (2001) and Bartelt et al. (2004) shrub cover within harvest/mechanical treatment units within 1.5 miles of boreal toad breeding sites should be protected.

While there are some negative effects associated with early-seral communities and with the act of creating early-seral communities, the net effects of fire, timber harvest, and mechanical treatments are typically positive so long as sufficient large woody material is retained, associated roads do not impede movements or elevate mortality rates, there is not a reduction in habitat due to roads, water quality is not adversely affected, and crushing by heavy equipment does not measurably elevate mortality rates. Where there are questions about effects, deference should be given to the conditions under which amphibian communities formed in the BTNF area. Additionally, history is clearly showing that attempts to hold off fire in large landscapes beyond the natural fire return intervals results in larger or more severe fires. To the extent shifts to early succession are detrimental to spotted frogs and boreal toads, attempting to maintain larger-than-natural proportions of forestland in late succession has the potential to ultimately adversely impact these species.

Deviations from Estimated Natural Conditions to Accommodate other Uses

On balance, the proportion of early-seral communities that is ultimately targeted on the BTNF as desired conditions[H] (or, at a minimum, realistically achievable on the BTNF) may be substantially lower than what existed naturally. For most resources and uses, there is no need to make any adjustments to the coarse-filter approach of approximating the natural mix of succession stages as a management target at the landscape scale. This is because approximating a natural mix of succession stages would benefit native wildlife-communities as a whole and wildlife species that require early- and mid-seral habitat conditions, and would support timber harvest and fuels management objectives of the Forest Plan.

On the other hand, there are several resources and uses for which the targeted proportion of early-seral communities may need to be lower than what it was historically for conifer forestland. Examples include requirements to meet Standard VEG S6 of the *Northern Rockies Lynx Management Direction*[I], a focus on retaining late-seral forest conditions for goshawks, limitations on treating forested vegetation in Inventoried Roadless areas, and possibly requirements to meet visual retention standards in some places (this is only a partial list). Also, despite the large overrepresentation of late-seral forestland on the BTNF and the small acreages that are actually prescribed burned and harvested, environmental groups are actively working to prevent timber harvest on the BTNF. These factors, along with other limitations on restoring an approximation of a natural mix

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[H] A desired mix of succession stages has not yet been determined for the BTNF.

[I] Note that lynx evolved in fire systems and require stand-initiation stages (as explained in the *Northern Rockies Lynx Management Direction Final EIS*), but some lynx experts are advocating retention of larger-than-natural proportions of late-seral forestland.

of succession stages, will result in a lower-than-natural proportion of early-seral forest communities and a higher-than-natural proportion of late-seral forest communities over the long term, except possibly as influenced by insect epidemics and wildfires (however, even with the recent insect epidemic, the proportion of late-seral forestland remains above natural levels).

Even though there are several resources and uses that could potentially pull in the direction of maintaining larger proportions of late-seral forestland than existed under the natural fire regime, it does not appear that a larger-than-natural proportion of late-seral forestland would fall within the range of suitable habitat conditions for spotted frogs and boreal toads.

An abundance of large woody material is ideal for boreal toads in early-, mid-, and late-seral forest communities. However, this conflicts with logging operations and fuel reduction projects, which would — if it were not for having to minimally meet wildlife needs — result in all large woody material being removed or burned. While minimum densities and/or volumes of large woody material have been established for boreal toads or similar species in similar environments, the following provides a preliminary estimate of the degree to which large woody material can be reduced in treatment units while maintaining an adequate amount of suitable moist microsites and hiding cover for boreal toads:

- A Minimum of 10-15 Tons per acre of Large Woody Material and a Minimum of 2 Live and 2 Dead Trees per acre in Harvest/Treatment Units – This is based on the following. While timber harvest and mechanical treatments can benefit spotted frogs and boreal toads where there is an overrepresentation of late-seral forestland, this is very highly dependent on sufficient large woody material being retained (Raphael 1988, deMaynadier and Hunter 1995, Wind and Dupuis 2002, Bartelt et al. 2004, Bull 2006, PARC 2008). If insufficient large woody material is retained, habitat for these species is unsuitable.

  PARC (2008) recommended, in their "maximizing compatibility" category of recommendations (i.e., where needs of amphibians are met along with other uses) for several forest types, to consider leaving large woody debris during harvest operations. The Dead and Down Large Woody Material Standard for DFC areas 10 and 12 (USFS 1990:236, 244) requires retaining a minimum of 4 class 1 and 2 logs (i.e., logs that have not begun to decompose) per acre, specifying that the logs must be at least 12 inches in diameter at the large end and 20 feet in length. This originates from Maser et al. (1979:95) and it equates to about 8 tons per acre (using information in Sikkink et al. 2009). The recommendation by Maser et al. (1979) also included retaining *all* class 3, 4, and 5 logs (all branches gone and entire log touching ground, with some decomposition to logs that are nearly entirely decomposed). These other logs provide important microsites for boreal toads and numerous other wildlife species, and would bring the total tonnage above 8 tons/acre. Also, there is some question as to whether leaving 10-15 tons/acres is sufficient for wildlife dependent on large woody material (Bull et al. 1987), meaning that 8 tons/acre likely is insufficient except in forest communities that naturally have less than 10 tons/acre of large woody material (e.g., some lodgepole communities on the BTNF). An overall target of 10-15 tons per acre would provide for various log sizes and various stages of decomposition, thereby providing a range of microsite conditions for boreal toads immediately after logging operations and into the future. Because there is a question about whether 10-15 tons/acre is sufficient, this minimum figure needs to be reevaluated with additional information.

  Impacts of timber harvest and mechanical treatments can also be lessened, at a somewhat longer term, by retaining dead and/or live trees that will provide large woody microsites in the future, which could involve periodic girdling of a portion of live trees that are retained. The Dead and Down Large Woody Material Standard for DFC areas 10 and 12 (1990:236, 244) requires retaining an average of 2 dead or cull-leaning trees per acre. However, this is a very low density compared to the density of standing dead trees after a fire.

Suitable Condition Statements

The following set of suitable condition statements is an adjustment to the estimated natural mix of succession stages, to some degree, by (1) building in a small number of fine-filter adjustments to better ensure the needs of spotted frogs and boreal toads are met and (2) accounting for some adjustments to accommodate other wildlife and other uses, as discussed above in the previous two sections ("Deviations from Estimated Natural Conditions…"), while still satisfactorily providing for the needs of spotted frogs and boreal toads.

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports.

1. A natural mix of succession stages is approximated at the BTNF level and in most 6th-order HUCs (e.g., based on percentages of seral stages in LANDFIRE 2007 and other scientific information), with an emphasis on the creation of early-seral forestland in watersheds above known existing and historic breeding sites and areas formerly supporting beavers but not presently supporting beavers due to reductions in aspen and dominance of forestland by conifers.

   Table 4 provides midpoints for the mix of succession stages, but these midpoints should be converted to ranges in order to be more ecologically meaningful.

2. In approximating a natural mix of succession stages, ensure that:
   a. Late-seral forestland conditions are maintained within 100 ft. of breeding wetlands.
   b. A minimum of 60-70% of the forestland (depending on forest type) within 1/3 mile and within 1½ miles of boreal toad breeding sites remains in late succession.
   c. A minimum of 10-15 tons/acre of large woody material (≥75% of which is comprise of ≥12-inch diameter logs at their bases) are retained in created openings and in treatment units with substantial removal of trees and downed woody material.

The BTNF level refers to the entirety of the BTNF, and this geographic scale is used for suitable condition statement '1' because (1) this is important to restoring historic distributions of spotted frogs and boreal toads, combined with having very limited information on their historic distributions; and (2) it is a coarse-filter suitable condition that would benefit native wildlife-communities as a whole as well as the restoration of forest and rangeland health (i.e., in some shape or fashion, it will be applied at this scale regardless of the needs of amphibians). Nonetheless, an emphasis is placed on (1) watersheds above known existing and historic breeding sites because this could help to focus vegetation treatments and designations of lightning-strike fires to be managed for beneficial use; and (2) areas formerly supporting beavers, as discussed in the "A.3. Occurrence and Extent of Beaver Pond Complexes."

The mix of succession stages is also applied at the 6th order hydrologic unit, but where large fires occur that span across 6th order HUCs, application at larger scales such as 5th order HUCs and ranger districts may be more ecologically meaningful.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.4. Herbaceous Species Composition — Recovery of herbaceous species composition, especially in upland non-forested areas, has the potential to play a small role in efforts to restore a more natural fire return interval.

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Suitable herbaceous retention levels have the potential to play a small role in efforts to restore a more natural fire return interval. The greater amounts of fine fuels that are provided across the landscape, the higher the potential will be of fire spread across rangeland and meadow habitats. At a landscape level, herbaceous retention levels likely only play a small role in fire spread on the BTNF.

Risk Factors and Restoration Factors

Risk factors outlined in this section fall into two categories: (1) factors that have altered the mix of succession stages and are maintaining and/or have the potential to maintain altered conditions, and (2) side effects of creating early-seral communities through ecological processes and management actions. All of these risk factors in turn are currently limiting or have the potential to limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads. Restoration factors described below have the potential to contribute to the restoration of suitable conditions.

Late-seral communities are overrepresented in most parts of the BTNF (USFS 1997). For example, ≥90-95% of forestland on the Greys River Ranger District is in a late stage of succession (USFS 2004a, Loosen et al. 2009), compared to 65-70% for most forested biophysical settings (Table 4).

The current mix of succession stages as compared to a natural mix, primarily in forested systems, has the potential to affect spotted frogs and boreal toads in a variety of ways, as detailed in the “Estimated Natural Conditions” section, which in turn can limit the ability to meet Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard with respect to these species in specific ways. Pilliod et al. (2003:172) noted that “Habitat changes associated with fire suppression could be another potential cause of regional amphibian declines.” Effects of the mix of succession stages can be divided into three categories: (1) effects of an overrepresentation of late-seral forestland and underrepresentation of early- and mid-seral communities, (2) effects of increases in early-seral communities, and (3) effects of natural processes and management activities that produce early-seral communities. Each of these three categories are covered in more detail below.

Factors that Contribute to Perpetuation of Overrepresentation of Late-Seral Forestland

The following are risk factors that limit the restoration of a natural or relatively-natural mix of success stages:

- Fire Suppression — Fire suppression is the leading cause of the large overrepresentation of late-seral forests and corresponding underrepresentation of early-seral communities in most parts of the BTNF (Gruell 1980a,b, USFS 1997, USFS 2004a, USFS 2009), and the ongoing suppression of fires continues to contribute to continuing this resource problem and widening the gap between desired and existing conditions in many areas.

  The presence of developments on National Forest System lands like oil and gas developments, recreation residences, and communication sites brings with it the propensity to suppress fires that could spread to such developments, thereby contributing to factors limiting the natural role of fire on the landscape. In contrast to roads, developments contribute to reducing fire spread well beyond their footprints.

  Hossack and Corn (2007), Guscio et al. (2007), Semlitsch et al. (2009), and other studies provide direct indication that fire suppression may be having negative effects on boreal toads, and other scientific information outlined in “Estimated Natural Conditions” subsection, above, provides indirect indication that fire suppression likely is negatively affecting boreal toads and spotted frogs.

- Artificial Limitations on Fire Spread — Several factors artificially limit the spread of wildfires, fire-use fires, and prescribed burns, including the following:
  - *Roads* — Roads may contribute to the large overrepresentation of late-seral conditions in some rangeland types and possibly some forest types on the BTNF by creating fire breaks (spotting reduces the effectiveness of roads as fire breaks). This includes new roads constructed for oil, gas, and mineral developments, and for timber harvest. The contribution of roads to providing fire breaks is limited to

  their footprint. Because roads are relatively narrow, they may only have a minimal effect on fire spread in many areas, especially in forestlands.

  - *Reduced Density and Height of Herbaceous Vegetation* — While overall a fairly small factor in forest fire ecology, reduced density and height of herbaceous vegetation, due to historic heavy to severe livestock grazing likely contributed some to the expansion of fire return-intervals on the BTNF, especially in rangeland types and possibly in some forested areas. The main contribution is the reduction in fine fuels through long-term declines in herbaceous canopy cover and overall height of the herbaceous layer and increases in bare ground (Gruell 1980a,b, Miller et al. 1994, USFS 1997, Miller and Heyerdahl 2008). Current livestock grazing use and management can also affect fire-return intervals by reducing the amount of fine fuels through low herbaceous retention levels on a year-to-year basis.

- Constraints on Treating Vegetation — There are several constraints to treating vegetation to address the overrepresentation of late-seral forestland, including the following:

  - *Land Status and Regulatory Constraints on Treating Vegetation* — Several factors limit the amount of late-seral conifer forestland that will be converted to early-seral communities through prescribed burning, mechanical treatments, and timber harvest. These factors include vast acreages of Wilderness in which mechanical treatment and timber harvest are not allowed; large acreages of Inventoried Roadless in which mechanical treatment and timber harvesting are for all practical purposes not an option; restrictions imposed by the *Northern Rockies Lynx Management Direction* (USFS 2007), particularly Standard VEG S6, and for other species like goshawks.

  - *Environmental Constraints on Treating Vegetation* — Steep and rugged terrain in many parts of the BTNF, which limits road construction and conflicts with soil/hydrology standards and guidelines, further limits the areas in which timber can be harvested and mechanical treatments can be implemented. Short burn windows further constrain prescribed burning opportunities, given the fire personnel and resources available.

  - *Administrative Constraints on Vegetation Treatment Projects* — Several other factors currently limit the amount of late-seral conifer forestland that will be converted to early-seral communities through prescribed burning, mechanical treatments, and timber harvest: large analysis requirements, limited resource specialists' time to complete analyses, many other priorities making demands on their time, and appeals and litigation that require additional time and may result in requirements to reanalyze projects prior to implementation or projects being abandoned. These factors combine to greatly limit the number of acres that are treated each year on the BTNF and continued backsliding toward greater overrepresentation of late-seral forestland.

  - *Administrative Constraints on Managing Lightning-strike Fires for Beneficial Use* — While lightning-strike fires have been managed on the BTNF for beneficial use during the past several years, relatively few acres are being burned under this approach compared to the potential each year and compared to the large "backlog" created by many decades of fire suppression. Several factors can reduce the potential for any given lightning strike to be managed for resource benefit, including limited fire personnel and resources; other fire-use fires, prescribed burns, and wildfires being managed on the BTNF at the same time; possibly budgetary constraints at times; and conditions that may be too dry for safe management of fire-use fires (but ideal for fire spread in a natural system).

  - *Livestock-related Constraints on Managing Lightning-strike Fires for Beneficial Use and Conducting Prescribed Burns* — Livestock grazing use has the potential to reduce the extent to which lightning-strike fires are managed for beneficial use for several reasons and the extent to which prescribed burning is used in some livestock allotments, including (1) livestock safety concerns when livestock are present in potentially affected allotments, (2) difficulties of moving livestock out of the way of the potential path of the fire, (3) the need for the permittee to quickly make arrangements to truck or otherwise move their livestock to alternate pasture, (4) need for permittee to quickly find alternate pasture for the remainder of the season and the need to rest part or all of an allotment or several allotments following wildland fire use, which requires locating alternate pasture for this period, (5) resistance by some permittees to rest prescribed-burn project areas for one season to retain fine fuels, (6) dislike of burning by some permittees, and (7) pressure by some permittees and supporters to forego burning opportunities due to 1-7 and other reasons (USFS 2009).

Factors that Have the Potential to Result in an Underrepresentation of Late-Seral Forestland

The following are factors that have the potential to create excessive amounts of early-seral communities and to result in an underrepresentation of late-seral forestland at the scale of breeding sites, catchment scale, at the watershed scale (e.g., 6th order HUC), and at the BTNF scale. It is important to note that (1) there currently is little if any risk of major disturbances like fire, timber harvest, or mechanical treatment resulting in an underrepresentation of late-seral forestland, except at the scale of the breeding site and metapopulation (catchment), (2) there is very low potential for timber harvest and mechanical treatments creating too high of a proportion of early-seral communities in the immediate vicinity of breeding wetlands, due to required and recommended mitigation measures; and (3) there is a relatively low potential for wildfires, fires managed for resource benefit, and prescribed fires producing too high of a proportion of early-seral communities in the immediate vicinity of breeding wetlands. There are two main reasons why there is low potential for the relatively low risk with respect to fire. First, the chances are low of fire burning through breeding areas. Second, the net effect of fires burning close to breeding wetlands, at a low frequency, appears to be positive (see the "Estimated Natural Conditions" subsection, above).

All things considered, the following factors pose relatively low risk to spotted frogs and boreal toads, so long as Forest Plan standards, prescriptions, and guidelines, and pertinent best management practices are followed.

- Wildfires, Fires Managed for Resource Benefit, and Prescribed Burns — Concern has been expressed by some authors about too much forestland being burned within the range of local populations of boreal toads and forestland being burned in the immediate vicinity of spotted frog and boreal toad breeding wetlands (Maxell 2000, Patla 2001, PARC 2008). Negative impacts associated with such fire include the loss of the forested canopy and resultant drier and warmer ambient conditions near ground level (Bartelt et al. 2004).

  While there are some concerns about burning forestland in the vicinity of breeding wetlands and within the range of local populations of boreal toads, the net effect of fires appears to be neutral or positive, so long as their frequency remains within the natural range of variability and so long as they occur within the natural fire season (Keinath and McGee 2005, Hossack and Corn 2007, Pilliod et al. 2003).

- Timber Harvest and Mechanical Treatment — Patla (2001) identified the main concern with timber harvest on the BTNF as being the loss of moist sites due to reductions in the canopy and downed woody material, and several other experts identified timber harvest as a potential threat to amphibian populations in general (deMaynadier and Hunter 1995, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Semlitsch et al. 2009). The creation of early-seral communities and the removal of large woody material through timber harvest and mechanical treatments have the potential to negatively impact boreal toads, and the cutting and removal of trees in the immediate vicinity of spotted frog and boreal toad breeding wetlands have the potential to negatively affect both species.

  Some experts identify logging in the immediate vicinity of breeding wetlands (e.g., within about 100 yards) as a threat to amphibians, including spotted frogs and boreal toads (Patla 2001, Patla and Keinath 2005, Keinath and McGee 2005, PARC 2008). These authors stated that the threat stems from reduced integrity of wetlands, warming and drying of important habitat, and reduced connectivity between the wetland and surrounding terrestrial habitat. Pilliod et al. (2003) also identified removal of trees around wetlands results in ultraviolet-b exposure in wetlands, although they acknowledged the effects on amphibians in the short-term is not well understood. Concerns expressed by these experts led to recommendations of not allowing any timber harvest or mechanical treatment within 100-300 ft. of breeding sites. However, no studies in which specific measures of reproductive success were cited to support their assessments with respect to spotted frogs and boreal toads, or close relatives. Several studies have shown positive effects of reduced tree canopy cover in the immediate vicinity of breeding wetlands (Hossack and Corn 2007, Semlitsch et al. 2009).

However, the level of risk of timber harvest and mechanical treatment is low so long as (1) the mix of succession stages remains within the natural range of variability (with an emphasis on retaining a natural proportion of late-seral forestland at small scales; e.g., within 1/3 to 1½ miles of breeding sites), and (2) a sufficient amount of large woody material is retained. In additional to neutral to positive effects of moving toward a more natural mix of succession stages, creation of early-seral communities by timber harvest and mechanical treatment pose little threat to spotted frogs and boreal toads because these activities have produced very low acreages of early-seral communities on the BTNF in recent years and this trend likely will continue given all of the factors limiting these activities (see "Factors that Contribute to Perpetuation of Overrepresentation of Late-Seral Forestland," above). Furthermore, there are several Forest Plan standards and guidelines and best management practices that do not allow logging and mechanical treatment in the immediate vicinity of wetlands. Keinath and McGee (2005) noted that boreal toads appear to be less vulnerable to habitat changes following timber harvest than other amphibian species.

This equally applies to clear-cutting and other techniques that remove a majority of trees. Many of the results of studies on the effects of clear-cuts on amphibians, as summarized in the previous subsection, apply to reductions in tree canopy cover in addition to reductions in large woody material. Reductions in tree canopy cover also apply to fires.

- <u>Insect and Disease Epidemics</u> — The recent mountain pine beetle epidemic in large parts of the Intermountain West has shown that vast portions of mature and late-seral forestland can be converted to early-seral communities. While this has happened on some parts of the BTNF, creation of early-seral communities due to high insect-related tree mortality during this most recent mountain pine beetle epidemic appears to be uncommon on the BTNF.

- <u>Blow-downs</u> — Blow-downs have a negligible chance of causing an underrepresentation of late-seral forests, both because of the very small size of these events and the very low likelihood of blow-downs occurring in the immediate vicinity of breeding sites.

- <u>Climate Change</u> — Warmer temperatures and drier conditions will contribute to more acres being burned (Schoennagel et al. 2004; Kaufmann et al. 2008; Rieman and Isaak 2010; Glick et al. 2011:39-40,46; Chang and Hansen 2014). This has an important implication to future fire regimes and subsequent effects on the mix of succession stages, and elements of amphibian ecology affected by the mix of succession stages. On the one hand, it would contribute to restoring a more natural fire regime compared to existing conditions, given the lengthened fire return-intervals due to fire exclusion. On the other hand, the plant communities that form after fires may be different than what had formed prior to climate change (Breshears and others 2009; van Mantgem and others 2009, as cited in Rieman and Issak 2010). Chang and Hansen (2014), for example, predict a shift from forest- to shrub-dominated vegetation.

  See the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section for further discussion of climate change and potential effects on fire-return intervals.

Potential Effects of Perpetuating Overrepresentation of Late-Seral Forestland

This is covered in the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection of the "Estimated Natural Conditions" section, above.

Potential Side Effects of Fire, Timber Harvest, and Mechanical Treatment

Activities (e.g., the act of prescribed burning, timber harvest activities, mechanical treatment activities) and ecological processes (e.g., wildfires, fire-use fires) that move the mix of succession stages in the direction of a natural mix of succession stages in specific locations and across the landscape can have a variety of additional effects on spotted frogs and boreal toads beyond changes in the mix of succession stages.

Effects of late-seral forestland, early-seral communities, and the conversion of late-seral forestland to early-seral communities (through natural fire) on a range of habitat components were outlined in the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection of the "Estimated Natural Conditions" section, above. All of this information is incorporated by reference into this subsection. As such, most of the positive and negative effects of natural fire on spotted frogs and boreal toads apply as well to today's wildfire, lightning-strike fires managed for resource benefit, and prescribed fires, recognizing effects at the landscape level would be lower due to far fewer acres that are burned today. Therefore, for most of the risk factors and restoration factors related to wildfire, lightning-strike fires managed for resource benefit, and prescribed fire, see the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection of the "Estimated Natural Conditions" section, above. Non-natural aspects are addressed below.

The following discussion focuses almost exclusively on the side effects of timber harvest and mechanical treatments, as some of the habitat and survival components would be affected differently by timber harvest and mechanical treatment than was described for fires in the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection. In these cases, more detail is provided in the discussions. Also, fire outside the natural fire season would have effects identified below.

- Potential for Reduced Evapotranspiration and Increased Water Flow Volumes — To the extent timber harvest and mechanical treatments result in conifer mortality similar to that would occur in a natural fire, effects on evapotranspiration rates and water flow volumes would, on an acre-by-acre basis, be similar to that described in the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection. With increasing proportions of live trees remaining (e.g., selective cuts), benefits to water flow volumes would be incrementally lower. Far fewer acres having major mortality of mature trees are typically produced by timber harvest and mechanical treatment than would occur under a natural fire regime, meaning that landscape level effects are relatively low.

- Potential for Increased Distribution and Abundance of Beaver Pond Complexes — To the extent timber harvest and mechanical treatments result in conifer mortality similar to that would occur in a natural fire in areas occupied by aspen, effects on aspen regeneration would be similar to that described in the "Individual Habitat Components/Functions Affected by Succession and Disturbance Patterns" subsection. With increasing proportions of live trees remaining (e.g., selective cuts) and fewer benefits to aspen, benefits to beavers would be incrementally lower.

- Reduced Conifer Encroachment in Willow, Aspen, and Meadow Communities — Mechanical treatment designed specifically for removing encroaching conifer trees in these communities would have similar effects on this habitat component as that of natural fire, albeit at a far smaller scale. However, mechanical treatments designed for other purposes and timber harvest would have minimal effect on this habitat component.

- Reduced Shading of Breeding Pools and Reduced Structure at Breeding Pools — Timber harvest and mechanical treatments result in most cases would not reduce shading at breeding pools and would have minimal other effects in the immediate vicinity of breeding wetlands due to the Forest Plan standards and guidelines and best management practices that would be imposed (e.g., no logging within 100 ft. of wetlands). Literature reviews and conservation assessments for boreal toads and spotted frogs identify logging in the immediate vicinity of breeding wetlands (e.g., within about 100 yards) as a threat (Patla and Keinath 2005, Keinath and McGee 2005, PARC 2008). These authors stated that the threat stems from reduced integrity of wetlands, warming and drying of important habitat, and reduced connectivity between the wetland and surrounding terrestrial habitat. However, they did not cite any studies in support of their assessments.

- Potential for Reductions in Water Quality — Timber harvest and mechanical treatments that do not meet Forest Plan standards and guidelines and best management practices may result in sediment delivery to downstream breeding sites, which can affect tadpole survival (McMahon and deCalesta 1990, McNabb and Swanson 1990, Satturlund and Adams 1992, Maxell 2000, Patla 2001, Pilliod et al. 2003, Keinath and McGee 2005); see “B.1. Water Quality” for more detail. Sedimentation can also reduce the longevity of wetlands (see “Wetland, Stream, and Riparian Habitat Retention” section).

Fire suppression activities, which contribute to maintaining a larger-than-natural proportion of late-seral conditions has at least two side-effects on water quality: fire retardant fire potentially impacts water quality and sedimentation from fire breaks can impact water quality (Maxell 2000, Pilliod et al. 2003). This is addressed in more detail in the “B.1. Water Quality” section.

- Reductions in Large Woody Material — Possibly the largest impact to boreal toads and possibly spotted frogs resulting from changed habitat conditions after timber harvest and mechanical treatments is the reduction in large woody material (Patla 2001, Bartelt et al. 2004, PARC 2008, Rittenhouse et al. 2008, Blomquist and Hunter 2010) (see also McMahon and deCalesta 1990). Patla (2001) identified the main concern with timber harvest as being the loss of moist sites due to reductions in the canopy and downed woody material. Reductions in downed woody material limits the sites in which boreal toads can find suitable conditions to regulate body temperatures and conserve body water while foraging and dispersing. Discussion in the “B.3. Height and Structure of Herbaceous Vegetation” section discusses further the lower requirements by boreal toads for moist microsites as compared to spotted frogs. So long as large woody debris are left after logging operations, many of the results of logging mimic those of fires, which both sets of authors stated were a natural part of boreal toad ecology.

  Long and Prepas (2012) found that 38% of refugia used by boreal toads in their study consisted of large woody material, that relative humidity in these refugia was higher than random points, that boreal toads typically used a given refugia for 7-50 days (mean of 22 days), and that nightly straightline distances from refugia ranged from 26 to 59 feet per night. Male and female toads established their refugia 409 ± 167 and 428 ± 114 feet, respectively from surface-water features (range = 3− 1,687 feet, or 1-622 yards).

  Rittenhouse et al. (2008) found, in a study in a recently harvested oak-hickory forest in Missouri, that desiccation can be a major source of mortality for juveniles entering terrestrial habitats, especially habitat altered by human land uses like timber harvesting. They found desiccation risks to be greatest in areas with low soil moisture conditions, which in their study included clearcuts without large woody material. With brushpiles retained in clearcuts, water loss in American toads, green frogs, and wood frogs was comparable to water loss in non-treated forestland. Their study area received an average of about 17 inches of rain from March through May, and amphibians still had issues with desiccation (the study area received less rain during this period in one year of their study). While temperatures are higher in the Missouri study site than on the BTNF, ambient humidity is substantially higher than on the BTNF and and soil moisture (and, therefore, moisture levels under large woody material) is higher. Because the BTNF is less humid and receives less rain in spring, the principles found in their study are generally applicable to the BTNF, except the principles may be somewhat understated. This is because the potential for desiccation is greater on the BTNF, meaning there is a greater need for microsites and more closely-spaced microsites. Similar results would presumably have been obtained in their study with a suitable density of sufficiently large logs and other large woody material in clearcuts since they provide moist microsites just as brushpiles do.

  Schwarzkopf and Alford (1996) found that water loss in simulated toads was greatest in the open on sandy ground, somewhat lower in dry grassy sites, substantially lower in wet grassy sites, and lowest in burrows. Cane toads (*Bufo marinus*) in this study made greatest use of burrows and wet grassy sites and little or no use of dry grassy sites and open sites during the dry season, and made relatively high use of dry grassy sites and less use of burrows and wet grassy sites during the wet season.

  In a study of frogs and salamanders in Missouri, Semlitsch et al. (2008) found that frogs and salamanders moved out of recently clearcut patches faster than they moved into these patches, with “evacuation” rates being higher for clearcuts with lesser amounts of large woody material being retained. The authors assessed the primary factor leading to evacuations was higher ground-surface temperatures and that large woody material helped to moderate these temperatures and to offset reductions in moisture levels brought on by higher temperatures and elimination of the tree canopy. In another study, Semlitsch et al. (2009) found the net effect of clearcutting to be negative on adults and juveniles of the seven amphibian species studied. Negative effects were somewhat less in partial cut units. They attributed the strong results for clearcut units to alteration of "…the fundamental structure of forests by removing the canopy and exposing the forest floor to more sunlight and wind, leading to warmer, drier surface microclimate…" (Semlitsch et al. 2009:857). For amphibians that remained in clearcuts, they documented higher mortality rates compared to mortality rates in adjoining forestland. While there clearly are differences between the ecology of amphibians using forests in Missouri and amphibians using forests in western Wyoming, mechanisms of effects appear to be similar. As pointed out by Semlitsch et al. (2009), "…because all the basic needs of amphibians (e.g., food, shelter) usually require movement overland, every aspect of their lives in the terrestrial environment is affected by water loss." This applies in Wyoming just as it does in Missouri.

In a study in Maine, Blomquist and Hunter (2010) found — during short periods of time (days) — that wood frogs were more likely to occupy sites with more complex ground structure, especially large woody material, warmer temperatures, moister substrates, and greater canopy cover than random sites. "Notably, canopy cover played a lesser role than ground structure at the weekly activity centre and daily microhabitat scales" (Blomquist and Hunter 2010:261). While they ackowledged that amphibians need to balance the physiological constraints of thermo- and hydro-regulation with pressures such as predation risk and foraging to meet energetic demands, they reasoned that large woody material both reduces predation risk and facilitates thermo-and hydro-regulation.

After a fire, snags periodically contribute to large woody material (Maser et al. 1979) and the lifespan of snags — in the Pacific northwest — range from an average of about 5 years for a 8-inch diameter tree to 16 years for a 32-inch diameter tree (Wick 1979). On the BTNF, snags can last considerably longer; for example, many snags in the range of 10-inch to 16-inch diameter and larger, from 1988 fires on the BTNF and in Yellowstone National Park are still standing as of the summer of 2013 (25 years). If no snags or live trees are retained on logged units, the future addition of logs does not occur, which is a major difference in habitat conditions in a burned area and a logged area if no standing trees are retained. By retaining snags, logs would be available to toads and other wildlife for as many as 15 to 20 years longer than if no snags were left standing. By retaining a scattering of live trees, this would extend the period of time when standing trees contribute to large woody debris in the future, but this is not necessary since live trees typically are not left in naturally burned forests.

Negative effects of fire include the burning of logs and other large woody material that otherwise provide moist microsites, reduced shading (negative or positive effect), and changes in the prey base in the short term (Sullivan 1994, Maxell 2000, Patla 2001, Keinath and McGee 2005, Pilliod et al. 2003).

- Burning of Slash Piles — Boreal toads have been found to use slash piles for microsites and for hibernation (Bartelt and Peterson 1997 as cited in Patla 2001). Hibernation sites are likely within 100-200 yards of riparian areas (Bartelt and Peterson 1997 as cited by Patla 2001, Goates et al. 2007).

- Reduced Shrub Cover — Regardless of type of habitat used, shrubs appear to be important sources of moist microsites and protection from the sun for boreal toads (Bartelt et al. 2004, Keinath and McGee 2005). Therefore, removal of shrubby vegetation during timber harvest, mechanical treatments, and burning can add to the negative side of the ledger for these activities. However, there oftentimes is a large positive response by shrubs following fires in areas that support shrubs.

- New Roads, Upgrading Roads, and Vehicle/Heavy Equipment Use — The main activities related to timber harvest and mechanical treatment that can impact amphibians are the operation of heavy equipment in harvest/treatment units, construction of new roads and upgrading of existing roads, and vehicle use along system roads. The main potential effects are loss of habitat to new and upgraded roads, habitat fragmentation due to new and upgraded roads, increased mortality due to crushing by heavy equipment in harvest/treatment units and by logging trucks where haul routes pass near breeding wetlands, increased soil erosion and sedimentation resulting from soil disturbance, and soil compaction and reduced availability of rodent burrows due to heavy equipment (deMaynadier and Hunter 1995, Maxell 2000, Patla 2001, Keinath and McGee 2005, and Patla and Keinath 2005, and PARC 2008). Facilitation of motorized use beyond system roads and motor-vehicle trails, as a result of new/temporary road construction, skid trails, and reduced tree density and large woody material, is another possibly adverse side-effect. These are each discussed in more detail in pertinent sections of this report (e.g., "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat," "A.6. Habitat Connectivity," and "C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts).).

  Amphibians can also be crushed by vehicles and heavy equipment during prescribed burning operations, especially if operations are based in meadows near wetlands used by spotted frogs or boreal toads.

  Compared to other risk factors, these adverse effects pose minimal risk to boreal toads and spotted frogs on the BTNF, except for the construction of new roads and upgraded roads, given the many factors limiting the ability of the Forest Service to implement timber harvest projects. Maxell (2000:12) noted that "…it should be noted that many of the negative impacts associated with timber harvest may be associated with the building and maintenance of roads and road traffic." Each of these effects are addressed in pertinent sections of this report. Only a small percentage of the BTNF has the potential to see mechanical treatment or timber harvest as discussed previously.

- <u>Direct Effects of Fire</u> — Fire outside the natural fire season and in areas of high densities of boreal toads or spotted frogs have the potential to cause high mortality (Sullivan 1994, Pilliod et al. 2003, Keinath and McGee 2005). Fire can cause direct mortality to a variety of species (McMahon and deCalesta 1990). High mortality caused by fire has the potential to happen in spring in the vicinity of breeding sites (e.g., burning willow bottoms near breeding ponds in May or June), when juveniles are dispersing from breeding pools (highly variable timing during summer months), and in localized areas where large numbers hibernate. Maxell (2000) cited several papers indicating that amphibian species inhabiting forestlands may face high rates of fire-induced mortality.

  However, Pilliod et al. (2003) stated that "…mortality of amphibians during prescribed and wildland fires is thought to occur rarely and be of relatively minor importance to most populations," citing four studies in support. Maxell (2000) noted that effects of fire-induced mortality on amphibian population levels have not been examined.

  Mortality during and immediately after fires can be caused by burning, smoke inhalation, and possibly can result from ammonium toxicity in aquatic systems from smoke diffusion (Pilliod et al. 2003). Some amphibians can avoid direct effects of fire by remaining in water bodies, finding moist refugia, burrowing, and moving away from small fires, but most fires move too quickly for amphibians to avoid them if they are in the path of the fire (Pilliod et al. 2003).

  Patla and Keinath (2005) recommended avoiding prescribed burning outside the natural fire season or at times when amphibians are widely present in the habitat to be burned, particularly if the population in the area is isolated from other populations and thus at risk of extirpation if mortality is high.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including USFS (1990), deMaynadier and Hunter (1995), Bartelt (2000, *in Patla 2001*), Maxell (2000), Keinath and McGee (2005), Patla and Keinath (2005), PARC (2008), as well as publications cited earlier in this section and the "Buffer Zones and Levels of Protection" section.

Conservation actions dealing with roads and water quality, with respect to timber harvest, mechanical treatments, fire treatments, and fire suppression are listed in the "Wetland, Stream, and Riparian Habitat Retention," "B.1. Water Quality," "C.1. Survival, as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)," and "A.6. Habitat Connectivity" sections.

1. Design and implement vegetation treatment projects (e.g., prescribed burning, mechanical treatment, prescription logging) that increase the amount of early-seral communities, especially in (1) watershed areas that may currently be limiting water flow volumes into wetlands that exist within 1/3 mile of known existing and historic breeding sites having capable amphibian wetland habitat, and (2) parts of drainages that once supported aspen stands and beaver pond complexes but that currently support neither.
2. Avoid any timber harvest and mechanical treatment activities within 100 feet of wetlands used by boreal toads or spotted frogs and within 100 feet of riparian areas within 1/3 mile of boreal toad breeding sites. Exceptions are (1) for mechanical treatments designed specifically to benefit spotted frogs and boreal toads near breeding wetlands, and (2) where mechanical treatment of conifer trees would help restore natural plant community composition and structure, but the treatment would need to include no removal of downed trees.
3. In situations where lightning-strike fires would benefit spotted frogs or boreal toads, either within 1½ miles of known existing breeding sites or in other places which could facilitate emigration or watershed benefits (e.g., increased water flows), manage the fires for resource benefit to the greatest extent possible.
4. Avoid prescribed fire ignitions within 200 yards of breeding sites.
5. If, within prescribed burn areas, late-seral conditions are desired in the immediate vicinity of breeding sites, a 100-200 yard buffer of no fire may be needed. It may be possible in some situations to implement buffers in prescribed burning area.
6. Do not conduct prescribed burning outside the natural fire season in spotted frog and boreal toad habitat, especially within 1/3 mile of known breeding sites.
7. Do not allow the burning of slash piles within about 100 to 200 yards of perennial streams and riparian areas within 1½ miles of known breeding sites and known historic breeding sites.
8. Include in silvicultural prescriptions requirements to maintain minimum amounts of downed woody material as identified in the objective.
9. Retain a minimum of 20 live and/or dead standing trees (>10-inch DBH) per acre — where at least 20 trees/acre exist — within 200 yards of frog and toad breeding sites to contribute to large woody material into the future (where fewer than 20 trees/acre exist, retain 100% to the extent possible). This will need to be refined with additional analysis. The size and density of live trees and size and density of dead trees needed to sustain a minimum of 10-15 tons of large woody material per acre will need to be determined. The intent of this conservation action is to provide for large woody material into the future; logs retained as part of the mechanical treatment decompose, they would be replaced over time as additional trees fall.
10. Rest burned areas from livestock grazing for at least 2 livestock grazing seasons following fire, especially in wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, willow, aspen, aspen/conifer types within 1½ miles of known existing breeding areas and known historic breeding areas with capable amphibian wetland habitat.

Measures and Indicators

Currently Monitored Elements

- <u>Tons per Acre of Large Woody Material Retained by Project</u> — Existing and post-project levels can be readily estimated, and the amount of large woody material can easily be estimated after harvests, mechanical treatments, and fires. Data on the amount of large woody material is typically collected during stand exams during the planning phase of timber harvest and mechanical treatment projects.

- Number of Dead Trees per Acre by Project **—** Existing and post-project levels can be readily estimated, and the number of dead trees per acre can easily be estimated after harvests, mechanical treatments, and fires. Data on the amount of large woody material is typically collected during stand exams during the planning phase of timber harvest and mechanical treatment projects.

Additional Monitoring Elements to Consider

The following elements should be monitored, especially the first:

- Mix of Succession Stages **—** The Forest Service currently does not monitor the mix of succession stages on the BTNF. This can be tracked through remote sensing and GIS. This is critical for a wide range of wildlife species including amphibians and other resources (e.g., forest vegetation management, rangeland vegetation monitoring), and for analyzing effects of vegetation treatments, fire use, and wildfires on forest and rangeland vegetation, a large number of wildlife species, including amphibians.

A.3. OCCURRENCE AND EXTENT OF BEAVER POND COMPLEXES

Introduction and Background

Beaver pond complexes provide important habitat for spotted frogs and boreal toads, both in terms of pond, marsh, and wet-meadow habitat while the ponds still exist (Donker and Fryxell 1999 and Russell et al. 1999a, *as cited by Keinath and McGee 2005*; Maxell 2000; Patla and Keinath 2005; Amish 2006; PARC 2008; USFWS 2011) and in terms of moist and wet meadow habitat in the long term after ponds have filled with sediment. Beaver pond complexes are therefore important to meeting Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard with respect to these species.

Beavers were nearly extinct in Wyoming by 1860, due to over-trapping (Olson 1994), which likely had a major negative effect on spotted frog and boreal toads. Protective measures were put in place from 1899 through 1919, and was classified as a protective animal in 1958, when it was reclassified by WGFD as a furbearer. Olson (1994) reported that beaver still only occupy about one-third of their original range in Wyoming.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction specifically on sensitive species **—** which generally call for suitable conditions (which for spotted frogs and boreal toads necessarily addresses the occurrence and extent of beaver pond complexes) to be provided **—** the following provisions of the Forest Plan and executive orders requires the Forest Service to work toward achieving and maintaining conditions that would facilitate restoration of the distribution and abundance of beavers on the BTNF. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to the distribution and abundance of beaver ponds across the landscape.

> ***Executive Order 11988 (1977)* —** Floodplain management. Each federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by floodplains.
>
> ***Vegetation: General Prescription (Forest Plan)*** — "Whether range or timber, vegetation management activities enhance diversity of plant communities and various successional stages of those plant communities within the Management Areas. For aspen, priority is placed on perpetuating stands being invaded by conifers. Vegetation treatment projects are designed to retain diverse age classes."

Aspen Management Guideline (Forest Plan) — "Aspen sites should be managed for aspen-type perpetuation. The loss of aspen stands due to old age, conifer encroachment, and possible overgrazing should be prevented. Priority areas for aspen treatment should be big-game winter ranges, calving areas, and stands where type loss or conversion is imminent."

All Forest Plan Goals, Objectives, and Prescriptions, and Executive Order in "Mix of Succession Stages" — All of management direction listed in the "Mix of Succession Stages" applies to the development of suitable conditions for the occurrence and extent of beaver pond complexes, as it provides additional direction for converting late-seral conifer forestland to early-seral aspen communities (e.g., where conifer has overtopped aspen).

Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan) — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."

***Executive Order 13186* —** Applicable provisions are summarized in the "A.2. Mix of Succession Stages" section. Migratory bird conservation plans point strongly in the direction of restoring and maintaining the distribution and abundance of beavers given the major benefits of beaver pond complexes to a wide range of migratory bird species.

Estimated Natural Conditions

The following statement is a summary of the natural conditions for his element: the distribution and abundance of beaver pond complexes that would exist with a natural mix of succession stages (most importantly including a natural distribution and abundance of aspen), no loss of riparian habitat to roads and other facilities, riparian areas being in naturally-functioning condition, and no history of beaver trapping or removal of beavers. The range of natural conditions for this element is within the range of suitable conditions for spotted frogs and boreal toads, but it is recognized that suitable conditions may extend beyond the natural range of variability for this habitat element.

There are three main reasons why a natural distribution and abundance of beaver pond complexes provide suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, beaver pond complexes are an important habitat for both species, especially where other riparian wetlands and isolated basin wetlands do not exist or are uncommon (Donker and Fryxell 1999 and Russell et al. 1999a, *as cited by Keinath and McGee 2005*; Maxell 2000; Patla and Keinath 2005; Amish 2006; PARC 2008; USFWS 2011). In some places, beaver ponds may be the only wetland habitat for long distances and may provide the only available wetland habitat. Amish (2006) found that drainages with beaver pond complexes had four times as many lentic and breeding sites than drainages without beaver pond complexes, and breeding sites were more dispersed within drainages with beavers. He also found that spotted frogs were able to persist in isolated drainages containing beaver ponds where these apparently isolated spotted frogs were well beyond the dispersal ability. Patla and Keinath (2005:52) assessed that the protection and reintroduction of beavers could mitigate for some of the threats posed to spotted frogs by management activities or natural events. Beaver ponds provide habitat during droughts when isolated and temporary wetlands dry up, and beaver dams provide wintering sites for spotted frogs (Patla and Keinath 2005).

In addition to the wide valley bottoms where beavers today are most prevalent, they also historically occurred in in small, relatively steep gradient (up to 12%; Olson and Hubert 1994) streams where the riparian zone is very narrow (e.g., no off-channel pond habitat and very little if any valley-bottom wet meadow and/or willow habitat). In these situations, beaver ponds added pond and wet meadow habitat where none would have otherwise existed (e.g., Gruell 1975, DeByle 1985), thereby expanding the distribution and increasing the abundance of frogs and toads on the BTNF than would have existed in the absence of beavers. Over time, beaver pond complexes in these situations likely produced pockets of willow and meadow habitat where ponds filled in with sediments, including where willows did not exist prior to beavers colonizing the drainage. Even though these habitats eventually declined on such sites due to old beaver dams failing and possibly due to the stream channel down-cutting through the built-up sediments, other beaver ponds would have been created in the same drainage.

Also, a natural distribution and abundance of beaver pond complexes contributes to a wide range of riparian and hydrologic functioning elements. In addition to creating wetlands and creating or expanding willow habitat, beaver ponds also contribute to elevating water tables, improving riparian vegetation, reducing high flows, water storage and later release which can contribute to higher downstream flows later in the summer, improved water quality in lower beaver ponds (due to upper ponds capturing sediments), increasing aquatic invertebrate production, and increasing total aquatic productivity (Olson and Hubert 1994, Ohmart 1996, Pollock et al. 2003), all of which can positively contribute to suitable habitat conditions for spotted frogs and boreal toads.

Second, the *natural* distribution and abundance of beaver pond complexes provided a large amount of high quality habitat for spotted frogs and boreal toads on the BTNF. A natural distribution and abundance of beaver pond complexes likely represents the upper end of what can realistically be produced and sustained in the BTNF area, given the area's elevation, geomorphology, climate conditions, natural conditions in riparian zones, natural distribution and conditions of willows and aspen habitat, and predator base. Because it likely would not be possible for the BTNF area to sustain a larger-than-natural distribution and abundance of beaver pond complexes and because beaver pond complexes provide high quality habitat for both species, a natural distribution and abundance of beaver pond complexes cannot be considered less-than-suitable for spotted frogs and boreal toads.

Third, a natural distribution and abundance of beaver pond complexes are conditions under which amphibian communities formed or developed in this area.

No attempt was made to characterize (e.g., using GIS models) an approximated or estimated natural distribution and abundance of beaver pond complexes on the BTNF. However, it is recognized there are many drainages in parts of the BTNF that once had beaver pond complexes that no longer do (Gruell 1975; personal observations of author). In many cases, this is a consequence of major reductions in the density of sufficient-size aspen near streams in valley bottoms that do not support willow in the absence of beaver pond complexes. Aspen are needed for dam-building material and food in these situations. Olson and Hubert (1994:9) asserted that "Aspen abundance is the most significant factor of beaver density in many areas," and DeByle (1985) noted that aspen are superior to willow for dam construction on high gradient streams. DeByle (1985:146) made the following observation:

> "Aspen, because it is an upland hardwood type, provides essential habitat for beavers along streams that do not have sufficiently wide riparian zones to support an adequate supply of willow or cottonwood. Many of the streams in the West, especially in their upper reaches, fit this description. There, beaver are found only where there is aspen."

DeByle (1985) also assessed that potential beaver habitat in the aspen type is a strip perhaps 650-1,000 feet wide along each side of streams (a total of approximately 1/3 mile including both sides of streams). A sufficient amount of suitably-sized aspen (≥2-6 inch diameter; DeByle 1985) must exist within this strip. Given the natural fire regime and the prevalence of the aspen type within about 1,000 feet of many streams on the BTNF, aspen was likely prolific enough to sustain beaver colonies in a large number of these types of streams, recognizing that beaver distribution was probably dynamic.

After a period of time, conditions in beaver pond complexes in these narrow valley bottoms become conducive to establishment by willows, which further enhance habitat conditions for beavers. On the Greys River Ranger District, I have found remnants of dams built with aspen logs in narrow valley bottoms where aspen are now absent or rare (e.g., in parts of Fawn Creek, Deadman Creek, Blind Bull Creek). In some cases, a small number of willows remain. Wetland habitat typically is no longer present, but in a small number of cases, small areas of open water exist in otherwise sediment-filled ponds that mostly provide moist meadow habitat.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural distribution and abundance of beaver pond complexes in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because (1) the natural distribution and abundance of beaver pond complexes represents conditions under which amphibian communities formed or developed in the BTNF area; (2) the provision of natural conditions, compared to existing conditions, would benefit spotted frogs and boreal toads; (3) improved conditions, compared to natural conditions, would entail a larger-than-natural distribution and abundance of beaver pond complexes and this is not realistic; and (4) spotted frogs and boreal toads would not be adversely affected by increasing the amount and distribution of beaver pond complexes compared to existing conditions. Continued increases in the number and distribution of beaver ponds would increasingly restore the breeding and summer-long habitat for spotted frogs and boreal toads.

One possible exception to the assessment that no adjustments are needed to meet the needs of spotted frogs and boreal toads is that, given the multitude of factors that negatively currently affect these species, along with strong indications of reduced population levels at the BTNF scale and likely disappearance of local populations, a larger-than-natural distribution and abundance of beaver pond complexes may offset some of these other impacts. However, this would likely be impractical. Regaining a natural distribution and abundance of beaver pond complexes would be difficult enough.

Deviations from Estimated Natural Conditions to Accommodate other Uses

For most resources and uses, there is no need to make any adjustments to the coarse-filter approach of approximating a natural distribution and abundance of beaver pond complexes as a target of management. This is because approximating a natural distribution and abundance of beaver pond complexes would benefit native wildlife-communities as a whole and riparian and wetland species in particular, would benefit cutthroat trout and associated recreation, restoration of riparian areas, hydrologic functioning, water quality, among other benefits (Olson and Hubert 1994).

On the other hand, there are several resources and uses for which a natural distribution and abundance of beaver pond complexes would result in negative effects, including the road network and road management, cattle grazing in some situations (e.g., less available foraging acreage in valley bottoms due to flooded valley bottoms), and likely recreation facilities and activities in some situations. Existing roads in riparian areas and existing reservoirs — would not allow a natural distribution and abundance of beaver pond complexes to be restored or maintained in affected drainages, and this situation will likely not change appreciably. Also, the targeted distribution and abundance of beaver pond complexes needs to be in line with the mix of succession stages targeted for the BTNF (when this is actually identified). Furthermore, harvesting of beavers through recreational trapping (a legitimate use that managed by WGFD) has the possibility of not allowing natural distribution and abundances of beaver pond complexes to be attained. Determining a desired distribution and abundance of beaver pond complexes needs to account for these factors. Under any scenario, a desired abundance and distribution of beaver pond complexes will be lower than what occurred under natural conditions.

Because beavers are absent from many small drainages they historically occupied (e.g., narrow, relatively steep drainages that historically had abundant aspen near the streams) and because spotted frogs and boreal toads likely are absent from many of these small drainages due in part to a lack of wetland habitat, future increases are needed in the distribution and abundance of beaver pond complexes even when not considering all of the factors that have combined and interacted to reduce the distribution and abundance of spotted frogs and boreal toads. When considering these other negative influences, restoration of the distribution and abundance beaver pond complexes has the potential to play an important role in conserving spotted frogs and boreal toads on the BTNF.

Targeting ≥95% (or possibly as low as ≥90%) of a natural distribution and abundance of beaver pond complexes would seem to adequately provide for the needs of spotted frogs and boreal toads while allowing for conflicting facilities and uses to continue. The potential for facilities and uses to conflict with beaver pond establishment and maintenance appears to be rare on the BTNF, with a large portion of the national forest being in designated wilderness, a majority of the remaining acres being in inventoried roadless areas, and a large majority of stream miles being far enough away from roads and other facilities to not cause any conflicts. Reservoirs eliminated large reaches of suitable beaver habitat, but the total stream mileage across the BTNF is very low.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. Meeting the suitable conditions outlined below are important for (1) continuing to provide an important habitat for boreal toads and spotted frogs (e.g., in existing beaver pond complexes), (2) restoring beaver pond habitat in drainages in which beaver pond habitat has been lost; and (3) restoring indirect habitat benefits of beaver pond complexes (e.g., larger amount of moist meadow and willow habitat, longer duration of water flow in some streams below beaver pond complexes).

The following description of suitable conditions is written qualitatively and is founded primarily on the restoration of natural distribution and abundance of beaver pond complexes, but builds in some level of adjustment to this coarse-filter approach in recognition of the impracticality of fully achieving a natural distribution and abundance and the reality that there are places where beaver pond complexes are undesirable. This will allow for more specific objectives to be developed — that fit within the limits of suitable habitat conditions for spotted frogs and boreal toads — as part of a multidisciplinary process if this were to occur in the future.

1. The distribution and abundance of beaver pond complexes on the BTNF approximate a natural distribution and abundance (i.e., within 95%[J] of natural) — particularly where evidence (e.g., signs, pictures, and records of historic dams and lodges) indicate former occupancy and where capable beaver habitat exists or could potentially exist with pertinent restoration (e.g., aspen regeneration) — but recognizing that a full restoration of their distribution and abundance (1) is not practical given the existing road system, reservoirs, and other facilities/developments in riparian areas; and (2) may be further inhibited by future additions to roads and other facilities/developments where their placement in riparian areas cannot be avoided.

From the standpoint of aspen recovery that is needed to restore beaver populations in drainages lacking sufficient willow, efforts toward meeting this suitable condition would run parallel with Aspen Management Guidelines. If the above suitable condition statement was to be identified as an objective, they could provide "documented… wildlife… objectives" toward which Forest Plan Objective 4.2(b) can be applied. To facilitate expansion of existing distribution and abundance, application of the above suitable condition statement to management cannot be limited to existing areas occupied by spotted frogs and boreal toads.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — The healthier conditions that exist in riparian zones, and particularly the greater the extent of willow communities across riparian zones, the greater the potential of maintaining healthy and robust beaver populations.

A.2. Mix of Succession Stages — A suitable mix of succession stages in forestlands is important because, in drainages that do not support extensive stands of willow, aspen stands near the bottoms of drainages provide the only opportunity for beavers to occupy those drainages, and because fire suppression has allowed conifers to overtop and outcompete aspen to the point that aspen is no longer available to beaver in many of these drainages.

A.4. Herbaceous Species Composition — Recovery of herbaceous species composition in riparian zones, especially restoration of sedge communities where these have been lost or depleted, has the potential to contribute to recovery of beaver populations, albeit likely only in a small way.

A.5. Canopy Cover and Health of Willow Communities — Maintaining willow canopy cover and, where willow canopy cover has declined over time, restoring willow canopy cover would contribute to maintaining and increasing the occurrence and extent of beaver pond complexes on the BTNF.

[J] If 95% is not attainable, it may be necessary to identify 90% as the lower threshold of suitability.

Risk Factors and Restoration Factors

The following activities and conditions reduced beaver populations historically and/or have the potential to limit the recovery of suitable conditions identified above for the distribution and abundance of beaver pond complexes and, therefore, have the potential to limit the achievement of Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Historic Beaver Trapping — Extensive beaver trapping from 1818 through 1840 decimated the beaver population in the Greys River District (USFS 2004a) and presumably other parts of the BTNF. Prior to Euro-American settlement, beavers played a major role in shaping many riparian/riverine habitats (Collins 1993, Olson and Hubert 1994, Ohmart 1996) and this was likely true of drainages on the BTNF. Olson and Hubert (1994) assessed that beavers only occupy about one third of the area they originally occupied in Wyoming. USFWS (2011) described a situation in which beaver were removed from a drainage in Idaho resulted in a precipitous decline in spotted frogs, followed by reintroduction of beaver that resulted in a major increase in spotted frog numbers.

Munger et al. (2002, *as cited by Patla and Keinath 2005:52*) assessed that declines in beaver in Idaho likely caused a substantial decrease in breeding and hibernation habitat available to spotted frogs, and that reintroduction of beavers in an area where beavers had declined led to a rapid increase in the number of spotted frogs and re-establishment of breeding by spotted frogs.

Expanded Fire-return Intervals and Decline of Aspen — Although the beaver population has rebounded substantially since the population low, there still appear to be many drainages on the BTNF that historically supported beavers that currently do not. A key factor limiting the return of beavers in many drainages is the decline in aspen stands due to the ongoing conversion of aspen stands to conifer forestland, which is primarily a consequence of fire suppression (Collins 1993, Loosen et al. 2009). This was discussed by Gruell (1975) for the Greys River Ranger District, and evidence of old aspen-based beaver dams can be found in many drainages on the district (e.g., Fawn Creek, Deadman Creek, Blind Bull Creek on the Greys River Ranger District). Aspen are greatly diminished in abundance in these drainages.

Continued fire suppression and major limitations on implementing fire-use fires and prescribed burning will continue to limit the recovery of aspen communities (discussed in detail in the "A.2. Mix of Succession Stages in Forests" section) and, therefore, will continue to limit the recovery of the distribution and abundance of beaver on the BTNF. This may be a major factor contributing factor to reduced populations of spotted frogs and boreal toads on the BTNF.

Current Beaver Trapping — Beaver trapping by recreational trappers licensed by the WGFD has the *potential* to slow the recovery of beaver populations, but there is no indication that it is having negative effects on the recovery of beaver populations. While the Forest Service does not have any authority regarding the trapping of beavers, the agency can work with the Wyoming Game and Fish Department to help ensure that trends in beaver distribution and abundance in areas inhabited and potentially inhabited by boreal toads and spotted frogs are considered.

Breaching of Beaver Dams with and without Removal of Beavers — Breaching of beaver dams has been done in two situations on the BTNF, both of which have the potential to slow the recovery of the distribution and abundance of beavers on the BTNF. Breaching of dams has been done where beaver dams caused direct damage to roads and bridges or had the potential to cause direct damage to them. In some cases, beavers were removed through live-trapping and relocation or by lethal means, but in other cases they were not removed. This practice continues today to address localized situations with no more than limited lethal removal. Breaching of beaver dams had reportedly been done by ranchers in some drainages in the past due to concerns about loss of water to beaver dam complexes, which can adversely impact beaver populations depending on the timing and frequency of breaches. To the extent breaching continues today, it can contribute to slowed progress in regaining a natural distribution and abundance of beavers and can adversely affect spotted frogs and boreal toads associated with beaver ponds that are directly impacted.

Reductions in Bankside Willow Abundance — Reductions in bankside willows may result in reduced beaver activity and may limit expansion of beavers into new drainages (Keinath and McGee 2005). This factor is of limited relevance on the BTNF since capable willow habitat appears to be supporting relatively dense stands of willows in most places.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including Olson and Hubert (1994), Keinath and McGee (2005), Patla and Keinath (2005), PARC (2008), and Grand Canyon Trust (2013), as well as publications cited earlier in this section.

Approximating a natural distribution and abundance of beaver pond complexes primarily entails (1) approximating a natural mix of succession stages in drainages that historically produced suitable aspen for beavers but now do not; and (2) working with WGFD to avoid limitations (e.g., excessive trapping) on the expansion in the distribution of beaver on the BTNF and maintenance of suitable beaver populations in the drainages where they occur. These will be important in the process of achieving Forest Plan Objective 3.3(a) and meeting the Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

I. Aspen Related

1. Design and implement aspen restoration projects in drainages that historically contained beaver pond complexes but currently do not, with an emphasis on treatments within about 1,000 feet of streams (including aspen treatments as close to streams as possible, with care).

2. Ensure that livestock grazing is managed in ways that does not adversely affect aspen and willow communities, that allow for recovery of damaged communities, and that retain relatively high percentages of sedge plant material (an important summer food for beavers). For example, Bartos et al. (2014) found that limiting browsing (as simulated through clipping) to ≤40% of the current years growth would have only small negative effects on recruitment of aspen suckers, at least if this only occurred for 1-2 years. Loeffler et al. (2001:65) recommended limiting the browsing of willows to ≤15-20% of the number of leaders produced in the current year. Also, the 70% retention of all herbaceous vegetation identified in Objectives B.1 and B.2 should readily provide for the sedge-forage needs of beavers and to minimize impacts on willows, recognizing that this high of retention levels in the vicinity of beaver pond complexes likely is not necessary.

3. Rest burned areas from livestock grazing for at least two livestock grazing seasons following fire, especially in wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, willow, aspen, aspen/conifer types within 1½ miles of known existing breeding areas and known historic breeding areas with capable amphibian wetland habitat. Particular attention should be paid to resting aspen habitat within about 1,000 feet of streams).

4. Work with WGFD to keep elk from increasing beyond objective levels.

5. Work with WGFD to explore options for reducing the potential for elk excessively browsing aspen following fire and vegetation treatment, especially in drainages where beavers historically occurred and where capable habitat exists for beavers. This includes design of vegetation treatments, as well as post-treatment techniques.

6. In situations where a lightning-strike fires would burn through drainages formerly occupied by beavers and in which aspen is being adversely impacted by conifer forestland, manage the fires for resource benefit to the greatest extent possible.

II. Beaver Dams and Reintroductions

1. Where relatively large numbers of beaver dams are annually breached during high-water events and where this could be alleviated by several consecutive years of most or all beaver dams not being breached (e.g., to get to the point where water is spread far enough across valley bottoms for a long enough distance such that the force of the water no longer acts against a small number of dams), consideration should be given to reinforcing beaver dams (e.g., with posts driven through the dams into the substrate below). This is being explored by Dave Fogle, Fisheries Biologist for the West Zone.

2. If there are situations where beaver dams are being actively breached on National Forest System lands without the prior knowledge of the Forest Service, take actions to remedy the situation.

3. Work with the Wyoming Game and Fish Department and non-governmental organizations (e.g., Wyoming Wetland Society) to reintroduce beavers into suitable drainages.

III. Dealing with Conflicts Between Beavers and Roads and Other Developments

1. Where existing roads had been placed where they now create problems with beavers (e.g., beaver ponds backing across roads and beavers plugging culverts, both of which could result in removal of beavers and/or breaching of their dams), take actions to successfully address the problems caused by beaver dams and ponds (e.g., flooding of roads) with as little impact to beavers as possible. However, this needs to be balanced with an assessment of whether the stream is in the right place, is the road in the right place? Are there engineering solutions that would reduce or prevent conflicts? Potential solutions include:
   a. The installation of pond leveler devises to control unwanted flooding (Grand Canyon Trust 2013). This involves placing a pipe through a beaver dam to create a "permanent leak," with the inflow portion of the pipe protected by cage that prevents beavers from plugging the pipe.
   b. The installation of Protective culvert fencing and "pipe and fence" systems to prevent plugging of culverts (Grand Canyon Trust 2013).
   c. Relocating roads to avoid or minimize conflicts with beaver ponds, which would reduce the potential for beaver dams to be destroyed and beavers to be removed. The Streamside Roads Standard requires that "…Roads presently within riparian areas will be relocated outside riparian areas where possible," but this standard applies primarily to reducing impacts to water quality.

2. Evaluate placement of new roads in terms of their effects on the perpetuation of beaver pond complexes, where they currently exist, and their effects on the re-colonization of capable habitat. To the extent possible, avoid placing roads in riparian areas where future conflicts are likely (e.g., beaver ponds backing across roads and beavers plugging culverts, both of which could result in removal of beavers and/or breaching of their dams).

3. Work with WGFD to consider relocating problem beavers to drainages that currently do not have beavers, have sufficient food supplies, among other considerations. Munger et al. (1997, *as cited in Patla and Keinath 2005:60*) suggested "… reintroduce beavers in areas where a need for dam-building activities of beavers has been identified." PARC (2008) highlighted amphibian benefits of reintroducing beaver to appropriate drainages.

IV. Beaver Trapping

1. Work with WGFD on quotas to avoid excessive trapping that could impede expansion in the distribution of beaver on the BTNF and that could impede the maintenance of suitable beaver populations in the drainages where they currently exist. Munger et al. (1997, *as cited in Patla and Keinath 2005:60*) suggested to "Manage harvest of beaver to prevent decline or loss of beaver populations…" Harvest of beaver is restricted in some areas in at least two states to help conserve spotted frogs. In several parts of Idaho where spotted frogs occur, beaver harvest is restricted from November to March. The Oregon

Conservation Strategy for spotted frogs encourages allowing beaver to contribute to wetland creation and maintenance when compatible with existing land uses.

Measures and Indicators

Currently Monitored Elements

The Forest Service currently does not monitor the occurrence and extent of beaver ponds or the mix of succession stages in aspen types, but has started tracking the following over the long term.

- <u>Distribution of Aspen Communities</u> – This has been done through remote sensing (e.g., 2007 vegetation layer). A more detailed aspen assessment was completed on the Greys River Ranger District in 2009 (Loosen et al. 2009).
- <u>Density of Aspen Suckers ≥10 feet at 10 years Post-Treatment</u> – This is currently monitored on many aspen treatment projects.

Additional Monitoring Elements to Consider

The following could potentially be monitored, but given existing and declining budgets and other higher priorities, it likely will not be tracked to any large degree on most districts:

- <u>Distribution and Extent of Beaver Ponds</u> – This could be done by periodically delineating beaver ponds in drainages or indirectly by establishing permanent photo points of beaver dams and obtaining GPS locations of all beaver dams in drainages across the BTNF, and redoing this periodically (e.g., 10 years).
- <u>Locations and Numbers of Beavers Harvested</u> – This information may be available through WGFD.
- <u>Locations and Numbers of Beavers Harvested</u>

Even though the distribution and extent of beaver ponds likely may not be monitored across the BTNF, trends could potentially be indexed by monitoring and periodically evaluating several variables, including:

- Changes in distribution and acreage dominated by aspen.
- Distribution and proportion of aspen in early succession.
- Distribution and proportion of the willow type that has sufficient acreage and percent canopy cover to support beavers, including distribution and acreage of the willow type not been overtopped by conifers.
- Beaver trapping and beaver relocation. Managing beaver trapping is primarily a WGFD function, but the Forest Service has some authority with respect to trapping and relocating beavers, depending on the situation. Wildlife biologists on the BTNF could track WGFD trapping records, which would provide one indication of the ability of beavers to expand their distribution.

Additionally, (D. Deiter, District Ranger, Jackson Ranger District, personal communication 2013) recommended the potential comparison with historic photographs to ascertain locations of beaver ponds in specific areas.

A.4. HERBACEOUS SPECIES COMPOSITION

Introduction and Background

Herbaceous species composition is important in at least three settings for spotted frogs and boreal toads: (1) within and at the edges of pools and ponds, (2) in wet meadow, moist meadow, silver sagebrush, and open willow communities; and (3) in upslope rangeland, aspen, and open forestland communities. Herbaceous species composition directly affects some important habitat components (e.g., humidity retention near ground level, hiding cover for tadpoles and adults) and indirectly affects other important habitat components (e.g., water quality as affected by erosion in uplands, food for tadpoles).

Herbaceous species composition plays important roles in humidity retention, temperature moderation, shading, provision of substrate for eggs and tadpole forage, provision of invertebrate species richness and abundance, and maintenance of water quality. Several of these are discussed further in the section “B.3 Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter,” below, and the maintenance of water quality is discussed further in the section “B.1 Water Quality,” below.

Migration and summer-long habitat for spotted frogs and boreal toads encompass the habitat between breeding sites, sites where individuals spend most of the summer, and hibernation sites. Depending on localized situations and species, year-long distribution of local populations range from possibly as little as several acres up to several hundred acres. Spotted frogs can travel as far as several hundred yards to 2/3 mile or more between breeding sites and summer habitat, based on research in Yellowstone National Park and eastern Idaho (Turner 1960, Pilliod et al. 2002, Patla and Keinath 2005). Adult boreal toads are primarily terrestrial and inhabit a great variety of habitats sometimes over relatively long distances. Boreal toads use a wider range of habitats than spotted frogs, with habitats including a diversity of forested and non-forested wet and dry areas with wide ranging composition of herbaceous vegetation (Keinath and McGee 2005).

Herbaceous species composition is important to spotted frogs and boreal toads because — especially where shrubs and large woody debris are absent or relatively low in occurrence — herbaceous vegetation is what provides hiding cover on land in the water, protection from the sun, humidity retention, substrate for eggs, food for tadpoles, habitat for invertebrate prey, protection from erosion in uplands (which affects water quality and wetland longevity), and organic material that fosters infiltration (which can affect water-flow volume and timing, and stream channel integrity), among other functions (Hammerson 1982, Engle 2001, Keinath and McGee 2005, Patla and Keinath 2005, Pierce 2006, Shovlain 2006). Thus, herbaceous species composition can have a large influence on the whether Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard are met. Effects of herbaceous composition on water quality and stream channels are addressed in more detail in the introductions of “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” and “B.1. Water Quality.”

Sedges are particularly important in wetland, wet meadow, and moist meadow habitats. Two thirds of wetland sites used by spotted frogs in Yellowstone National Park had greater than 50% cover of emergent vegetation, mostly sedges (Patla and Peterson unpublished data, as cited by Patla and Keinath 2005:28). This is generally consistent with findings on the Greys River and Kemmerer Ranger Districts of the BTNF where nearly all of the wetlands used by spotted frogs and boreal toads for breeding contain sedges (primarily) and grasses (secondarily) (McEachern and Brick 2008, McEachern 2010a, McEachern 2010b, and McEachern 2011), and other parts of the BTNF. Also, Yosemite toad breeding pools in a study by Roche et al. (2012) averaged about 56-80% “herbaceous cover,” with much of the non-vegetated portions being open water. Pierce (2006) stated that adult toads move into high grasses and surrounding forests after breeding. Vegetation on streambanks is important in some areas (Maxell 2000).

Plant species composition is important to invertebrate prey Morris and Plant 1983, Morris 2000, Kruess and Tscharntke 2002, Hornung and Rice 2003, New 2004, Young and Barbour 2004, Samways 2005, Black et al. 2007, New 2009, Kimoto 2010, Black et al. 2011.

Herbaceous retention (in the “B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter” section) and plant vigor are integrally linked with herbaceous species composition. One way to look at herbaceous retention, for example, is that it reflects the aftermath of grazing in terms of herbaceous species composition. For example, what is the percent canopy cover of herbaceous vegetation above the height of grazed stubble? Even though pre-grazed canopy cover of vegetation in a 12-23.9 inch category may be 85%, if it is only 10% after the grazing season, this is inadequate canopy cover to provide for the functions of herbaceous vegetation in meadow communities. This is discussed in more detail in the “B.3. Herbaceous Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter” section.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan, policy, laws, and an executive order require the

Forest Service to maintain plant communities with satisfactory herbaceous species composition in satisfactory condition and to restore plant communities with less-than-satisfactory herbaceous species composition. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to herbaceous species composition.

Desired composition of herbaceous species, by major vegetation types, has not yet been defined for the BTNF. Defining the desired herbaceous species composition will be a multi-disciplinary effort.

Goal 4.7 (Forest Plan) — "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreational values or experiences."

Objective 4.7(a) — "Retain or improve forage and overall range condition."

Objective 4.7(b) — "Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present."

Vegetation: General Prescription — "Whether range or timber, vegetation management activities enhance diversity of plant communities and various successional stages of those plant communities within the Management Areas. For aspen, priority is placed on perpetuating stands being invaded by conifers. Vegetation treatment projects are designed to retain diverse age classes."

Vegetation: Range Prescription — "Forage is provided on a sustained-yield basis that protects rangeland values, wildlife habitat, and meets other resource needs. All practices available can be used to improve forage supplies and quality."

Forage Improvement Standard (Forest Plan) — "Range in less-than-satisfactory condition will be improved. Disturbed areas will be stabilized or regenerated prior to resuming grazing use."

Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan) — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."

Streambank Stability Guideline (Forest Plan) — "At least 90 percent of the natural bank stability of streams that support a fishery, particularly Threatened, Endangered, and Sensitive species, and all trout species, should be maintained. Streambank vegetation should be maintained at 80 percent of its potential natural condition or an HCI rating of 85% or greater. Streambank stability vegetation and fish numbers and biomass should be managed by stream type."

Forest Service Handbook 2209.22.1.2 — *Ground Cover:* The minimum ground cover needed for proper functioning sustainable ecosystems for primary cover types in the Region[K] are:

Cover Type	Minimum % Ground Cover for Functionality
Alpine	90%
Mountain Big Sagebrush	70%
Tall Forb	80%
Mountain Brush	70%
Aspen	80%

[K] O'Brien et al. (2003) identified similar minimum thresholds for ground cover specific to the Bridger-Teton National Forest, except that minimum ground cover should be 85% for mountain big sagebrush and should be 90% for aspen communities.

> ***Forest Service Handbook 2209.22.1.4*** *— Species Composition:* "…A rangeland site is functioning when all the desired plant species (e.g., all species endemic to the site) are present in the desired amount. The interpretation of desired species and amounts will change when goals change for specific purposes, like watershed sustainability, forage production, sage grouse habitat, low risk wildfire community, or a pleasing wildflower setting in a sagebrush community..."
>
> As such, desired species composition — where spotted frogs and boreal toads are an important resource to conserve — needs to be defined in a way that ensures suitable habitat conditions are maintained and, where there is gap between existing and desired conditions, restored. Desired species composition needs to be defined in the context of the capability of the land, even if decades are needed for restoration.

Estimated Natural Conditions

The composition of herbaceous vegetation that existed prior to Euro-American settlement and that would exist today in the absence of any deterioration of plant communities caused by human-related factors constitute natural conditions for this habitat element. The range of natural conditions for this element is within the range of suitable conditions for spotted frogs and boreal toads, recognizing that suitable conditions may extend beyond the natural range of variability.

There are three main reasons why a natural herbaceous species composition in wetlands, riparian areas, and rangelands provide or contribute to suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, a natural composition of herbaceous vegetation contributed substantively to (1) stable streambanks in low gradient systems which in turn contributed to maintaining riparian and wetland vegetation across valley bottoms, and (2) minimizing overland flow and erosion in rangeland and aspen communities. Leoffler et al. (2001), Keinath and Patla (2005), Patla and Keinath (2005), and other experts have recognized the importance of healthy riparian areas to spotted frogs and boreal toads. Today, an important indirect effect of restoring or approximating natural plant species composition on streambanks is that this would contribute to currently-altered stream channels being restored and stream channels returning to proper functioning condition, depending on stream type. This in turn would restore and maintain water tables at their natural potential levels, which benefit amphibians by retaining water for longer in associated wetlands. In many situations, altered plant species composition on streambanks (e.g., nonnative bluegrasses, sagebrush, and other non-riparian species) are inadequate to maintain stream channels in proper functioning condition.

Second, herbaceous species composition in these areas is important to both species in at least three settings: (1) within and at the edges of pools and ponds (e.g., typically sedge dominated) used for breeding and summer-long habitat; (2) in wet meadow, moist meadow, silver sagebrush, and open willow communities for migration habitat for both species and summer-long habitat for boreal toads; and (3) in upslope rangeland, aspen, and open forestland communities where herbaceous species composition at desired levels limits erosion and sedimentation in basin wetlands and streams (i.e., effects on water quality), and provides suitable conditions for migrating individuals. Important contributions of herbaceous vegetation — especially where shrubs and large woody debris are absent or relatively low in occurrence — include the following:

- *Hiding and Escape Cover on Land in Water* — Live and dead herbaceous vegetation provides visual and structural barriers that hide frogs, toads, and tadpoles from predators, increases the difficulty of predators catching frogs and toads where they rest or forage, and it provides structure within which they can escape from predators. This hiding and escape cover (which exists both in and above the water column) is important for tadpoles and for adult frogs and toads when they are in wetlands (Warkentin 1992, Jansen and Healey 2003, Shovlain 2006, Schmutzer et al. 2008), is important on shorelines for metamorphs and adult frogs and toads when they inhabit shorelines (Jansen and Healey 2003, Burton et al. 2009), and is important in wet meadows, moist meadows, silver sagebrush, and open willow-graminoid communities for juvenile and adult frogs and toads (Keinath and McGee 2005, Patla and Keinath 2005, Shovlain 2006). Where willow canopy cover is high and where there is an abundance of large woody material, herbaceous vegetation is of lesser importance for providing humid micro-sites.

The apparent preference of spotted frogs and boreal toads for selecting breeding ponds that contain substantial amounts of sedges and other emergent vegetation and the propensity for them to lay their eggs in marshy parts of wetlands (Keinath and McGee 2005, Patla and Keinath 2005, unpublished amphibian monitoring data of BTNF) may in part be explained by the contributions of emergent vegetation to protecting adult frogs and toads and tadpoles from predators. Portions of ponds and pools used for breeding on the BTNF typically have a large component of sedges (McEachern and Brick 2008, McEachern 2010a, McEachern 2010b, and McEachern 2011). Schmuzter et al. (2008) attributed markedly higher tadpole diversity and markedly higher abundance of some tadpole species in ungrazed wetlands in part to a 10.9x greater biomass of detritus in these wetlands — which provides escape cover, as well as feeding sites and forage — compared to grazed wetlands. Although this study compared grazed and ungrazed wetlands, similar results likely would be obtained when comparing wetlands with a high and low composition of herbaceous vegetation. Implications of herbaceous species composition on hiding cover for frogs and toads is discussed in more detail in Appendix A, in the "Hiding and Escape Cover" subsection of the "Roles of Herbaceous Vegetation."

- *Humidity Retention, and Temperature Moderation, and Protection from the Sun* — Moist and humid environments are important to frogs and toads because their bodies have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist (Schwarzkopf and Alford 1996, PARC 2008, Rittenhouse et al. 2008). They regulate skin moisture through the selection of places they inhabit. Dumas (1964) reported that relative humidity of 65% at about 78 °F is lethal to adult spotted frogs in approximately two hours. Therefore, when they move across terrestrial habitats, either the terrestrial habitat must be sufficiently moist or humid, or the distance from one moist site to each of the next moist sites must be of short enough that frogs will not be caught in-between for too long (Engle 2001, Pilliod et al. 2002, Patla and Keinath 2005). While moist environments and micro-sites are also important for boreal toads, it is somewhat less important than for spotted frogs since toads are able to withstand greater water loss than frogs (Thorson 1955, Schmid 1965, Duellman and Trueb 1986).

  Rittenhouse et al. (2008) found that desiccation can be a major source of mortality for juveniles after leaving breeding wetlands and while moving through terrestrial habitats. While adults may be able to call on previous experience in traveling through specific areas and be able to find somewhat scattered moist microsites as needed (although there is no actual data supporting this), juveniles have no previous experience in their movements away from breeding sites and may depend more greatly depend on closely spaced or homogenously-moist habitats with relatively high humidity at ground level.

  The canopy of herbaceous vegetation maintains higher humidity levels and lower temperatures near ground level during midday than would occur without the vegetation (Oke 1978:104-120, Baldocchi et al. 1983, Honek and Jarosik 2000). Closer plant spacing and taller plants with dense canopies retain more humidity and moderates temperatures near ground level more so than wider spacing and shorter plants with sparse canopies (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988). Litter and mulch contribute to retaining moisture at the ground surface, which contributes to higher humidity just above the soil surface, and litter and mulch buffer air temperatures near the ground level (Hopkins 1954, as cited by Fagerstone and Ramey 1996; Molinar et al. 2001), all of which are important to frogs and toads (Maxell 2000, Bartelt et al. 2004). Litter and mulch depend on inputs from herbaceous vegetation, and the level of contributions of herbaceous vegetation to litter and mulch are directly correlated with the height and canopy cover of herbaceous vegetation. The relationships summarized above are outlined in detail in Appendix A, in the "Humidity Retention, Temperature Moderation, and Protection from the Sun" subsection of the "Roles of Herbaceous Vegetation."

  Results of Schwarzkopf and Alford (1996) support the principle, specific to frogs and toads, that greater amounts of soil moisture and greater amounts of herbaceous canopy cover retain higher humidity levels at ground level. They found that water loss in simulated toads was greatest in the open on sandy ground, somewhat lower in dry grassy sites, substantially lower in wet grassy sites, and lowest in burrows. In another part of their study, Schwarzkopf and Alford (1996) found that cane toads (*Bufo marinus*) made greatest use of burrows and wet grassy sites and little or no use of dry grassy sites and open sites during the dry season, and made relatively high use of dry grassy sites and less use of burrows and wet grassy sites during the wet season.

- *Food for Tadpoles* — Tadpoles appear to be omnivorous, with an apparently large portion of their diet coming from decaying vegetation. They feed on green algae and planktonic material they either filter from the water or scrape from vegetation or sediment; detritus they obtain from the bottom of wetlands; dead tadpoles; and possibly bacteria and dissolved nutrients (Warkentin 1992, Keinath and McGee 2005, Patla and Keinath 2005, Schmutzer et al. 2008).

  Because much of what tadpoles eat appears to stem from detritus, most of which in many wetlands ultimately originates from herbaceous vegetation, the availability of tadpole food appears to be directly related to the amount of herbaceous vegetation that is produced and maintained on site. Schmuzter et al. (2008) attributed markedly higher tadpole species diversity and markedly higher abundance of some tadpole species in ungrazed wetlands, in part, to a 10.9x greater biomass of detritus in these wetlands — which provides feeding sites and forage, as well as escape cover — compared to grazed wetlands. They did not detect any differences in the biomass of filamentous algae at the P = 0.35 level.

- *Forage, Cover, and Substrate for Invertebrate Prey* — As a general rule in meadows, grasslands, and shrub-herb communities, the number of invertebrate species and the relative abundance of each are directly related to the amount of herbaceous vegetation produced and the composition of herbaceous species, and the occurrence of specific plant species in plant communities is important to maintaining a range of individual invertebrate species (Morris and Plant 1983, Morris 2000, Kruess and Tscharntke 2002, Hornung and Rice 2003, New 2004, Young and Barbour 2004, Samways 2005, Black et al. 2007, New 2009, Kimoto 2010, Black et al. 2011). Invertebrate species richness and abundance is strongly affected by plant species composition. Many insect species prefer herbaceous species that provide tall/dense or moderately tall/moderately dense cover (Evans 1984, Kruess and Tscharntke 2002).

- *Protection from Erosion in Uplands* — Herbaceous vegetation canopies, along with litter and organic soils derived from herbaceous vegetation and along with the roots of herbaceous plants, serve critical roles in protecting the soil surface from water drops during rain storms, proper infiltration of water, and slowing of overland flow, all of which contribute substantively to reducing soil erosion and, eventually, the amount of sediments reaching wetlands and streams (Thurow 1991, Satturlund and Adams 1992, National Research Council 1994, USFS 1997, Holechek et al. 2011). Sediments can negatively affect water quality (see “B.1. Water Quality” section) and, in large enough quantities, can prematurely fill-in wetlands (see “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” section). Large pulses of water, stemming from unnaturally high rates of overland flow, can exacerbate erosion of streambanks and stream channels, which can contribute to lowering of water tables, which in turn reduces the extent of riparian vegetation and the duration of surface water in riparian wetlands (see “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat”).

  Keinath and McGee (2005), Patla and Keinath (2005), and other authors discussed the implications of soil erosion and sedimentation to amphibian conservation, specifically as it pertains to reduced water quality.

  On most uplands that drain into wetlands and streams inhabited by spotted frogs and boreal toads, a natural composition of herbaceous vegetation likely provides among the highest possible level of protection from raindrops and the highest possible infiltration rates, given the potential of the land… since the natural herbaceous species composition is a direct reflection of the potential of the land.

- *Organic Material for Soils and Litter* — Another important feature of spotted frog and boreal toad habitat in herbaceous communities is the presence of a well-developed litter layer, mulch, and organic soil. Litter is important in herbaceous communities and in herbaceous layers for several reasons, including its contributions to moist/humid microsites, hiding cover, and protecting the soil from erosion. Mulch and organic soils are important in herbaceous communities/layers because they facilitate infiltration of water,

> thereby contributing to reduced overland flow and erosion (Thurow 1991, Satterlund and Adams 1992, Molinar et al. 2001), and they facilitate burrowing by amphibians (Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006). Higher rates of infiltration contribute to reduced rates of overland flow and lower rates of erosion (Thurow 1991, Molinar et al. 2001), which in turn reduces the potential for excessive sediments to reach wetlands and streams as discussed above.
>
> Large amounts of litter, thick mulch layers, and organic soils in herbaceous and shrub-herbaceous communities are dependent on relatively large annual inputs of herbaceous vegetation, which in turn depend on a high overall composition of herbaceous vegetation (Molinar et al. 2001).

A natural herbaceous species composition in in wetland, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities likely represents the upper end of what can realistically be produced and sustained in the BTNF area, given a site's elevation, soils, aspect, slope, and climate conditions. There likely are no instances of altered conditions providing taller, denser, and more diverse herbaceous vegetation that provides better hiding cover, humidity retention, temperature moderation, forage for tadpoles, and invertebrate habitat than would occur under a natural herbaceous species composition. While a natural herbaceous species composition in uplands may not be at the upper end of what can realistically be produced and maintained on the BTNF for facilitating infiltration and holding soil in place, it is well within what can be considered satisfactory for these functions. A relatively large number of native species rate as only moderate or low "erosion control potential rating" (R4, FSH 2209, Exhibit 22.1).

Rather than providing estimates of natural species compositions of each of the major vegetation types in this subsection, estimates are provided of relatively natural species compositions in the "Deviations from Estimated Natural Conditions to Accommodate other Uses" subsection, below.

Third, amphibian communities formed or developed in this area with a natural composition of herbaceous species.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural composition of herbaceous vegetation in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction for sensitive species. This is because (1) the natural composition of herbaceous vegetation represents conditions under which amphibian communities formed or developed in the BTNF area, (2) a natural herbaceous species composition would be favorable to spotted frogs and boreal toads compared to existing conditions, and (3) upward trends toward natural herbaceous species composition and a natural species composition would not adversely affect spotted frogs and boreal toads relative to existing conditions. A natural herbaceous species composition would be favorable to spotted frogs and boreal toads compared to existing conditions because there numerous situations in which the existing plant species richness, vegetation height, vegetation canopy cover, and overall ground cover are lower than what they were under natural conditions and likely no situations in which the opposite is true.

While a larger-than-natural amount of land supporting wet and moist plant communities would benefit spotted frogs and boreal toads, this is not necessary to achieve management direction for these species and it likely is impractical. Regaining a natural composition of herbaceous vegetation would be difficult enough.

Deviations from Estimated Natural Conditions to Accommodate other Uses

Given the multiple-use mandates of the Forest Service and given some of the inherent limitations of fully restoring and maintaining natural plant species composition under uses like livestock grazing, recreational horse grazing, and camping, it may be necessary to accommodate some degree of deviations from natural conditions caused by these uses. However, lowering the bar on herbaceous species composition can only be accommodated to the extent suitable conditions are still provided for spotted frogs and boreal toads, both in terms of direct effects of plant species composition on hiding and escape cover, humidity retention, shading and temperature moderation, forage for tadpoles, and insect habitat, and indirect effects of plant species composition on sedimentation originating in uplands (and its effects on water quality and filling of wetlands) and on stream channel integrity as affected by the degree to which precipitation flows overland and stream channel integrity as affected by plant species composition on banks.

From the standpoint of indirect effects of plant species composition (e.g., effects on erosion and sedimentation rates), plant species composition in uplands that satisfactorily provides for proper watershed functioning would suffice for providing suitable habitat with respect to habitat elements affected by sedimentation. This means that herbaceous species composition in uplands can decline, from a natural composition, and still contribute to suitable conditions for frogs and toads. At a minimum, the composition of herbaceous species in uplands must provide for a relatively high "erosion control potential" (FSH 2209.22.1.2) and ground cover levels as defined in FSH 2209.22.1.2 and in O'Brien et al. (2003). The concept of proper watershed functioning allows for some deviation from natural conditions as a result of human uses so long as major functions of upland vegetation are adequately maintained. With respect to spotted frogs and boreal toads in wetlands and riparian areas, this primarily involves the role that herbaceous vegetation (including subsequent litter and organic material in soil) plays in watershed functioning, including facilitating infiltration, protecting soil against impacts of rain drops, and slowing overland flow, as discussed above in the "Estimated Natural Conditions" subsection. Desired herbaceous species composition in uplands has not yet been defined, at the BTNF level.

Wetlands, Riparian Areas, and Non-Riparian Meadows

From the standpoint of direct effects, suitable herbaceous species composition on a site by site basis must, at a minimum, reflect or approximate the class of vegetation (e.g., sedges, forbs, bunchgrasses), height class, and vegetation density of the plant community that would naturally occur on the site (i.e., absence of any history of alteration due to human activities or actions). This not only includes herbaceous species composition in wetlands and riparian areas, but it also includes species composition in uplands where frogs and toads migrate. The plant *species* do not need to match the species that would occur on the site in the absence of the last 100+ years of human influence. Of greater importance is the degree to which the vegetation approximates cover qualities (e.g., for hiding and escape, humidity retention, temperature moderation) and vegetation conditions suitable for insect diversity. A range of possible herbaceous species compositions (i.e., the exact makeup of individual plant *species*) can accommodate the needs of spotted frogs and boreal toads. (However, it must be recognized that the make-up of plant species is important to many vertebrate wildlife species and even invertebrate wildlife.)

Marsh, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities are naturally high in herbaceous canopy cover. The following characterizations of herbaceous canopy cover reflect approximations of natural levels of canopy cover as affected at least to some degree by uses that currently affect canopy cover (i.e., *relatively* natural conditions). This is because in most if not all areas in which canopy cover was assessed by the scientists had a history of livestock grazing use and possibly other uses. Total herbaceous canopy cover refers to the total canopy cover of herbaceous vegetation relative to the total amount of area occupied by a given plant community. Canopy cover of individual groups of plant species is presented relative to the total herbaceous canopy cover.

- *Wet Meadow and Marsh* — Under natural conditions, total herbaceous canopy cover typically is characterized as "dense" and relatively natural canopy cover typically is 80-100% (Mueggler and Stewart 1980, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Winward 1989, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). A minimum threshold of 80% appears to represent somewhat altered conditions because communities sampled by Norton et al. (1981), Youngblood et al. (1985), Padgett et al. (1989), and Manning and Padgett (1995) were sampled after a century of livestock grazing and other activities. Also, Winward (1989) identified — in examples of the potential natural community of several wet meadow communities — sedge composition and canopy cover of 85% or higher; dominant sedges in these communities were variously Nebraska sedge, beaked sedge, and water sedge, which are the dominants in most wet meadow communities on the BTNF. The predominant height of leaf tufts in sedge-dominated wet meadow and marsh communities under natural or relatively natural conditions is variable depending on site conditions, ranging from approximately 6-11.9 inches (short height-class), to 12-23.9 inches (moderate height-class), to 24-35.9 inches (tall height-class) (Herman 1970, Norton et al. 1981, Padgett et al. 1989, Kinney and Clary 1994). When in healthy condition, most wet meadow and marsh communities likely are in the moderate and tall categories. Norton (1981:57) noted that the beaked sedge and water sedge communities they sampled in the Greys River drainage averaged about 24 inches tall.

An estimated minimum of 75% of the total herbaceous canopy cover of most wet meadow and marsh communities when in relatively natural condition typically consists of beaked sedge, water sedge, analogue sedge, Nebraska sedge, slender-beak sedge, Hood's sedge, silver sedge, wooly sedge, or bluejoint reedgrass, individually or in combination (Norton et al. 1981:57, Youngblood et al. 1985:Appendix B, Padgett et al. 1989:Appendix B, Winward 1989; Manning and Padgett 1995: Appendix B). This represents relatively natural conditions. In one study of riparian plant communities in western Wyoming, the average canopy cover of just one sedge species in each wet meadow community ranged from 59% to 88%, and other species resulted in considerably higher total herbaceous canopy cover in each community (Youngblood et al. 1985:Appendix B). In a similar study of riparian plant communities in Utah and southeastern Idaho, the average canopy cover of just one sedge species in each wet meadow community ranged from 82% to 89%, and other species resulted in higher total herbaceous canopy cover (Padgett et al. 1989:Appendix B).

A sedge community does not have to cover an entire wetland for the wetland to provide suitable habitat. For example, some ponds that sustain populations of frogs and/or toads only have the potential to sustain a sedge community along one side of the pond. Small non-vegetated patches, whether patches of open water or small shoreline patches where sunlight hits the soil, are desirable for boreal toads (Keinath and McGee 2005). Wetlands used exclusively for summering (e.g., spotted frogs) can be less vegetated than wetlands used for breeding (Patla and Keinath 2005).

Ideally, the composition of Kentucky bluegrass in wet meadows should be 0% (Winward 1989), but it is recognized that areas supporting Kentucky bluegrass and other nonnative bluegrasses will continue to have at least some bluegrass represented.

- *Moist Meadow Communities* **—** Under natural conditions, total herbaceous canopy cover typically is characterized as "dense" and relatively natural canopy cover typically is 80-100% (Norton et al. 1981:57, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). Where tufted hairgrass and/or small-winged sedge are the dominant graminoid species, the predominant height of communities (i.e., minus seedheads) ranges from the upper end of 6-11.9 inches to12-23.9 inches, and where the herbaceous layer is dominated by basin wildrye, the predominant height of communities is 24-35.9 inches (Herman 1970, Cronquist et al. 1977, Padgett et al. 1989, Kinney and Clary 1994, Skinner 2010).

  Relatively natural conditions for graminoid-dominated moist meadows are in part indicated by ≥25% canopy cover of tufted hairgrass (except possibly where small-winged sedge is the dominant graminoid) and, in combination, ≥60% of the total canopy cover is comprised of tufted hairgrass, alpine timothy, timber danthonia, small-winged sedge, wooly sedge, silver sedge, and slenderbeak sedge (and, in small-winged sedge communities only, additional species are beaked sedge, aquatic sedge, and bluejoint reedgrass) or ≥60% of the total canopy cover is comprised of tufted hairgrass, Columbia needlegrass, slender wheatgrass, basin wildrye, mountain brome, and various sedges, combined (Mueggler and Stewart 1980, Youngblood et al. 1985, Kovalchik 1987, Padgett et al. 1989, Taylor 1994a, Taylor 1994b, NRCS 2008a, NRCSb). Exact replication or approximation of these conditions is not needed for spotted frogs and boreal toads and prevalence of nonnative species is acceptable, so long as the height, structure, and diversity is approximated. The most important part of herbaceous species composition in these communities is that height, structural density, and species diversity are representative of the natural community.

  Relatively natural conditions for graminoid-dominated moist meadows are in part indicated by the absence of nonnative bluegrasses, redtop, and smooth brome or a combined canopy cover of <20%; a combined canopy cover of Virginia strawberry, orange sneeze weed, alpine leafbract aster, northwest cinquefoil, and introduced clover species of <10%; and canopy cover of noxious weeds being 0% (Mueggler and Stewart 1980, Youngblood et al. 1985, Padgett et al. 1989).

- *Silver Sagebrush and Shrubby Cinquefoil* — Herbaceous species composition in the understories of these communities is similar to that of moist meadow communities, with a caveat that increasing percent canopy cover of shrubs, above a certain threshold, reduces overall herbaceous canopy cover. Also, high canopy cover of silver sagebrush is naturally occurring on at least a small proportion of the silver sagebrush type, but livestock grazing can result in a larger proportion of the silver sagebrush type supporting high or very high levels of shrub canopy cover.

- *Meadow-Willow* — Herbaceous species composition in the meadow (non-willow) portions of these communities is similar to that of wet meadow and moist meadow communities, above.

While relatively small reductions in the canopy cover of sedges brought about by long-term effects of trampling and grazing in the wetland perimeter may be favorable to spotted frogs and boreal toads where sedge canopy cover would otherwise be at or very near 100% across an entire wetland, this is not necessary to meet management direction and it would be difficult to produce without excessive long-lasting reductions in sedge cover. To obtain small long-term reductions in sedge canopy cover in wetlands having 100% canopy cover or near 100% canopy cover of sedges, another effect may be substantial reductions in height and density on an annual basis.

Streambanks

Plant species composition on streambanks is one of the most important factors for maintaining stream channel integrity and maintaining healthy riparian areas. This is addressed in the "Deviations from Estimated Natural Conditions to Accommodate Other Uses" subsection of the section entitled "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat" section, above. A minimum canopy cover of sedges and other deep-rooted graminoids of 80-85% was identified for streambanks where willows do not dominate streambanks.

Rangelands

Because the main function of herbaceous species composition in uplands is the restoration or maintenance of low overland flow rates and erosion rates, relative to natural conditions, the exact herbaceous species composition in these communities is less important than the mix of species and overall canopy cover that produces satisfactory ground cover. For rangeland and aspen plant communities occurring within migration routes of spotted frogs and boreal toads (primarily within 1/3 mile of breeding sites but as far as 2½ miles or more) and foraging habitat of boreal toads (typically within about 100 yards of riparian areas and wetlands), the height and density of vegetation likely are important as well. For these reasons, relatively natural herbaceous species composition is expressed primarily in terms of the composition that produces satisfactory ground cover and secondarily (within frog and toad use areas) in terms of an approximation of a natural plant species composition or a mix of native and nonnative species that provides similar height, canopy cover, and diversity.

- *Big Sagebrush* — Under healthy, proper functioning conditions, herbaceous understories are dominated by native species or species with high erosion control potential ratings and ground cover is either 70-90% or more on relatively dry big sagebrush sites (FSH 2209.22.1.2) or 85-100% on relatively moist big sagebrush sites (O'Brien et al. 2003). Ground cover in mountain shrubland and grassland types are similar.

- Forbland — Under healthy, proper functioning conditions, herbaceous communities are dominated by native species or species with high erosion control potential ratings and ground cover is an estimated 80-100% or more (FSH 2209.22.1.2, O'Brien et al. 2003).

- *Aspen* — Under proper functioning conditions, herbaceous understories are dominated by native species or species with high erosion control potential ratings and ground cover is an estimated 95-100% or more (FSH 2209.22.1.2, O'Brien et al. 2003).

Deviations that are Outside the Range of Suitable Conditions

There are many situations on the BTNF in which herbaceous species composition has been altered by human-related activities to the point it clearly falls outside the range of suitable conditions for spotted frogs and boreal toads. Examples are moist meadow, silver sagebrush, and meadow-willow communities that have converted to plant communities or understories that are now dominated by non-native bluegrasses, redtop, smooth brome, tarweed, Canada thistle, and/or houndstongue. Where these species dominate communities and understories, many components of meadow habitat have declined (many times by major degrees), including reduced hiding and escape cover, lower humidity retention and temperature moderation, reduced tadpole forage, and lower insect species richness and abundance (see "Risk Factors and Restoration Factors" for more discussion). In some cases, the altered plant communities can be restored through changes in management (e.g., noxious weed control efforts, changes in livestock grazing management that allow water tables to recover), but in other cases, plant communities have transitioned to a new state that would require major efforts to convert them back to something approximating a natural herbaceous species composition and in many of these cases it may be unrealistic to restore them (see Stringham et al. 2001, Stringham et al. 2003 for an explanation of state-and-transition). Kovalchik and Elmore (1991:115) provide a diagram of the conversion of native willow-herb communities to willow-Kentucky bluegrass communities and ultimately to sagebrush-bluegrass communities. Where recovery is possible, it may take decades for near-complete recovery. In other situations, the species now dominating sites (e.g., Kentucky bluegrass, redtop, smooth brome) exert such strong domination that native species cannot compete and reassert their former abundance. However, while some experts have asserted that it is not possible, without major restoration efforts, to shift from nonnative bluegrass-dominated sites to a relatively natural mix of herbaceous species (Heitschmidt et al. 1998) and while evidence has been put forward that composition of nonnative bluegrasses like Kentucky bluegrass is heavily influenced by water table depth (Stringham et al. 2001), other experts have found that changes in livestock management (e.g., exclusion of cattle) can result in major shifts away from nonnative bluegrass to a more desirable mix of species (Kaufman and Krueger 1984, Schulz and Leininger 1990).

On the other hand, there are many nonnative species (e.g., timothy, orchardgrass, and intermediate wheatgrass) that will continue to persist in plant communities, but likely will not limit the ability of the communities to provide suitable habitat conditions for spotted frogs and boreal toads.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. It is important to (1) continue providing habitat for boreal toads and spotted frogs where existing herbaceous species composition matches the descriptions below, and (2) restore herbaceous species composition where it has been altered to the point that spotted frogs or boreal toads no longer have suitable habitat conditions.

Many of the following descriptions of suitable conditions are written qualitatively and are founded primarily on the merits of restoring a natural composition of herbaceous vegetation, but builds in some level of adjustment to this coarse-filter approach in recognition of the impracticality of fully achieving a natural herbaceous species composition. This will allow for more specific objectives to be developed — that fit within the limits of suitable habitat conditions for spotted frogs and boreal toads — as part of a multidisciplinary process if this were to occur in the future.

1. At a coarse scale, suitable conditions consist of marshes, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities occupying sites they would occupy when water table elevations are approximately where they would be under natural conditions, beavers are at levels within the natural range of variability, and other factors contribute to relatively natural conditions (i.e., the correct class of vegetation on a site-by-site basis). While spotted frogs and boreal toads can inhabit a wide range of habitat conditions, they favor sedge-dominated wetlands, wet meadows, moist meadows with a

diverse assemblage of herbaceous vegetation, meadow-willow and willow stands with herbaceous understories (Hammerson 1982, Keinath and McGee 2005, Patla and Keinath 2005, Pierce 2006). These coarse-scale conditions are needed to meet Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

2. A relatively-natural composition of herbaceous vegetation is provided in wetland, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities within 1½ miles of known existing and historic breeding sites having capable amphibian wetland habitat:
    a. In wet meadow communities and in vegetated portions of wetlands, total herbaceous canopy cover is approximately 80-100% and a minimum of 75% of the total herbaceous canopy cover is comprised of beaked sedge, water sedge, analogue sedge, Nebraska sedge, slender-beak sedge, Hood's sedge, silver sedge, wooly sedge, or sedges with similar hydrologic needs, singly or in combination. Marshland habitat is similar, but overall canopy cover may be lower due to natural hydrologic and soil conditions that maintain open water conditions. Bluejoint reedgrass and Baltic rush dominate some wet meadow and marsh sites, but it must be recognized that domination by Baltic rush in some cases is a result of disturbances that reduced the abundance of sedges and, in these situations, domination by Baltic rush is outside the range of suitable conditions.
    b. In moist meadow, silver sagebrush, and shrubby cinquefoil communities, total herbaceous canopy cover is approximately 80-100%; ≥25% of the total herbaceous canopy cover is comprised of tufted hairgrass (except possibly where small-winged sedge is the dominant graminoid); and, in combination, ≥60% of the total canopy cover is comprised of tufted hairgrass, alpine timothy, timber danthonia, small-winged sedge, wooly sedge, silver sedge, and slenderbeak sedge (and, in small-winged sedge communities only, additional species are beaked sedge, aquatic sedge, and bluejoint reedgrass) <u>or</u> ≥60% canopy cover of tufted hairgrass, Columbia needlegrass, slender wheatgrass, basin wildrye, mountain brome, and various sedges, combined, or equivalent native or nonnative species in each case. Equivalent means similar functions, including similar height, vegetative density, and provision of forage, cover, and substrate for invertebrates. Total herbaceous canopy cover may be lower in silver sagebrush and shrubby cinquefoil communities where total shrub cover is at a point that it limits herbaceous production, provided that only a small proportion of these types have "excessive" shrub cover.
    c. In the "meadow" portions of meadow-willow communities, total herbaceous canopy cover approximates the percentages outlined above in 'a' and 'b'.

    A radius of 1½ miles is used because of the importance of herbaceous species composition to a wide range of habitat elements and because this distance encompasses a large majority of the habitat of spotted frogs and boreal toads at known breeding sites and historic breeding sites that still have capable breeding habitat. See the "Buffer Zones and Levels of Protection" section for further details.

3. A relatively-natural composition of herbaceous vegetation should also be provided in wetland, wet meadow, moist meadow, and riparian communities beyond 1½ miles of known existing and historic breeding sites having capable amphibian wetland habitat to facilitate expansion of the existing distribution of spotted frogs and boreal toads (i.e., movement toward a closer approximation of a natural distribution).

4. Herbaceous species compositions in rangeland and aspen communities that drain into spotted frog and boreal toad wetland habitat (including beaver ponds and riparian wetlands) generally reflects natural species compositions[L] and are sufficient to sustain the following ground cover levels, provided that (1) rock cover is not appreciably higher than what would occur under natural conditions, and (2) the

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[L] Where frogs and/or toads migrate or otherwise move through upland areas, it is important that herbaceous species providing sufficient cover (height and density of vegetation, combined with shrubs), which allows for nonnative species that provide similar structural attributes as native species but does not allow for noxious weeds.

watershed functioning values (i.e., soil-holding capabilities) of plant species, as a whole on a site, approximate that of a natural plant species composition. Suitable ground cover levels are as follows:

a. 70-100% on dry big sagebrush and mountain shrubland sites (e.g., porous soils on south-facing slopes).

b. 85-100% on relatively moist big sagebrush and mountain shrubland sites.

c. 80-100% on tall forb sites.

d. 95-100% on aspen sites.

5. Rangelands and aspen stands within 200 yards[M] of wetlands and riparian zones within 1/3 mile of known breeding sites and historic breeding sites with capable breeding habitat have a relatively natural herbaceous species composition or a composition consisting of native and nonnative species that approximates the important functions of a natural composition (e.g., shading, relatively moist microsites, invertebrate diversity).

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — Conditions outlined for riparian zones are central to restoring and maintaining suitable herbaceous species composition in riparian areas. This is because streambank stability and stream channel integrity, in many stream types, affect the elevation of the water table relative to the elevation of the valley bottom, which in turn affects water availability to riparian vegetation.

A.2. Mix of Succession Stages — A suitable mix of succession stages in rangelands, meadows, and forestlands is important because the stage of succession is a major determinant of herbaceous species composition. Also, in some drainages, the limiting factor for restoring beavers to their historic distribution is a lack of sufficient aspen to support beavers due to advanced succession (see A.3, below).

A.3. Occurrence and Extent of Beaver Pond Complexes — Meeting suitable conditions for the occurrence and extent of beaver pond complexes would contribute to restoring and maintaining herbaceous species composition because beaver pond complexes have a major influence on valley bottom conditions (e.g., hydrology, soil moisture levels, duration of water availability, ponding).

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Maintaining suitable herbaceous retention levels would facilitate the achievement of suitable herbaceous species composition.

B.4. Soil Looseness and Maintenance of Overhanging Banks — Meeting suitable conditions for soil looseness in riparian areas would also facilitate the achievement of suitable herbaceous species composition.

Risk Factors and Restoration Factors

Of human-related factors on the BTNF, herbaceous species composition is mainly affected by livestock grazing, but also is affected in more localized situations by camping and associated motorized use, horse grazing (recreational horses and outfitter horses), altered hydrology due to roads, and noxious weeds. All of these risk factors are discussed further below.

The following risk factors have altered and/or have the potential to alter the composition of herbaceous vegetation in riparian areas, wetlands, and rangelands, which in turn limit the attainment of suitable conditions and,

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[M] Goates et al. (2007) found that most female boreal toads remained within about 330 feet of water sources, including <1 ft. wide perennial streams (Brazier and Whelan 2004).

ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Landscape Context — Just as it is important to recognize the overrepresentation of late-seral conifer forestlands in assessing risks of logging, fire, and forest management on wildlife, it is important to recognize the underrepresentation of herbaceous vegetation at a wide range of scales when assessing the risks of livestock grazing on wildlife that depend on or are associated with herbaceous vegetation.

At that landscape scale, herbaceous and shrub-herb habitat has been lost to agricultural cropland, seeded pastureland, housing developments, reservoirs, roads, and changes in hydrology. Most habitat loss has occurred on private lands. Overrepresentation of late-seral forestland and shrubland has further reduced the amount of herbaceous communities. On lands that still support native or relatively native herbaceous and shrub-herb communities, several factors have reduced herbaceous species composition and herbaceous production, including increased shrub canopy cover, increasing conifer canopy cover, conversion to lower-producing communities like Kentucky bluegrass, and reduced vigor due to factors such as a history of heavy grazing pressure. Compounding these factors further is the removal of herbaceous vegetation through mowing and grazing.

Livestock Grazing — Changes in plant species composition, which includes the spacing of individual plants, can affect amphibian use of particular areas. In particular, broad-level changes in plant species composition (i.e., shifts from one community type to another) and changes in the abundance of particular plant species on a site, both of which influence plant height and spacing and ultimately cover, are important (Appendix A).

It is well established that many wet meadow, moist meadow, and meadow-willow communities and the understories of many silver sagebrush, shrubby cinquefoil, and willow-herb communities throughout the intermountain West have been converted to communities and understories dominated by Kentucky bluegrass and other nonnative bluegrasses, in large part due to over-use by livestock (Mueggler and Stewart 1980, Kaufman and Krueger 1984, Padgett et al. 1989, Schulz and Leininger 1990, Kovalchik and Elmore 1991, Manning and Padgett 1995), and this also is prevalent on the BTNF (Norton et al. 1981, Youngblood et al. 1985, USFS 2004a, NRCS 2008a, NRCS 2008b). As an example, herbaceous layers in a large majority of low-elevation moist meadow and silver sagebrush sites on the Greys River are now dominated by nonnative bluegrasses (personal observation of author, as supported by Youngblood et al. 1985, USFS 2004a); the extent of conversions from wet meadows to domination by nonnative bluegrasses and conversion of understories of willow communities to domination by nonnative bluegrasses (Youngblood et al. 1985, Kovalchik and Elmore 1991, NRCS 2008a, NRCS 2008b) is not clear. Experimental studies have supported the assessment that over-use by livestock facilitates conversions to Kentucky bluegrass; for example, “Pond (1961), in Wyoming, found clipping native bunchgrass meadows every 2 weeks for 4 years caused a marked reduction in native sedges (Carex spp.), tufted hairgrass (Deschampsia caespitosa) and fostered the appearance of Kentucky bluegrass where it was not present before” (Kauffman and Krueger 1984:434).

In addition to nonnative bluegrasses, some meadow sites have also been converted to domination by smooth brome, Canada thistle, and/or even tarweed. These conversions, including domination by Kentucky bluegrass, have reduced the suitability of the habitat for spotted frogs due to shorter vegetation height, reduced plant species diversity (in moist meadows), and reduced cover qualities than sedge communities and native meadow communities, especially where plant vigor is lowered (DeLong 2009a, DeLong unpublished data 2010). Reductions are three-pronged: (1) conversion from a relatively-natural species composition to domination by nonnative bluegrasses and/or smooth brome reduces the height, diversity, and cover provided by herbaceous vegetation, as outlined above; (2) reductions in vigor of nonnative bluegrasses and other herbaceous species further reduces the height and cover that is produced on these sites; and (3) grazing reduces or eliminates herbaceous habitat attributes. Sites dominated by nonnative bluegrasses attract heavy use by cattle. It is common for cattle to graze nonnative bluegrass sites to heights as short as 1 inch, which reduces vigor (Alderfer and Robinson (1949, as cited by Kauffman and Krueger 1984; Hall and Bryant 1995) and completely eliminates habitat for the season. For these reasons, conversion to nonnative bluegrasses and other undesirable plant species and associated livestock grazing has adversely impacted spotted frog and boreal toad habitat on the BTNF.

For meadows or portions of meadows dominated by Kentucky bluegrass, Hall and Bryant (1995) assessed that, “Unacceptable impacts from livestock grazing can be avoided in riparian areas by recognizing that a shift in cattle preference can occur as the 3-inch stubble height is approached. Assume undesirable impacts will occur at any time as stubble height changes from 3 inches to 3/4 of an inch as a result of major shifts in livestock preference.” [Heitschmidt et al. 1998 equated 3-inch stubble of Kentucky bluegrass to 50% utilization, and this is supported by Kinney and Clary (1994) in which an average 3-inch stubble height equated to about 50% removal of plant material through clipping.] However, the ability to avoid impacts to riparian functioning with >3/4-inch stubble to 3-inch stubble of bluegrass does not account for wildlife habitat provided by herbaceous vegetation.

Spotted frogs and boreal toads feed on invertebrates; and invertebrate species richness and abundance is strongly affected by plant species composition (Morris and Plant 1983, Morris 2000, Kruess and Tscharntke 2002, Hornung and Rice 2003, New 2004, Young and Barbour 2004, Samways 2005, Black et al. 2007, New 2009, Kimoto 2010, Black et al. 2011). Where plant species composition has shifted from diverse meadow habitat to domination by nonnative bluegrass or smooth brome, reductions in invertebrate species richness and abundance can be particularly large due to the simplification of communities and tendency for reduced plant vigor. Heavy grazing compounds these effects. As an example, most of the low elevation meadowland and silver sagebrush communities on the Greys River Ranger District have seen this conversion.

Depleted ground cover in uplands, especially when less than about 60-65%, contributes to elevated rates of overland flow, which can contribute to increased scouring of stream channels lower in the watershed, which in turn can result in lowered water tables (Thurow 1991, Satturlund and Adams 1992, National Research Council 1994, USFS 1997, Holechek et al. 2011). As assessed by USFS (1997:23), “Historically, excessive sheep grazing on the southern end of the forest removed upland vegetation with resulting soil loss and water infiltration reduction…” Large reductions in plant species composition and ground cover and subsequent increases in erosion is not uncommon across fairly large parts of the BTNF (USFS 1997, USFS 2001, O’Brien et al. 2003, USFS 2004a, USFS 2004b, USFS 2005, USFS 2009). USFS (2009) discussed this in terms of impacts to boreal toads and chorus frogs on the BTNF. Elevated erosion rates across such large areas likely has affected water quality in places and likely has reduced the longevity of wetlands in some places (see “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” and “B.1. Water Quality” sections). Riparian habitat comprises a small minority of habitat across the landscape (e.g., <5%), and historic reductions in the amount of moist and wet meadow habitat and small wetlands due to lowered water tables further reduces the amount of this important habitat for amphibians.

Plant species composition on streambanks is critical to the stability of streambanks and the many aspects of amphibian ecology influenced by streambank stability and channel integrity (e.g., extent and composition of riparian vegetation in valley bottoms, availability of wetlands, duration of water in riparian wetlands), as discussed in the “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” section. Plant species composition, especially as related to ground cover in uplands, also is an important factor affecting overland flow and stability of down-gradient stream channels (and elevation of water tables), water quality, duration of basin wetlands as affected by sedimentation, as discussed in the “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” section. USFS (1997:23) assessed that, in addition to causing large reductions in ground cover, excessive historic sheep grazing “created extensive rilling and gullys with the elimination of previous riparian vegetation in headwater areas. In some areas, sheep grazing resulted in a lowering of the stream bed and water table. This caused riparian areas to transform into less stable, drier sites with associated [dry-site plant] species.”

Recreation — Dispersed camping along roads and the motorized use that accompanies this camping (e.g., cars, trucks, campers, recreational vehicles, ATVs), which oftentimes takes place in riparian areas, contributes to altered vegetation composition in these areas on the BTNF. These impacts were discussed by the Federal Interagency Stream Restoration Working Group (1998) and Douglass et al. (1999). Douglass et al. (1999) provides extensive documentation of off-road vehicle impacts on vegetation. A growing issue on the BTNF is the continual expansion of dispersed camping sites, which mostly affect riparian areas and uplands immediately adjacent to riparian areas. This is an issue that needs to be addressed further.

Widening and straightening of roads invites increased traffic and larger campers and RVs further into the national forest, which in turn can increase the amount of riparian and adjoining plant communities that are altered by intensive, localized camping pressure. The shorter stature of the altered vegetation and sometimes extensive areas of bare ground — combined with even shorter vegetation resulting from reduced vigor, trampling, and grazing — increase the exposure of amphibians to predation for any individuals that attempt to cross dispersed camping sites. Added to this is exposure to predation by dogs. These mortality factors likely contribute to reduced populations in the vicinity of dispersed camping areas.

Grazing and trampling by horses also can contribute to alterations in plant species composition (Olson-Rutz et al. 1996). Grazing by horses has similar effects as livestock grazing (discussed above), but at smaller scales.

Even low levels of snowmobiling can affect the survival of individual plants underneath snowmobile tracks and higher levels of snowmobile activity can have more serious effects on vegetation on woody-vegetation (e.g., willow, riparian scrub, mountain shrub), early seral forests, and southerly-facing slopes (Douglass et al. 1999, Stangl 1999). Because some mountain meadows receive considerable use by snowmobiles, potential exists for this to be a contributing factor to reduced herbaceous species composition. Brown et al. (2015:53) identified snowmobiling as a potential source of impacts to Yosemite toads.

Altered Hydrology due to Roads — Road construction can also alter hydrology, which in turn can lead to the loss of wetlands and associated wetland vegetation (Satterlund and Adams 1992, Forman et al. 2003, Andrews et al. 2008). Even when a road is located to the side of a wetland, it is possible for hydrology to be altered enough such that the wetland vegetation shifts to drier vegetation. Both the disappearance of water and the shift in vegetation can adversely affect amphibians that would otherwise use the habitat.

Unnaturally High Populations of Native Ungulates — Elk at unnaturally high population levels have potential to contribute to altered plant species composition in riparian meadows, shrubby cinquefoil, and silver sagebrush communities as well in nearby upland communities, due to high grazing pressure, soil compaction, and accumulations of feces and urine deposition, but these situations are fairly limited. Examples include winter feedground areas, staging areas near winter feedgrounds, and winter/transition ranges (Boyce 1989, Dobkin et al. 2002, Smith et al. 2004, Dean and Hornberger 2006, WGFD 2011, USFS 2015); and possibly portions of the Teton Wilderness north into Yellowstone National Park where summer and transition ranges continue to sustain large elk numbers due in part to winter feeding on the National Elk Refuge and feedgrounds in the Gros Ventre River drainage (a range of citations provided in Boyce 1989). Contributions of elk to overuse of herbaceous vegetation typically occur where favorable forage exists in the spring as elk follow the snow line upwards, especially near feedgrounds and in the vicinity of winter ranges (Boyce 1989). Boyce (1989:92-98), however, cited several authors contending that vegetation conditions had been altered by elk (e.g., reduced ground cover), but that this should not cause concern since it was 'natural.' Whether the conditions are truly natural depends on the how grazing patterns **—** as affected by winter feeding **—** compare to those of pre-EuroAmerican settlement. Winter feeding has allowed elk numbers to remain consistently high, compared to natural conditions under which numbers likely fluctuated greatly from population peaks to low population levels, the latter of which would have allowed several to many years of recovery of vegetation (Boyce 1989, Wolfe et al. 2002, USFS 2015).

Introduction and Spread of Noxious Weeds — Noxious weeds alter plant species composition, including increased amount of bare ground (Miller et al. 1994, Westbrooks 1998). Livestock grazing, disturbances associated with camping, increases in the number and length of designated and user-created roads and motor-vehicle trails, timber harvest, and other activities can contribute to the introduction and spread of noxious weeds. On the BTNF, noxious weed infestations are widespread, but in most places are widely scattered or concentrated in localized areas. Noxious weeds are not yet causing major adverse effects to watersheds in most parts of the BTNF, although the stage is set for major, rapid expansions if not adequately controlled. This is based on relatively small acreages of noxious weeds in most watersheds of the BTNF, but also recognizing the very high capability of some noxious weeds (e.g., spotted knapweed, leafy spurge, and yellow toadflax to rapidly or fairly rapidly increase in distribution and abundance as it has in places like Montana and North Dakota). One exception may be along the lower Snake River where spotted knapweed has become a major problem.

Competition with Woody Vegetation — A consequence of greatly expanded fire return intervals in rangelands (e.g., due to fire suppression and human-related factors that limit fire spread, as well as human-caused lowered water tables, and reductions in beaver distribution and abundance), meadows, aspen communities, and riparian areas is an ongoing increase in the abundance and canopy cover of conifer trees and sagebrush. As the abundance and canopy cover of conifer trees increase, production of the herbaceous layer declines (Thomas et al. 1979d; Pieper 1990; Riggs et al. 1996; Stam 2008) to the point that once productive and diverse herbaceous layers virtually disappears under a mature conifer overstory. Therefore, prescribed burning, mechanical treatments, and timber harvest can have a positive effect on herbaceous species composition.

Climate Change — Lowered precipitation levels and higher temperatures in this part of the Rocky Mountains due to climate change (see the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section) has the potential to contribute to reductions in herbaceous production levels due to direct effects of reduced precipitation and higher temperatures and indirect effects stemming from any further reductions in stream flow and water table levels and wetland water supplies and duration. Any reductions in herbaceous production has the potential to differentially affect plant vigor of different plant species, which in turn could affect plant species composition. Reduced herbaceous production due to climate change will, therefore, compound the effects of other factors that have caused reductions in the distribution and abundance of wet and moist habitat and moist microsites.

Conservation Actions to Consider

By providing adequate controls on livestock and livestock grazing use, the following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including USFS (1990), Bartelt (2000), Maxell (2000), Patla (2000), Engle (2001), Keinath and McGee (2005), Patla and Keinath (2005), Shovlain (2006), and Schmutzer et al. (2008), DeLong (2009b), as well as publications cited earlier in this section and the "Buffer Zones and Levels of Protection" section.

1. As per the Forage Utilization Standard, wildlife biologists need to be involved in the process of defining desired species compositions for vegetation types affecting spotted frogs and boreal toads, as per FSH 2209.22.1.4 especially in DFC areas in which wildlife is emphasized or is generally co-equal with livestock grazing.

2. With respect to controlling livestock grazing to limit soil erosion and sedimentation, identify maximum utilization levels that maintain herbaceous species composition and ground cover (where they are at desired levels) and restore them to desired levels (where they are below desired levels), in addition to meeting other Forest Plan Objectives (as per provisions of the Forage Utilization Standard). Note: this is a range management requirement (note a conservation action *to consider*), and minimizing negative effects on spotted frogs and boreal toads is yet another basis for identifying and adhering to maximum utilization limits. It will be important, when identifying maximum utilization limits as per provisions of the Forage Utilization Standard, to be able to demonstrate whether utilization limits will allow desired levels of species composition and ground cover to be met.

3. Stabilize stream banks in areas inhabited by boreal toads and spotted frogs (Perkins and Lentsch 1998, *as cited in Patla and Keinath 2005:60*), as well as above areas inhabited by these species to minimize sedimentation effects on water quality and premature filling-in of wetland habitat. Stubble heights can be used to manage livestock use of streambanks, and limits on streambank shearing can be used for the same purpose. Streambank stability is addressed further in the "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section.

4. Season of livestock use can be adjusted as needed to achieve this part of the objective.

5. Livestock grazing systems can be adjusted. For example, changes from season long grazing to deferred rotation, rest rotation, or other system.

6. Riparian pastures can be created to more closely manage livestock use in riparian areas and where wetland complexes exist.
7. Herding, fences, water developments, and salt placement can be used to manage use of vegetation.
8. A last resort would be exclusion of livestock.
9. Continue to treat noxious weeds as aggressively as possible and look for ways to expand the program, for example, to more effectively reduce the abundance of Canada thistle in riparian habitats.

Measures and Indicators

Currently Monitored Elements

Range management specialists currently monitor the following elements.

- Herbaceous Species Composition **—** Sites for monitoring herbaceous species composition have traditionally been selected by Rangeland Management Specialists, but because defining desired conditions for herbaceous species composition is multidisciplinary, including the need to meet amphibian needs depending in part on DFC area (FSH 2209.22.1.4), selection of sites needs to be multidisciplinary. This does not necessarily mean the selection of more monitoring sites, but should entail the review of existing sites by wildlife biologists and other applicable specialists. Wildlife biologists need to be involved with this.
- Ground Cover – At a coarse scale, ground cover (especially if rock cover is excluded) can provide a rough indication of whether plant species composition is below suitable or desired condition (if existing ground cover is below ground cover objectives), or if there is a chance it is at suitable or desired conditions (e.g., if existing ground cover meets ground cover objectives). See FSH 2209.22.1.2.
- Percent Retention of Herbaceous Vegetation – This provides an indirect indication of the degree to which suitable or desired conditions for herbaceous species composition and ground cover can be maintained or attained in the future. Percent use of key forage species and percent use of total herbaceous vegetation is being monitored to varying degrees on different districts.

Additional Monitoring Elements to Consider

No additional monitoring elements are needed.

A.5. CANOPY COVER AND HEALTH OF WILLOW COMMUNITIES

Introduction and Background

Willow stands provide habitat for post-breeding boreal toads and are particularly important to boreal toads where sedges comprise the understory of willows stands and dominates the openings between willows; this appears to provide one of the more important summer habitats of this species (Keinath and McGee 2005, Pierce 2006). Willow habitat provides suitable microclimatic conditions and hiding and escape cover. Also, willow is an important food source of beavers and, if willow canopy cover and persistence of willows is not sufficient, otherwise suitable areas for beaver may not sustain beaver populations (Ohmart 1996, Maxell 2000). Willow stands are less important to spotted frogs, which typically are found in aquatic habitat except during migrations and, when they do occur in non-aquatic habitats, appear to favor more open habitats than willow stands (Hammerson 1982, Patla 2000, Patla and Keinath 2005). On the other hand, some authors (e.g., Reaser and Pilliod 2005) stated that spotted frogs can be found in dense willow clumps.

While the relatively small decline in willow canopy cover (USFS 2009) may only affect boreal toads to a small degree on the BTNF, there likely are many narrow, relatively-steep drainages that currently have sparse or no willows that historically had substantial, albeit localized willow communities. Loss of willow and aspen in small drainages due to advancing conifer succession and lack of fire has eliminated beaver activity in small drainages in at least some parts of the BTNF (Gruell 1975, Collins 1993, Ohmart 1996), which in turn has reduced site potential for willows. Also, an unknown proportion of the willow type on the BTNF currently is in a drier condition, with lower vegetation density below the canopy, and with less herbaceous vegetation than occurred prior to being affected by livestock grzing, recreation, and other activities.

Other factors that can reduce willow canopy cover include browsing by livestock, browsing by native ungulates especially wintering moose and elk, snowmobiling, off-trail motorized use, and expansion of dispersed camping.

The amount of willow habitat, which has been reduced due to roads, reservoirs, dispersed camping, and other activities is discussed in the section, "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat."

Included in this section are willow communities that contain other species of riparian shrubs and mixed-deciduous riparian shrub communities (e.g., comprised of black hawthorn, mountain alder, water birch, bog birch; Youngblood et al. 1985) that have similar structure as willow communities. To reduce the length of sentences, the term "willow communities" and "willow canopy cover" is used.

Herbaceous vegetation may not play more than a minor role in moderately-dense to dense willow stands, except where willow height is short (e.g., <2 ft. tall), because there is a naturally low amount of herbaceous vegetation in these willow stands and because many of the functions performed by herbaceous vegetation in herbaceous communities is performed by willows and other deciduous shrubs in willow communities. On the other hand, in willow communities that have a naturally low density of willows and other shrubs and in willow communities in which willow canopy cover has been reduced as a consequence of mechanical damage by livestock (e.g., trailing, rubbing) and browsing by livestock, but also by dispersed camping and motorized use in localized areas. Herbaceous vegetation is addressed to some extent in this section, but is addressed in more detail, for meadow-willow communities, in the "Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section, below.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan and an executive order require the Forest Service to restore and maintain the health and sustainability of willow communities, as part of the riparian system. Desired willow canopy cover has not yet been defined for the BTNF. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to canopy cover and health of willow communities.

> ***Goal 4.3 (Forest Plan) —*** "Overall diversity of [forestland] and riparian habitats within the Bridger-Teton National Forest are enhanced as timber is removed."
>
> > ***Objective 4.3(c) (Forest Plan) —*** "Protect and rehabilitate riparian areas to retain and improve their value for fisheries, aquatic habitat, wildlife, and water quality."
>
> ***Goal 4.7 (Forest Plan) —*** "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreational values or experiences."
>
> > ***Objective 4.7(b) —*** "Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present."
>
> ***Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan)*** — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."

Executive Order 13186 — Applicable provisions are summarized in the "A.1 Distribution and Amount of Wetland and Wet/Moist Riparian Habitat" section. Migratory bird conservation plans point strongly in the direction of restoring and maintaining riparian willow communities.

Estimated Natural Conditions

The canopy cover of willows and herbaceous understories that existed prior to Euro-American settlement and that would exist today in the absence of the alteration of willow communities by human-related factors constitute natural conditions for his element. The range of natural conditions for this element is within the range of suitable conditions for spotted frogs and boreal toads, recognizing that suitable conditions may extend beyond the natural range of variability. Also, a natural canopy cover of willows and level of health contributes to a range of riparian functioning elements (e.g., stabilization of streambanks, food and dam-building material for beaver) which ultimately contribute to suitable habitat for spotted frogs and boreal toads.

There are three main reasons why a natural canopy cover of willows and understories in willow stands provide suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, willow canopy cover and herbaceous understories in willow stands are important to both species, especially boreal toads (Munger et al. 1998, Patla 2001, Bartelt et al. 2004, Keinath and McGee 2005, Patla and Keinath 2005). Important contributions of willow canopy cover and herbaceous understories include the following:

- *Hiding and Escape Cover on Land in Water* — Willow canopy cover, clusters of live and dead willow stems, accumulations of down dead stems, and herbaceous vegetation provide visual and structural barriers that hide frogs, toads, and tadpoles from predators, increases the difficulty of predators catching frogs and toads where they rest and forage, and it provides structure within which they can escape from predators. This hiding and escape cover is important for adult frogs and toads occupying willow stands. Where willow canopy cover is high, herbaceous cover is of lesser importance and, where willow canopy cover is very high, herbaceous canopy cover may be naturally almost non-existent.

- *Humidity Retention, and Temperature Moderation, and Protection from the Sun* — Moist and humid environments are important to frogs and toads because their bodies have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist (see this same bullet heading in the "A.4. Herbaceous Species Composition" section, above, for more detail).

  The canopy of willows and other deciduous shrubs and, to a lesser degree, herbaceous vegetation, maintains higher humidity levels and lower temperatures near ground level during midday than would occur without the vegetation. This is discussed in more detail for herbaceous vegetation in this same bullet heading in the "A.4. Herbaceous Species Composition" section and in even more detail in Appendix A. Because willow stands have more substantive canopies, willow stands are better at retaining humidity and moderating temperatures near ground level. Down woody stems contribute to this. Also, where willow canopy cover is somewhat open, this allows herbaceous vegetation to be produced and it can contribute as well.

- *Organic Material for Soils* — Another important feature of spotted frog and boreal toad habitat in willow communities is the presence of a well-developed mulch layer and organic soil. Mulch and organic soils are important because they facilitate burrowing by amphibians (Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006).

- *Forage and Dam-Building Material for Beaver* — Where aspen is not available or in low abundance, willow is favored by beaver for food and dam building (Collins 1993, Olson and Hubert 1994, Naiman et al. 1986, Collen and Gibson 2001). To sustain beaver colonies over long periods, willow must be abundant and stands must be in healthy condition so that re-sprouting and growth outpaces the rate at which beaver cut willow stems. Beaver ponds provide important habitat for spotted frogs and boreal toads, especially where wetland habitat would otherwise be rare or nonexistent (Maxell 2000; Keinath and McGee 2005, Patla and Keinath 2005; Amish 2006; PARC 2008; USFWS 2011). The section, "A.3. Occurrence and Extent of Beaver Pond Complexes" discusses this in much more detail.

- *Streambank Stability* — In many stream systems on the BTNF, willows are important for stabilizing streambanks (Chaney et al. 1993, Ohmart 1996). When they grow on streambanks, willow roots help bind the soil and resist the erosive influences of water flow, especially during peak flows. The section, "A.1. Distribution and Amount of Riparian of Wetland and Wet/Moist Riparian Habitat" explains the major importance of stable streambanks to spotted frogs and boreal toads.
- *Open Patches* — Several authors identified the importance of having small openings in willow thickets to allow sunlight to penetrate to the soil surface in order to provide basking sites (Patla 2001, Bartelt et al. 2004). For low growing willow species such as Wolf's willow, much smaller gaps are needed compared to tall species of willow.

Second, a *natural* density and canopy cover of willows and herbaceous vegetation provide or contribute substantively to high quality habitat for spotted frogs and boreal toads in willow stands on the BTNF, especially boreal toads. A natural density and canopy cover of willows in willow communities likely represents the upper end of what can realistically be produced and sustained on the BTNF, given a site's stream type, geomorphology, elevation, soils, and climate conditions. There likely are no instances of altered conditions providing denser willow, higher canopy cover of willow, or more productive herbaceous vegetation at a given willow canopy cover.

Rather than providing estimates of natural willow canopy cover in willow communities in this subsection, estimates are provided of *relatively* natural willow canopy cover in the "Deviations from Estimated Natural Conditions to Accommodate other Uses" subsection, below.

Third, amphibian communities formed or developed in this area with a natural extent of willow stands and a natural density and canopy cover of willows and herbaceous vegetation within these willow stands.

Fourth, as discussed previously, there is no shortage of short, sparse herbaceous vegetation on the BTNF and there is an underrepresentation of tall, dense herbaceous vegetation. Given the overrepresentation of short, sparse herbaceous vegetation caused by a range of factors, any place where communities providing tall, dense herbaceous — including in open willow stands — will benefit spotted frogs and boreal toads.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural willow canopy cover and health of willow stands in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because (1) the natural willow canopy cover and level of health represents conditions under which amphibian communities formed or developed in the BTNF area; (2) the natural canopy cover of willows and level of health would be favorable to spotted frogs and boreal toads compared to existing conditions; and (3) upward trends toward natural willow canopy cover and level of health would not adversely affect spotted frogs and boreal toads relative to existing conditions. Such an upward trend may negatively affect individual spotted frog populations in isolated situations since they prefer more open habitats. However, a natural canopy cover and natural level of health in willow stands would contribute to streambank stability and would facilitate an increase in the distribution of beavers in some places, both of which would benefit spotted frogs.

Deviations from Estimated Natural Conditions to Accommodate other Uses

Given the multiple-use mandates of the Forest Service, and given some of the inherent limitations of maintaining fully natural canopy cover and health of willows under uses like livestock grazing and dispersed camping, it may be necessary to accommodate some degree of deviations from natural conditions caused by these uses. However, lowering the bar on the willow canopy cover and health can only be accommodated to the extent suitable conditions are still provided for spotted frogs and boreal toads, both in terms of direct effects of composition on shading, humidity retention, hiding cover, and insect habitat, and indirect effects on streambank stability, duration of beaver occupancy of any given site, and distribution of beaver pond complexes.

The following characterization of willow/deciduous-shrub canopy cover reflects approximations of natural levels of canopy cover as affected at least to some degree by uses that currently affect canopy cover (i.e., relatively natural conditions). This is because in most if not all areas in which canopy cover was assessed by scientists had a history of excessive browsing by livestock and/or native ungulates (e.g., elk at unnaturally high number) and possibly other uses. Total shrub canopy cover refers to the total canopy cover of willows and other deciduous shrubs relative to the total amount of area occupied by a given plant community.

An approximation of a natural level of canopy cover as affected at least to some degree by uses that currently affect canopy cover (i.e., relatively natural conditions) is 70-100%, except in a limited portion of moose and/or elk winter range where canopy cover may be as low as 60%. In most situations, willow sites produce and sustain substantially higher levels of willow canopy cover than 50% (Youngblood et al. 1985, Singer and Zeigenfuss 2003). In the Jackson Hole area, Singer and Zeigenfuss (2003) recorded average canopy cover of about 50% to 55% when browsing of leaders by elk and moose was between 11% and 35%, and average canopy of about 84% for stands where browsing pressure was 10% or less. Canopy cover averaged about 20% in areas where browsing of leaders exceeded 35%. A low-end threshold of 70% was identified in recognition that a large majority of willow stands fall outside moose/elk critical winter range, elk currently exceed herd unit objectives in most herd units, and moose historically were low in abundance in the BTNF area. A low-end threshold of 70% canopy cover, therefore, is anchored in a low-browsing situation (i.e., where browsing pressure is ≤10%), but builds in a moderately-low to moderate amount of browsing.

Two other important attributes that contribute to assessments of the health of willow communities are (1) the proportion of willow stems that are alive at any given time relative to the proportion that are dead, and (2) density of young willows. This needs to be investigated further.

Expansion of willow habitat into areas that it formerly occupied depends in part on an approximation of the historic fire return interval. The former distribution of willow habitat is not clear, but an approximation of the natural fire return interval would allow aspen and willow to become part of the overstory of plant communities in drainages now dominated by a dense overstory of conifers. Aspen would contribute to a closer approximation of a natural distribution of willow habitat by providing a food source and dam-building material for beavers where there currently is a dense overstory of conifers and few aspen trees. Where recovery of aspen facilitates re-colonization by beavers, beaver pond complexes and a lower percent conifer canopy cover would contribute to expansion of the distribution of willow habitat.

Suitable conditions, therefore, includes a lower density and canopy cover of conifer trees in these communities. A lower density and canopy cover of conifer trees (and corresponding higher canopy cover of willow, other riparian shrubs, and cottonwoods) would result from higher water tables, in part due to increased beaver activity, and increased frequency and extent of fires.

Total herbaceous canopy cover is generally inversely related to the canopy cover of moderate-height to tall shrubs (Youngblood et al. 1985, Padgett et al. 1989). Where canopy cover of willows and other riparian deciduous shrubs is high (e.g., 75-100% canopy cover), canopy cover of herbaceous vegetation typically is low, except at the scale of microsites between shrub canopies. Total herbaceous canopy cover in these non-shrub patches would be similar to that described for wet meadow and moist meadow communities. In some cases (e.g., wolf willow, red osier dogwood-cow parsnip communities), percent canopy cover of herbaceous vegetation can be high even when percent canopy cover of shrubs is high. Sites with a naturally moderate-level of percent canopy cover of willows and riparian deciduous shrubs would likely have “moderate” levels of percent canopy cover of representative herbaceous vegetation, possibly in some cases approaching that described for wet meadow and moist meadow communities. Sites with naturally low percent canopy cover of willows likely would be classified as either wet meadow or moist meadow communities (see the “Herbaceous Species Composition” section). The “Wet Meadow and Emergent Marsh Types” and “Moist Meadow, Silver Sagebrush, and Shrubby Cinquefoil Types” subsections should be consulted for percent canopy cover information of particular herbaceous communities.

Suitable Conditions

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the “suitable habitat” portions of Objective 3.3(a) and the higher-level authorities this objective supports. To meet these requirements, (1) existing canopy cover of willows and other deciduous shrubs needs to be maintained where it matches the descriptions below, and (2) canopy cover of willows and other deciduous shrubs needs to be restored where it has been altered to the point that it no longer provides suitable spotted frog or boreal toad habitat.

Most of the following descriptions of suitable conditions are written qualitatively and are founded primarily on the merits of restoring a natural canopy cover of willow and other deciduous shrubs, but builds in some level of adjustment to this coarse-filter approach in recognition of the impracticality of fully achieving a natural canopy cover of willow and other deciduous shrubs. This will allow for more specific objectives to be developed — that fit within the limits of suitable habitat conditions for spotted frogs and boreal toads — as part of a multidisciplinary process if this were to occur in the future.

1. Willow communities are, at a bare minimum, at naturally functioning condition, especially those within 1½ miles of known existing breeding sites and historic breeding sites having capable habitat, and those that exist up-gradient of these breeding sites.
2. Within 1½ miles of known existing breeding sites and historic breeding sites having capable habitat, shrub canopy cover in willow communities is 70-100%, except in a limited portion of moose and/or elk winter range where canopy cover may be as low as 60%.
3. Canopy cover of conifer trees on a large majority (e.g., >80%) of acreage that naturally supports willow stands is <10%. Ten percent is a fairly standard threshold for distinguishing between conifer community types and non-conifer community types, and 80% is included to represent a large majority.
4. Composition of herbaceous vegetation in patches between willow canopies should be comparable to the compositions outlined in the “Herbaceous Species Composition” section, above.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — Suitable conditions for riparian areas under A.1 contribute to maintaining willow conditions identified in suitable condition statements for willow, above, because streambank stability affects the rate at which banks are eroded and the elevation of water tables, depending on stream type, both of which influence willow establishment, productivity, and conditions within willow stands. Suitable conditions in willow communities is actually a subcomponent of suitable condition statements of A.1

A.2. Mix of Succession Stages — In many cases, the limiting factor for attaining conditions discussed in the following paragraph is a lack of sufficient aspen to support beavers due to advanced succession, and restoring an approximation of succession stages would in the long term restore aspen communities in some of these drainages.

A.3. Occurrence and Extent of Beaver Pond Complexes — Conditions outlined for beaver pond complexes contribute to maintaining willow conditions identified in suitable conditions described above because, as beavers become established in drainages where they historically occurred and where willows now are uncommon or do not occur (Gruell 1975), re-colonization by beavers could increase the extent of willow habitat in these drainage bottoms.

Risk Factors and Restoration Factors

Willow canopy cover and the health of willow communities are affected by a relatively small number of factors related to human activities, as summarized below. The risks identified below do not include factors that have reduced the amount of willow habitat and that have the potential to reduce the amount of this habitat; these are discussed in the section, "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat."

The following risk factors have altered and/or have the potential to alter the canopy cover and health of willow communities, which in turn limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Browsing and Mechanical Damage by Livestock — It is well established that livestock grazing use, without adequate controls, can readily alter and deplete riparian willow habitat (Chaney et al. 1993, Elmore and Kauffman 1994, Ohmart 1996), recognizing that much of the willow habitat on the BTNF appears to be at or near proper functioning condition (USFS 2009). This recognizes also that a substantive portion of willow habitat categorized as being at PFC has reduced structure below the canopy (e.g., due to mechanical damage by livestock through trailing, seeking shade) altered herbaceous composition, and drier-than-natural conditions.

The combination of mechanical damage by livestock and browsing can reduce shrub canopy cover and increase the amount of trailing/tunneling under the shrub canopy. In some cases, this can substantially alter the structure of the woody vegetation, which in turn can reduce the community's ability to retain below-canopy humidity, compound reduced soil moisture, and provide access to predators.

Recreation — Dispersed camping along roads and the motorized use that accompanies this camping (e.g., cars, trucks, campers, recreational vehicles, ATVs), which oftentimes takes place in willow habitat, contributes to reduced canopy cover of willows and other deciduous shrubs and reduced health of willow communities. A growing issue on the BTNF is the continual expansion of dispersed camping sites, which many times impacts willow communities.

Widening and straightening of roads invites increased traffic and larger campers and RVs further into the national forest, which in turn can increase the degree to which willow communities higher in watersheds are impacted by dispersed camping and motorized use. Browsing effects of horses can be similar to that of cattle in more localized areas (i.e., where outfitters and recreationists graze their horses).

Lowered Water Tables and Altered Herbaceous Composition due to Livestock Grazing, Recreation, etc. — The lowering of water tables can impact the canopy cover of willows and other deciduous shrubs in riparian zones and can affect other aspects of the health of willow communities (e.g., herbaceous species composition and production, soil moisture, humidity levels). Herbaceous species composition, production, and retention in the understory can be further impacted by livestock grazing. The drier conditions, altered herbaceous composition and production, lower herbaceous retention levels, and more-open shrub canopy and existence of major trailing/tunneling under willow canopies (see "Browsing and Mechanical Damage by Livestock," above) can result in substantially different conditions for boreal toads than what would exist under natural conditions.

Altered Hydrology due to Roads — Road construction can also alter hydrology, which can lead to the decline in the elevation of water tables, which in turn can impact willow communities. Even when a road is located along the edge of a riparian area or outside a riparian area, it is possible for hydrology to be altered enough to affect willow vegetation. Both the reduced canopy cover of willows and other deciduous shrubs and the disappearance of surface water can adversely affect amphibians that would otherwise use the habitat.

Browsing by Native Ungulates at Elevated Population Levels — Elk and moose at unnaturally high population levels may have contributed to lower-than-natural canopy cover of willows and other deciduous shrubs in some willow communities on the BTNF (Boyce 1989, Singer and Zeigenfuss 2003). The greatest potential for this to occur is in the vicinity of elk feedgrounds and in winter ranges in which willow bottoms are used heavily by elk and/or moose (Smith et al. 2004, Dean and Hornberger 2006, USFS 2015). Moose have declined substantially on many parts of the BTNF, but elk numbers in most herd units remain above herd objectives and they are highly concentrated at feedgrounds. It is possible that changes in riparian willow communities resulting from high elk numbers has contributed to the reduction in boreal toad distribution and abundance on the BTNF.

Introduction and Spread of Noxious Weeds — Noxious weeds alter the composition of the understories of willow communities and can indirectly contribute to reductions in the canopy cover of willows and other deciduous shrubs as a consequence of herbicide spraying. Livestock grazing, disturbances associated with camping, increases in the number and length of designated and user-created roads and motor-vehicle trails, and other activities can contribute to the introduction and spread of noxious weeds. On the BTNF, it is not untypical for willow communities to be infested with Canada thistle. Other noxious weeds that infest large acreages of willow communities include houndstongue and black henbane. Spotted knapweed also poses a threat in some places. In all cases, noxious weeds reduces the health of willow stands.

Competition with and Overtopping by Conifer Trees Vegetation — A consequence of greatly expanded fire return intervals in forestlands and rangelands (e.g., due to fire suppression and human-related factors that limit fire spread) human-caused lowering of water tables, and reduced distribution and abundance of beaver is an ongoing increase in the abundance and canopy cover of conifer trees in willow communities. The succession of willow communities into conifer forestland results in a reduction in willow canopy cover, substantial alteration of the plant species composition and vegetation structure of the communities, and eventually a loss of willow habitat.

Conservation Actions to Consider

Conservation actions identified in the following sections would contribute to achieving and maintaining suitable conditions outlined in the “Suitable Condition Statements,” above:

- A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat, including measures to reduce conifer encroachment.
- A.3. Occurrence and Extent of Beaver Pond Complexes.
- A.4. Herbaceous Species Composition.

Other conservation measures include to following:

1. Within 1/3 miles of known existing breeding sites and historic breeding sites with capable breeding habitat, limit percent utilization of current years’ leader production to ≤15-20% for all browsers combined, including domestic livestock and native ungulates (Loeffler et al. 2001). Where utilization exceeds this level due to wintering native ungulates, work with WGFD to reduce the level of use.
2. Between 1/3 miles and 1½ miles of known existing breeding sites and historic breeding sites with capable breeding habitat, limit percent utilization of current years’ leader production to ≤40% for all browsers combined, including domestic livestock and native ungulates (WGFD 2006); this is different than the maximum level identified in ‘1’, above, because it includes more browsing by native ungulates. Where utilization exceeds this level due to wintering native ungulates, work with WGFD to reduce the level of use.
3. Work with WGFD to take action to reduce browsing levels by native ungulates in other areas where it is determined browsing rates are unnaturally high and has the potential to adversely impact spotted frog or boreal toad habitat.
4. Use utilization limits on herbaceous vegetation, including minimum stubble heights and maximum percent utilization, and season of use restrictions (e.g., no late summer or fall use) as ways to maintain browsing levels below the maximum levels identified above. Clary and Leininger (2000:562) noted that a minimum stubble height of 6-8 inches on green-lines “may be required to reduce browsing of willows…”
5. Manage the timing of livestock grazing to reduce potential browsing impacts. Cattle tend to increase consumption of willow leaders in late summer and fall when herbaceous vegetation becomes less palatable (Kovalchik and Elmore 1991).

Measures and Indicators

Currently Monitored Elements

The Forest Service currently monitors the following elements.

- Distribution and Acreage of Willow Communities **—** This has been done through remote sensing at a coarse scale (e.g., 2007 vegetation layer). Over time, it will be possible to track changes in the distribution and acreage of willow communities meeting coarse-scale criteria.
- Retained Stubble Heights on the Green-line – Combined with knowing the season during which cattle graze a given riparian area, stubble height can be used as a general indicator of whether cattle shift their diet to browse such as willow (Clary and Webster 1989, Clary and Leininger 2000, Univ. Idaho Stubble Height Review Team 2004). A minimum of 6-8 inches appears to be needed to avoid cattle shifting to willow browsing (Clary and Leininger 2000:562). In turn, if cattle are not browsing willows to any discernible amount, their browsing will not impact willow canopy cover. However, this does not account for the effects of mechanical damage by cattle, including creation and maintenance of trails and rubbing.

Additional Monitoring Elements to Consider

Canopy cover of willows is currently not monitored on the BTNF and there do not appear to be any surrogates. Consideration should be given to monitoring willow canopy cover at least where concerns exist.

- Canopy Cover of Willows and other Deciduous Shrubs – This measure directly relates to the habitat element discussed above.
- Canopy Cover of Conifer Trees – This measure directly relates to the habitat element discussed above.
- Retention of Willow Leaders – The percent of willow leaders retained (or browsed) on a site provides an indication over the years on the extent to which suitable canopy cover of willows can be maintained or restored. It is currently being measured in limited parts of the BTNF, but could be monitored more consistently, especially as part of MIM.
- Proportion of Willow Stems that are Alive – This entails several attributes, including the canopy cover of willows and other deciduous shrubs (above) and canopy cover of conifer trees (above), elevation of the water table relative to natural potential, proportion of willows stems that are alive, characterization of the degree to which willows have been mechanically damaged, relative composition of the herbaceous understory, and prevalence of noxious weeds.

A.6. HABITAT CONNECTIVITY

Introduction and Background

Habitat connectivity is crucial for spotted frogs and boreal toads (Keinath and McGee 2005, Loeffler et al. 2001, Funk et al. 2005, Keinath and McGee 2005, Muths 2005, Murrell 2013). Keinath and McGee (2005:30) assessed that "….suitable habitat for dispersal (e.g. shrub or forest cover, small wetlands, no barriers) would be required to allow for exchange between metapopulations. This connectivity is essential for survival of boreal toads on a regional scale because isolated populations are inevitably more vulnerable to extinction from stochastic events."

The habitat connectivity issues addressed in this section were identified based on effects of roads and other facilities and activities on the movements (especially migrations and emigration) of spotted frogs and boreal toads. Restricting and eliminating migrations, dispersal, emigration, and other movements can have major adverse effects on amphibian populations (Maxell and Hokit 1999, Forman et al. 2003, Patla and Keinath 2005, Andrews et al. 2008, Beebee 2013). Some of these connectivity issues may not apply to a range of wildlife species, which is unlike all of the other elements in this section (section A).

Key movements include the following: (1) movements from their existing hibernation sites to breeding sites, from breeding sites to their summering habitat, and from summering habitat back to their hibernation sites; (2) movement to and from habitat they had used in the past that may now be blocked by a road; (3) colonization of new areas; and (4) movement between different metapopulations which would foster genetic interchange. For a given metapopulation, movements are especially important within 200 yards of each existing breeding site and each known historic breeding site having capable amphibian wetland habitat, and it is also very important within 1/3 mile from each of these breeding sites. And, depending on the local situation, movements are important within 1½ mile of these breeding sites and beyond this perimeter, particularly for establishment of new breeding sites or re-establishment of previously-used breeding sites and for genetic interchange among local populations.

Additionally, movements between metapopulations is increasingly being recognized as important to the long-term sustainability of populations of amphibians (Marsh and Trenham 2001, Funk et al. 2005, Smith and Green 2005). This requires habitat connectivity at distances of as much as 3 miles or more (i.e., 1½ miles x 2) between breeding sites in two different metapopulations (see "Within 1½ miles of Breeding Wetlands" subsection of the "Buffer Zones and Levels of Protection" section).

Habitat connectivity is most important in riparian corridors since this is where most movement of spotted frogs and boreal toads likely occurs (see the "Buffer Zones and Levels of Protection" section), but habitat connectivity in uplands is increasingly being shown to be important in amphibian conservation (Skelly et al. 1999, Marsh and Trenham 2001, Pilliod et al. 2002). Pilliod et al. (2002), for example found that spotted frogs migrated through a wide range of habitats including big sagebrush and forestland. Marsh and Trenham (2001) cited eight or more studies showing that terrestrial conditions between breeding wetlands, including habitat fragmentation due to human activities, strongly influenced amphibian populations in areas in which this was evaluated.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan require the Forest Service to minimize road building in riparian areas and to relocate existing roads in riparian areas outside of riparian areas where possible, which directly addresses issues related to habitat connectivity and fragmentation. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to habitat connectivity.

> ***Goal 4.1 (Forest Plan) —*** "Road management preserves wildlife security, soil, visual resource, and water-quality values."
>
> > ***Objective 4.1(a) —*** "Minimize new road building and downgrade or close existing roads and motorized access trails to maintain or increase wildlife security."
> >
> > ***Objective 4.1(b) —*** "Design roads and structures to retain soil, visual resource, and water-quality values."
>
> ***Streamside Roads Standard (Forest Plan)*** — "Wherever possible, roads will avoid riparian areas or drainageways. Where riparian areas or drainageways cannot be avoided, location and design of roads will apply sediment-reduction practices to prevent degradation of riparian or stream quality. Roads presently within riparian areas will be relocated outside riparian areas where possible."
>
> ***Road Maintenance in Riparian Area Standard (Forest Plan)*** — "Maintenance, improvement, and repair of roads within riparian zones would mitigate impacts of the road to water quality, but would not avoid impacts because erosion and sedimentation would continue, albeit at a lower rate, and roads would continue to be a source of contaminants."

The 2012 Planning Rule addresses connectivity also addresses connectivity; although BTNF is not yet fall under the 2012 Planning Rule, it will within the next few years. The planning rule will require new Forest Plans to include plan components that will "maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity, taking into account…" a wide range of considerations, such as system drivers, including dominant ecological processes, disturbance regimes, and stressors (USFS 2012:21264, § 219.8(a)). This is consistent with the ecological literature.

Estimated Natural Conditions

The biophysical setting in which amphibians moved from site to site prior to Euro-American settlement and that would exist today in the absence of any human-created structures and facilities (e.g., roads, reservoirs, campgrounds) constitute natural conditions for his element. In other words, natural conditions for this element entail habitat conditions that do not artificially restrict the migrations, dispersal, and other movement of amphibians in any way. While natural conditions for this element represent the high end of suitability, in the context of what the area naturally supports, they do not represent the entire range of suitable conditions, as discussed in the "Deviations from Estimated Natural Conditions to Accommodate Other Uses" section, below.

It is recognized that there were many barriers to amphibian movement prior to Euro-American settlement (e.g., large contiguous stands of dense conifer forestland, cliff bands, extensive big sagebrush steppe), but this part-and-parcel with the natural landscape and it influences the natural capacity of the BTNF to maintain amphibian populations. Because spotted frogs and boreal toads are part of the amphibian community in the BTNF area, this means they were able to persist and possibly flourish despite these biophysical limits to movements.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating habitat connectivity, with respect to artificial restrictions on movements, in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because (1) there are no beneficial aspects of human-constructed facilities and human activities that restrict amphibian movements, (2) all human-related facilities and activities that restrict amphibian movements are detrimental to varying degrees, and (3) movements unrestricted by human-constructed facilities and human activities represents conditions under which amphibian communities formed or developed in the BTNF area.

Deviations from Estimated Natural Conditions to Accommodate other Uses

Given the multiple-use mandates of the Forest Service, and given the impossibility of having movements of amphibians totally unrestricted by human-related factors on the BTNF that support multiple uses (e.g., roads, reservoirs), it will be necessary to accommodate some degree of deviations from natural habitat connectivity caused by these roads and other facilities. On the other hand, roads and other facilities and activities that restrict movements of spotted frogs and boreal toads can only be accommodated to the extent that suitable conditions with respect to habitat connectivity are still provided for these species, including through the use of mitigation measures. Two important characteristic of roads that result in disproportionately greater restrictions to movements than natural biophysical features are as follows: (1) roads run perpendicular to riparian corridors and there are few natural biophysical features that hinder or block amphibians attempting to move up and down these corridors; and (2) motorized vehicles traveling on roads compound the impact by killing some of the individuals that attempt to cross roads, and in some cases, the level of mortality can combine with the physical presence of a road to create effective blockage as well as elevated mortality. Roads that run parallel to riparian areas also introduce an unnatural limitation to movements given the length of this physical feature and potentially elevated mortality. Two important characteristic of reservoirs that result in disproportionately greater restrictions to movements than natural biophysical features (e.g., lakes formed due to landslides) are as follows: (1) some reservoirs are substantially larger than lakes formed due to landslides; and (2) highly fluctuating water levels, especially large reductions in water levels during the summer, result in bare ground where amphibians would normally move (very wide shorelines of bare ground for miles). Also, there are more reservoirs than there are naturally formed lakes along rivers and streams.

Characterizing the suitable biophysical settings that allow adequate movements by spotted frogs and boreal toads is difficult. It is clear that natural restrictions to movements were not sufficient to hinder the establishment and maintenance of spotted frog and boreal toad populations in the BTNF area, but how many human-constructed facilities (to meet Forest Plan direction for recreation and other uses) can be added in any given area without negatively impacting local populations?

Thus, a key question is, at what point — starting with no artificial restrictions to movements and incrementally adding more — do human-constructed facilities like roads and reservoirs limit movements of these species enough to contribute to substantive declines in local populations (metapopulations) and declines in populations at the BTNF level? The emphasis needs to be on metapopulations populations for reasons discussed in the "Requirement to Maintain Sufficient Distribution to be Resilient and Adaptable to Stressors" subsection in the beginning of Part I and in the "Multiple Stressors" section. From the standpoint of meeting Objective 3.3(a) with respect to spotted frogs and boreal toads, especially in DFC areas 10 and 12 of the BTNF, any assessments of this habitat element should begin with the understanding that an absence of artificial restrictions on movements within about 1½ miles of all existing breeding sites would best provide suitable habitat conditions. Then, the assessment should identify the roads and other facilities that can definitively be shown to not materially inhibit or restrict amphibian movements.

The situation would need to be addressed on a population by population level on the BTNF. Intensive inventory and modeling would be needed to assess natural and artificial biophysical features that hinder or block amphibian movements for any given local population of spotted frogs or boreal toads on the BTNF. Because there is insufficient funding for doing this for even a small number local populations, a two-pronged approach could be used as a starting point to defining suitable conditions: (1) focus on minimizing occurrence of artificial features that hinder or that could hinder frog and toad movements, especially close to wetlands and in riparian areas; (2) identify maximum densities of artificial features that have potential to hinder frog and toad movements.

Suitable biophysical conditions at local scales include the ability of a large majority of spotted frogs and boreal toads to move between hibernation habitat, breeding sites, and summer habitat unimpeded or relatively unimpeded by roads and other facilities. Given the magnitude of negative effects of roads on spotted frogs and boreal toads especially near wetlands and in and near riparian areas (see "Risk Factors and Recovery Factors," below), suitable biophysical conditions related to amphibian movements entail no net increase in roads/facilities that could hinder amphibian movements, lower number and density of roads and other facilities that could hinder amphibian movements relative to the number and size of riparian "spokes" leading away from breeding sites, and lower potential for roads and other facilities to hinder movements (e.g., through mitigation measures). Where a breeding complex exists along a riparian corridor and where no other riparian corridors have the potential to provide for movements of frogs or toads to and from the breeding complex, one road crossing the riparian zone has the potential to have major effects on the local population. Similarly, even where multiple riparian corridors provide travel routes to and from a breeding complex, one or two road crossings have the potential for major effects on movements if the road(s) cross a major riparian area that provides access to the other riparian corridors.

Suitable Condition Statements

Ideal habitat connectivity with respect to artificial restrictions on movements, from the standpoint of spotted frogs and boreal toads (i.e., natural conditions), would be for there to be no roads, motor-vehicle trails, reservoirs, or other facilities that act as barriers to their movements within 1½ miles of spotted frog and boreal toad breeding sites or anywhere where movements can be restricted. However, because of the multiple-use directives of the Forest Service and because a large network of roads already exists that support several uses (e.g., recreation, timber harvest, livestock grazing), these ideal conditions are not possible.

With this reality in mind, suitable conditions for this element at the local population level — in order to meet Forest Plan Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads — is for a large majority of frogs and toads at any given breeding site to be able to (1) move from their existing hibernation sites to breeding sites, and from breeding sites to their summering habitat, and from there back to their hibernation sites; (2) move to and from habitat they had used in the past that may now be blocked by a road; (3) colonize new areas; and (4) move between different local populations which would foster genetic interchange.

A quantitative statement of suitable habitat connectivity is premature at this time, and may not even be possible. Also, while landscape-scale suitable conditions for this element may be helpful, this would require a major effort that would involve determining and analyzing the existing network of system and non-system roads, amphibian distribution and movement patterns, and biophysical land features, as well as the process to actually develop suitable condition statements using this and other information (e.g., see Andrews et al. 2008). Based on suitable condition statements developed through such a process, they would likely step down eventually to the suitable conditions identified in the previous paragraph.

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the “suitable habitat” portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions of suitable conditions are written qualitatively.

1. A large majority of spotted frogs and boreal toads in each local population are able to make the following movements unimpeded or nearly unimpeded by roads and other facilities and activities: (1) movement from their existing hibernation sites to breeding sites, from breeding sites to their summering habitat, and from summering habitat back to their hibernation sites; (2) movement to and from habitat they had used in the past that may now be blocked by a road; (3) colonization of new areas; and (4) movement between different local populations which would foster genetic interchange. This is most important within 200 yards of existing breeding sites and historic breeding sites having capable amphibian wetland habitat; is also very important within 1/3 miles of these breeding sites; and is also important within 1½ miles of these breeding sites.

“Existing breeding sites and known historic breeding sites having capable amphibian wetland habitat” is identified as the geographic scope because restrictions on placement of roads and other facilities that impede movements are most critical where breeding sites exist, but restrictions can only be imposed around breeding sites that are known. Existing and known historic breeding sites only comprise a portion of the capable amphibian wetland habitat, and applying restrictions over such a large area would be overly restrictive. This highlights the importance of conducting thorough pre-development surveys to ascertain whether any existing or capable breeding sites would be affected. Objective 3.3(a) and the requirement to avoid or minimize impacts to sensitive species (FSM 2670.32) must be met regardless of whether locations of breeding sites are known. Pre-development surveys and appropriate changes to any development proposal would account for this.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — The greater the extent to which suitable conditions for riparian habitat are achieved, especially with respect to roads in riparian zones (i.e., fewer roads), the higher will be the attainment of suitable conditions for habitat connectivity.

C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts) — To the extent suitable conditions with respect to survival as affected by crushing by vehicles are achieved, suitable conditions for habitat connectivity will also be achieved.

Risk Factors and Restoration Factors

Several facilities and human activities (risk factors) **—** described below **—** reduce habitat connectivity and thereby work against the achievement of Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard with respect to spotted frogs and boreal toads. Sufficient constraints need to be placed on these human activities in order to be able to achieve Objective 3.3(a).

Roads — Andrews et al. (2008) identified two general ways in which roads act as barriers for amphibians: (1) animals are killed on roads in large enough numbers that functionally prevents genetic interchange between populations, and (2) animals avoid roads on a behavioral basis, thereby contributing to isolation and habitat fragmentation. They also noted that crossing roads can increase desiccation rates, which can become an especially important factor where adjoining habitats are altered and no longer provide the moist conditions they did prior to their alteration (e.g., due to livestock grazing or camping).

Forman et al. (2003:129-133, 226-230) described, in a little more detail, several ways that habitat connectivity is reduced or impacted by roads: roads can be barriers to the movement of amphibians, small mammals, and other wildlife by restricting or preventing movement up and down riparian corridors, between riverine/wetland habitat and riparian habitat, between riparian/riverine habitat and upland habitat, and between wetland complexes within a riparian zone. By acting as barriers to animal movements, roads reduce the amount of habitat available to some species, thereby shrinking available habitat more than the road base destroyed.

Even narrow roads and roads with low traffic volumes can block or limit amphibian movement. Forman et al. (2003) and Maxell and Hokit (1999) cited several studies showing that narrow roads and motor-vehicle trails (e.g. less than 10-feet wide) can restrict movements of some species of amphibians. Andrews et al. (2008) cited one study indicating that low-use forest roads can impede movements of some amphibian. The following description of one example of habitat fragmentation was provided by Patla and Keinath (2005:50):

> "A study of Columbia spotted frogs in Yellowstone National Park documented a population decline of approximately 80 percent between the 1950s (when the population was initially studied) and the 1990s, declining from about 1500 frogs to 300 frogs. Road construction was identified as one of the most likely causes of the local decline (Patla 1997, Patla and Peterson 1999, Patla and Peterson in prep). The road, which was constructed during the interval between the two studies, separated a breeding site from an over-wintering habitat. Thirty years after road construction occurred, the frog population was concentrated in habitat areas clustered on one side of the road, and the migration pattern documented in the 1950s across the area subsequently bisected by the new road was nearly abandoned. Spotted frogs ceased to attempt breeding at the pond nearest the road after 1994…"

This example highlights the sometimes major or severe impacts that occur that are never known. If the first study had not been conducted, researchers in the second study may very well not have known that spotted frogs once occupied habitat on the other side of the road. Prior to about five years ago, there was very little monitoring on the BTNF, and many changes in distribution and abundance could easily have occurred without any understanding of what took place.

Patla and Keinath (2005:49) listed the following ways in which roads fragment amphibian habitat:

- "alter amphibian behavior and movement patterns, causing disruption of breeding activities and migration (examples and sources in Jochimsen et al. 2004)
- prevent individuals from reaching habitat components needed for breeding, foraging, and over-wintering
- reduce the chance of colonization of unoccupied or new habitats, and a higher risk of local extirpation
- isolate populations from each other, resulting in lower chances of successful interchange of individuals and a higher risk of local extirpation (Vos and Chardon 1998). "

Jochimsen (2004:30) characterized roads as "…landscape features that alter and fragment natural habitats, and as a result, may impede the movement of amphibians and reptiles. The barrier effect can occur when 1) animals are killed on the road in unsustainable numbers such that sufficient interchange of individuals does not take place; 2) the surrounding habitat quality is reduced such that animals cannot persist; or 3) animals behaviorally avoid the road contributing to isolation and habitat fragmentation." They cited numerous scientific studies demonstrating the habitat-fragmentation capability of roads.

In a study of moor frogs in the Netherlands, Vos and Chardon (1998) found that lower probabilities of moor frogs occuping a pond corresponded with higher levels of road density. They concluded that roads increased isolation between ponds which contributed to habitat fragmentation, and that even minimally fragmented habitat resulted in detectable negative effects on moor frogs.

New road construction and road widening on the BTNF (including for timber harvest and oil and gas development) in riparian areas occupied by spotted frogs or boreal toads and near wetlands used by these species, could cumulatively impact spotted frogs and boreal toads to the extent the road(s) prevent or limit movements to previously used breeding sites, summering habitat, or winter habitat; prevent or limit movements to currently unused areas; or isolate populations from each other. It is possible that some of the major roadways on the BTNF and possibly even smaller roads are bisecting riparian habitat and creating divisions between riverine and riparian habitat and between riparian and upland habitat. Widening roads increases the potential that a given road acts as a barrier to movements.

Restricted or impeded movements due to roads can be mitigated to some degree in some situations with wildlife underpasses (greater than about 2 ft. tall and 1 ft. wide), culverts, and fencing (Maxell 2000, Andrews et al. 2008, Beebee 2013). However, these measures have been shown to be ineffective in at least some situations (Andrews et al., Beebee 2013). As an example, Maxell (2000) reported on one study showing that less than 4% of a local toad population used the culverts installed for their migrations. This highlights the importance of being certain that a new road is needed in the first place and, if it is determined to be worth the environmental effects, locating the road in ways that avoid barriers to amphibian movement. While Andrews et al. (2008) described several cases where culverts, bridges, and overpasses were demonstrated to be effective in facilitating movement of certain reptile and amphibian species across roads while minimizing mortality, they stressed that “Post-construction mitigation measures serve only as a second option as they do little to minimize, remove, or avoid the majority of indirect effects of roads…” Patla (2001) highlighted the amphibian tunnel installed as part of the Greys River road upgrade in 2000, but monitoring was not undertaken to ascertain the extent to which it is being used.

Expansion of Forestland and Overrepresentation of Late-Seral Forestland — It is possible that the expansion of conifer forestland and overrepresentation of late-seral forestland limits migrations of spotted frogs and boreal toads in some parts of the BTNF. Boreal toads typically do not venture deep into forests, especially in closed canopied forests (Rafael 1988 and Wind and Dupuis 2002). Spotted frogs likely do not venture far into closed canopied forest even during migrations.

Plant Communities with Depleted Species Composition — Because of the large reduction in hiding and escape cover and large reduction in shading and humidity retention attributes caused by shifts in species composition from relatively tall, dense herbaceous vegetation to short, sparse herbaceous vegetation (see “A.4. Herbaceous Species Composition” section), it is possible this could present or contribute to barriers to movements by spotted frogs and boreal toads. An example is riparian communities dominated by nonnative bluegrasses that (1) produce shorter vegetation of less canopy structure than native communities, (2) many times have reduced vigor which further reduces height and canopy cover, and (3) typically are heavily grazed which essentially eliminates cover for frogs and toads. Another example is tall forb communities that were converted to communities dominated by mule ears or tarweed.

Heavy to Severe Grazing — Because low retention of herbaceous vegetation (e.g., ≤50% retention of total herbaceous vegetation) in spotted frog and boreal toad habitat eliminates most if not all of the hiding and escape cover, shading, and moisture-retention attributes (see the “B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter” section), herbaceous communities that are heavily or severely grazed could pose a barrier to movement by adult or juvenile spotted frogs and boreal toads. When combined with wide roads, the barrier effect could be compounded. For individuals that do attempt to cross such areas, it could increase mortality. Andrews et al. (2008) noted that increased desiccation rates due to crossing roads can become an especially important factor where adjoining habitats are altered and not providing the moist conditions they did prior to their alteration (e.g., due to livestock grazing). Where heavily or severely grazed areas do not deter amphibians from crossing them, low retention conditions have the potential to elevate mortality rates through increased predation stemming from lack of hiding cover and increased desiccation due to depleted shade and moist microsites.

The Forage Utilization Standard allows for as high as 65% utilization in riparian areas, and up to 55% where conditions are less than satisfactory. This level of grazing is sufficient to remove most or all shade that may have been available before grazing, depending on the community type (e.g., species composition) and pre-grazed height of vegetation.

Oil, Gas, and Mineral Developments and Building Complexes — Oil, gas, and mineral development sites and building complexes also have the potential, depending on their location, to act as barriers to dispersal, migrations, and other movements. These sites act as barriers in similar ways that Forman et al. (2003:129-133, 226-230), Patla and Keinath (2005), and Andrews et al. (2008) described roads as presenting barriers, except that sites are much shorter (i.e., not linear) but wider and may include physical structures that present more solid barriers than roads. In some ways, oil, gas, and mineral development sites and building complexes present lesser movement barriers because they are non-linear, but despite being smaller, some sites may present more-effective barriers.

The short vegetation and extensive areas of bare ground (e.g., gravel, pavement) increase the exposure of amphibians to predation for any individuals that attempt to cross oil, gas, or mineral development site or building complexes. Also, because of the wide areas to cross with minimal if any moist microsites, and physical barriers or “traps” (e.g., window wells) that may stop amphibian movement, there is an elevated potential for toads and frogs attempting to cross these sites to die of desiccation.

Camping and Associated Activities — It is possible that campgrounds and dispersed camping areas in and adjacent to riparian areas, and some of the activities associated with camping (e.g., ATV use in the camping area) contribute to barriers to movements in some situations. Herbaceous vegetation is maintained at a short height, willow communities may be incrementally “pushed back” (due to mechanical damage), human activity is prevalent, dogs are common, and predators (e.g., ravens, magpies, jays) may be more common (Maxell and Hokit 1999, Maxell 2000, Patla and Keinath 2005, USFWS 2012).

Reservoirs — Large reservoirs can also create barriers to movements (Maxell 2000, Patla and Keinath 2005).

Fish-Stocked Lakes — Murphy et al. (2010b) provided genetic evidence that habitat connectivity was negatively affected by the presence of predatory fish in northeastern Idaho, among other factors. This is supported by assessments by USFS (1997:23), Maxell (2000), Pilliod and Peterson (2001), and Reaser and Pilliod (2005:561), and is particularly relevant to the Wind River Range (see the “Habitat Effectiveness and Survival with Respect to Fish” section).

Conservation Actions to Consider

The following conservation actions would contribute to achieving and maintaining suitable conditions outlined in the “Suitable Condition Statements,” above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including USFS (1990), deMaynadier and Hunter (1995), Maxell (2000), Patla (2000), Forman et al. (2003), Keinath and McGee (2005), and Patla and Keinath (2005), Andrews et al. (2008), PARC (2008), WGFD (2010a,b), and Beebee (2013) as well as publications cited earlier in this section and the “Buffer Zones and Levels of Protection” section.

I. Roads

1. Adhere to the Streamside Roads Standard and Logging in Riparian Area Standard.

1. All recommended conservation actions identified for roads and motor-vehicle trails in the “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” and “C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)” would contribute to achieving desired conditions related to habitat connectivity and, therefore, apply here as well.

2. Wherever possible within 1/3-mile of breeding sites, especially within 200 yards of known breeding wetlands and known historic breeding sites having capable amphibian wetland habitat, obliterate and restore roads that may impede frog or toad movements or that may elevate mortality rates.

3. Mitigation measures to consider include the incorporation of bridges, underpasses, and culverts, in combination with fencing, to existing roads and ATV trails where roads and trails and motorized use on these roads and trails may be acting as barriers to movements, especially where roads cross riparian corridors or run parallel to riparian corridors. Where a road or motorized trail crosses a water course, bridges, underpasses (e.g., concrete box culverts), and culverts should be wide enough that streambanks exist on both sides of the water course inside of these structures. Wherever possible, low-water bridges and vented fords with concrete box culverts (Clarkin et al. 2006, pages 5-16 through 5-20) should be constructed, as they would allow movement of the stream channel over time and for riparian vegetation to form inside the structures, allowing for movement of amphibians.

4. Although less effective, large single culverts can be used for the same purposes if they are wide enough to encompass streambanks that are wide enough for travel by frogs and toads, except possibly during peak flows. Wing fences can add to the effectiveness.

5. Construct new roads and motorized trails on the appropriate side of breeding sites to reduce or eliminate the need for spotted frogs and/or boreal toads to migrate or disperse across a given road or motorized trail. This is a heavily involved process and would need to be followed up by monitoring to determine effectiveness.

6. Where roads block or hinder movements to suitable habitat that currently is not used or is only being used at a low rate, consider options from removing or moving the road or facility, constructing underpasses or overpasses. This includes habitat created by the reestablishment of beavers in drainages they formerly occupied and where one or more roads may hinder dispersal into the drainage.

II. Depleted Herbaceous Species Composition and Livestock/Horse Grazing

1. Take action to allow for the restoration of plant species composition (see conservation actions identified in the “B.1 and B.2” sections.

2. Provide for greater herbaceous retention levels as outlined in Objective B.2 (i.e., ≥70% retention of total herbaceous vegetation).

III. Oil, Gas, and Mineral Developments and Building Complexes

1. Ensure that the footprint of oil, gas, and mineral developments are beyond 200 yards of breeding wetlands and are at least 200 yards from riparian areas within 1/3 mile of toad and frog breeding sites. This would limit the potential of heavy equipment crushing frogs and toads.

2. No building complexes within 200 yards of breeding sites and no building complexes within 100 feet of riparian areas within 1/3 mile of breeding sites.

IV. Reservoirs

1. Avoid, to the greatest extent possible, creation of reservoirs within the riparian areas within 1/3 mile of breeding sites.

2. If a given reservoir is being considered for elimination, habitat connectivity for spotted frogs or boreal toads would be an additional justification, depending on location.

Measures and Indicators

Currently Monitored Elements

The following information is available to monitor this element at a coarse-scale relative to known existing breeding sites and known historic breeding sites having capable habitat. While this provides some indication of the potential for habitat fragmentation and the potential for inhibiting frog and toad movements, it does not directly indicate this, as there may be roads and motor-vehicle trails that do not inhibit frog and toad movements.

- Location of Roads and Motor-Vehicle Trails, by Class — The BTNF currently has GIS layers for designated-open roads and motor-vehicle trails by class, as well as a layer for non-system roads and motor-vehicle trails.

- Location and Extent of Reservoirs — This data set should already be complete for the BTNF. Long-term monitoring would not be very straightforward.

- Known Existing Breeding Sites and Known Historic Sites — While incomplete (i.e., there are many existing and historic breeding sites that remain unknown), there is an existing layer that identifies all known amphibian breeding sites.

Together, these layers can be used to determine the location of roads, motor-vehicle trails, and reservoirs within different distances of known existing breeding sites and known existing historic breeding sites.

Additional Monitoring Elements to Consider

Other elements that would help in monitoring habitat connectivity include the following:

- Location and Extent of Dispersed Camping Sites, by Intensity of Use — Some of the dispersed camping sites on the BTNF have been mapped, but the data set is incomplete.

Knowing the locations of all historic breeding sites, at least those still having capable habitat, would be useful, but except for data that was collected historically this likely will not be possible to attain.

B. SHORT-TERM (E.G., ANNUAL) HABITAT ELEMENTS

These are important elements to achieving Objective 3.3(a) and other direction with respect to spotted frogs and boreal toads, and they are also applicable to a wide range of other native wildlife species.

B.1. WATER QUALITY

Introduction and Background

This element is important because reductions in water quality, sometimes even relatively small reductions, can adversely affect the health and survival of eggs, tadpoles, juveniles and adults, with the potential of mass mortalities, as discussed later in this section. Alterations to water quality have the potential to limit the achievement of Forest Plan Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

The “Water Quality” section in Appendix A addresses most aspects of water quality in much more detail than the discussion on the following pages.

The skin of amphibians is porous, which makes them susceptible to contaminants in water. Also, the aquatic and terrestrial life history stages of amphibians and the permeability of their skins to water and gases renders amphibians vulnerable to levels and types of chemicals that have been judged safe for other organisms (Patla and Keinath 2005, Andrews et al. 2008).

Insects that frogs and toads feed upon can also be impacted by reduced water quality (Hornung and Rice 2003).

The most critical period is the larval stage (Keinath and McGee 2005), which spans from the egg-laying period through the metamorphosis of frogs and toads, which is from late April through mid July at low elevations, and from June through early September at high elevations (mid elevations fall between these two ranges). Therefore, on cattle allotments, the highest potential for adverse effects is from the onset of the grazing season through mid July, about 1 month for allotments with on dates in mid June. This period is missed on lower elevation portions of sheep allotments. At higher elevations, the highest potential for adverse effects is from the onset of sheep grazing through early September, typically about 1½-2 months. Although much larger numbers of sheep use any given water source compared to cattle allotments, the duration of use is considerably shorter (e.g., a much shorter period in any given day, and far fewer days) and sheep do not venture as far into the water as cattle.

Development of Suitable Condition Statements

Summary of Direct and Indirect Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following legislation, executive orders, and Forest Plan management direction provide protection against the loss of wetlands to roads and other facilities and, to a lesser degree, against the loss of riparian habitat to roads and other facilities. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to water quality.

> ***Section 101, 303, 319, of the Clean Water Act (1972, and amendments in 1977) —*** Section 101(a)(2) identifies the following goal: to protect and enhance the propagation of fish, shellfish, wildlife, and recreation in and on waters of the United States. In the absence of specific wetland standards, water quality standards established for other surface waters can apply to wetlands as well.
>
> ***Goal 1.3 (Forest Plan) —*** "Water quantity and quality are retained or improved for local users."
>
>> ***Objective 1.3(a) —*** "Protect municipal, agricultural, and other potable water supplies and ensure that management activities do not cause a deterioration in water-flow, timing, quality, or quantity."
>>
>> ***Objective 1.3(b) —*** "Meet or exceed current State water quality standards and National Forest Service water quality goals."
>
> ***Goal 4.1 (Forest Plan) —*** "Road management preserves wildlife security, soil, visual resource, and water-quality values."
>
>> ***Objective 4.1(a) —*** "Minimize new road building and downgrade or close existing roads and motorized access trails to maintain or increase wildlife security."
>>
>> ***Objective 4.1(b) —*** "Design roads and structures to retain soil, visual resource, and water-quality values."
>>
>> The Forest Challenge Statement for minimizing impacts of roads is as follows: "Wildlife security, soil values, and water quality are often affected by poorly designed or maintained roads. Frequently, BTNF users create their own "roads" by simply driving off highway. The challenge is to manage roads and their use to minimize wildlife security, soil, and water value losses. If the challenge is not met, irretrievable loss of resources will occur through increased hunting and human-presence pressures on wildlife, soil erosion, and stream sedimentation" (USFS 1990b:80).
>
> ***Goal 4.7 (Forest Plan) —*** "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreational values or experiences."
>
>> ***Objective 4.7(b) —*** "Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present."
>
> ***Soil, Water, and Air Prescription (Forest Plan) —*** "Activities are planned to protect the quality of the basic watershed resources of soil, water, and air."
>
> ***Water Quality Standard (Forest Plan) —*** "Forest Service or permitted activity or project will, at a minimum, adhere to state rules and regulations concerning surface and ground water quality."
>
> ***Streamside Roads Standard (Forest Plan)*** — "Wherever possible, roads will avoid riparian areas or drainageways. Where riparian areas or drainageways cannot be avoided, location and design of roads will

> apply sediment-reduction practices to prevent degradation of riparian or stream quality. Roads presently within riparian areas will be relocated outside riparian areas where possible."
>
> ***Road Maintenance in Riparian Area Standard (Forest Plan)*** — "Maintenance, improvement, and repair of roads within riparian zones would mitigate impacts of the road to water quality, but would not avoid impacts because erosion and sedimentation would continue, albeit at a lower rate, and roads would continue to be a source of contaminants."

A gap in management direction for water quality is that water quality in isolated basin wetlands may not be covered under any direction in the Forest Plan, except that (1) Water quality standard applies wherever state water quality standards apply, and (2) the Clean Water Act appears to require satisfactory water for wildlife (e.g., amphibians) in isolated basin wetlands. The Act states that, in the absence of specific wetland standards [e.g., for isolated basin wetlands], water quality standards established for other surface waters can apply to wetlands as well. This means that Wyoming State water quality standards for aquatic life other than fish can be applied to isolated basin wetlands, recognizing that water quality in some wetlands may naturally be near or below thresholds for spotted frogs and boreal toads which in turn means that natural exceedences in all likelihood will need to be accommodated.

Estimated Natural Conditions

The water quality that existed prior to Euro-American settlement and that would exist today in the absence of any artificial impact on water quality constitute the natural conditions for his element. While the range of natural conditions for this element does not encompass the entirety of suitable conditions for spotted frogs and boreal toads (i.e., suitable conditions may entail lower-than-natural water quality in some wetlands), natural conditions are encompassed within the range of suitable conditions for these species since these are the conditions under which amphibian communities formed or developed in this area. Natural levels of water quality reflect what the BTNF area can support in the absence of human-related impacts.

There are three main reasons why a natural level of water quality provides or contributes to suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, water quality is important to both species, especially during the breeding season. Water quality is important because reductions in water quality, sometimes even relatively small reductions, can adversely affect the health and survival of eggs, tadpoles, juveniles and adults, with the potential of mass mortalities (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Andrews et al. 2008, PARC 2008, Schmutzer et al. 2008, Burton et al. 2009). Sources include sedimentation from uplands; urination, defecation, and trampling by livestock within wetlands; contaminants from motorized vehicles; contaminants from oil and gas developments; human waste; and pesticides.

Second, a *natural* level of water quality provides or contributes to satisfactory breeding wetland habitat and summer wetland habitat. While there are places on the BTNF where water quality in wetlands prior to Euro-American settlement was degraded to varying degrees, this represents the baseline, and it is unlikely that water quality affected by human facilities and activities would ever be of higher quality than natural conditions. This means that a natural level of water quality likely represents the best possible water quality, relative to natural factors that affect water quality on the BTNF (i.e., it represents the natural capability of the land).

Rather than providing estimates of a natural level of water quality in this subsection, estimates are provided of relatively natural water quality in the "Deviations from Estimated Natural Conditions to Accommodate other Uses" subsection, below.

Third, amphibian communities formed or developed in this area with natural levels of water quality.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural level of water quality in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because (1) natural water quality represents conditions under which amphibian communities formed or developed in the BTNF area; (2) natural water quality would be favorable to spotted frogs and boreal toads compared to existing conditions where water quality is below natural levels; and (3) upward trends toward a natural water quality, where it currently is below natural levels, would not adversely affect spotted frogs and boreal toads relative to existing conditions.

One possible exception to this is that, given the multitude of factors that negatively currently affect these species, along with strong indications of reduced population levels at the BTNF scale and likely disappearance of local populations, maintaining higher-than-natural water quality may offset some of these other impacts. However, this likely would not be feasible.

Deviations from Estimated Natural Conditions to Accommodate other Uses

Given the multiple-use mandates of the Forest Service, and given some of the inherent limitations of attaining and maintaining fully natural water quality under uses like livestock grazing, motorized use, dispersed camping, and timber harvest, and associated facilities like roads and trails, it likely will be necessary to accommodate some degree of deviations from natural conditions caused by these uses. However, lowering the bar on water quality can only be accommodated to the extent suitable water quality conditions are still provided for spotted frogs and boreal toads, especially in breeding wetlands.

It also needs to be recognized that amphibian communities in this area developed with defecation, urination, and trampling by native ungulates, including bison to some degree (DeLong 2009b) periodic fires and landslides that indirectly resulted in pulses of high sedimentation rates. Compared to existing conditions, defecation, urination, and trampling by native ungulates was likely higher prior to Euro-American settlement in wide, low-elevation due to periodic use of these valley bottoms by bison and potentially higher use of these valley bottoms by elk (e.g., prior to roads and recreation). Bison probably only affected a small minority of breeding pools on the BTNF and impacts were likely sporadic over time in wide low elevation valley bottoms, and elk densities were likely higher in habitats that now have roads through them or along them (e.g., valley bottom habitat) (DeLong 2009b for the Greys River RD). Elk wallows provide an example where impacts to potential amphibian habitat are extremely high. Elk wallows are traditional and it is unlikely they are used for breeding by amphibians given the high level of impacts.

State of Wyoming Water Quality Standards were developed to protect water quality while allowing for a range of other uses of the land (e.g., livestock grazing, timber harvest, roads, motorized use), and the level of protection varies depending on the intended use and type of water body. Spotted frogs and boreal toads have the opportunity to inhabit Class 1, 2AB, 2A, 2B, 2C, 3A, 3B, and 3C waters on the BTNF. The following material was obtained from section 4 (pages 1-10 to 1-12) of Wyoming Department of Environmental Quality (2013).

> Class 1, Outstanding Water — "...surface waters in which no further water quality degradation by point source discharges ther than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices."
>
> Class 2, Fisheries and Drinking Water — "…waters, other than those designated as Class 1, that are known to support fish and/or drinking water supplies or where those uses are attainable. Class 2 waters may be perennial, intermittent or ephemeral and are protected for the uses indicated in each subcategory…" Class 2AB water are used for both fisheries and drinking water; Class 2A waters may not support fish but are used for domestic or public drinking water supplies; and 2B waters are used to support fish but drinking water uses are not attainable; and 2C waters support nongame fish but not game fish. All subcategories are also protected for aquatic life other than fish, wildlife, and a range of other uses.
>
> Class 3, Aquatic Life other than Fish — "…waters, other than those designated as Class 1, that are intermittent, ephemeral or isolated waters and because of natural habitat conditions, do not support nor have the potential to support fish populations or spawning, or certain perennial waters which lack the natural water quality to support fish (e.g. geothermal areas). Class 3 waters provide support for invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles… Generally, waters suitable for this classification have wetland characteristics, and such characteristics will be a primary indicator used in identifying Class 3 waters."

> “Class 3A are isolated waters including wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable.”
>
> “Class 3B waters are tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters.
>
> “Class 3C waters are perennial streams without the natural water quality potential to support fish or drinking water supplies but do support wetland characteristics. These may include geothermal waters and waters with naturally high concentrations of dissolved salts or metals or pH extremes.”

While water quality may be lower-than-natural in some to many situations as a result of uses of the land and associated facilities, meeting Wyoming State water quality standards in streams likely would maintain water in these streams within the range of suitable conditions for spotted frogs and boreal toads (Keinath and McGee 2005:44), although one of the scientists that reviewed a draft (W. Estes-Zumpf, Wyoming Natural Diversity Database) of this report assessed that maximum limits for some elements may not be set low enough for spotted frogs and boreal toads and some important elements may be missing. W. Estes-Zumpf pointed out that, because water quality standards only address a limited number of potential contaminants, it is possible for contaminants in a particular wetland to exceed an acceptable range for spotted frogs and boreal toads while not exceeding any limits of water quality standards.

An example that was identified in a more thorough review of the literature after the draft document is nitrate and nitrite levels. The maximum allowable concentration of for both nitrate and nitrate+nitrate in waters protected for fish and drinking water (Class 2 waters) is 10 mg/L (Wyo. DEQ 2013), and this exceeds levels that are safe for spotted frog and boreal toad reproduction (see Appendix A). There are no maximum allowable thresholds for nitrate or nitrite with respect to protecting aquatic life other than fish. Also, water quality standard for all Class 1 and 2 waters in Wyoming is 4.15 mg/L at pH 7.0 and 20 ºC (Wyo. DEQ 2013:Appendix C), which is higher than what the EPA (2013) identified as a threshold for chronic effects on aquatic organisms (1.9 mg/L total ammonia nitrogen at pH 7.0 and 20 ºC). As with nitrate and nitrite, there are no maximum allowable thresholds for ammonium with respect to aquatic life other than fish. There also are no standards for phosphate.

Suitable water quality in breeding wetlands isolated from channelized-surface flow would likely be provided in most situations when these waters meet the Wyoming State water quality standards for Class 3A and 3B waters (i.e., for aquatic life other than fish), except as discussed above and in Appendix A.

In most cases, it is likely that water quality would remain within a suitable range where ground cover and plant species composition in adjoining rangelands are satisfactory to maintain proper watershed functioning (see “A.4. Herbaceous Species Composition”); roads and trails do not contribute more than minimal amounts of sediment (i.e., if pertinent Forest Plan Standards, Prescriptions, and Guidelines and Wyoming State best management practices are being met); if defecation, urination, and trampling by livestock and wildlife, in combination, are kept to a minimum; contaminants from oil, gas, and mineral developments do not exceed established limits according to Wyoming State water quality standards for aquatic life other than fish; and other elements affecting water quality are kept to levels that do not exceed Wyoming State water quality standards for aquatic life other than fish.

Water quality under this approach should be sufficient to meet Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and the Diversity of Wildlife Habitat Guideline with respect to spotted frogs and boreal toads so long as ground cover and plant species composition in uplands is meeting desired levels, streambank stability is at desired levels (see “A.3. Herbaceous Species Composition”), roads and trails are managed according to Forest Plan direction and Wyoming State best management practices (e.g., see the conservation actions listed below), and herbaceous vegetation is retained at suitable levels in and around pools used by amphibians (see "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter").

Appendix A

Effects of changes in water quality on tadpoles is addressed in detail in the "Water Quality" section of Appendix A; this appendix should be consulted for these details and for supporting scientific information.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. While the following descriptions of suitable conditions are themselves written qualitatively, the Wyoming State water quality standards (e.g., Wyo. Dept. Environmental Quality 2013) are quantitative.

1. At a bare minimum, within areas of capable amphibian habitat, water quality in perennial streams and lakes meet Wyoming State Water Quality Standards applicable to the particular stream. (However, some of the standards (e.g., for nitrate) are insufficient to protect tadpoles from altered behavior and increased mortality.)

2. At a bare minimum, in isolated, basin wetlands within 1/3 mile of known existing breeding sites and known historic breeding sites, water quality meets Wyoming Water Quality Standards for Class 3A and 3B waters, except where standards are naturally exceeded; and nitrate, ammonium, and phosphorus do not exceed concentrations that lead to chronic and acute effects on tadpoles, except to the extent these thresholds are naturally exceeded. (However, some of the standards (e.g., for nitrate) are insufficient to protect tadpoles from altered behavior and increased mortality.)

3. Nitrate concentrations do not exceed 2.5-5.0 mg/L, except where natural conditions exceed this level. (This is based on scientific information in the "Water Quality" section of Appendix A.) Note: The identification of maximum concentration of 2.5-5.0 mg/L is not intended to require any additional monitoring; rather, it is provided to guide the development of objectives, design features, and best management practices (e.g., minimum percent herbaceous retention threshold).

Capable amphibian habitat is used as the geographic scope of the first suitable condition statement because (1) it encompasses known existing breeding sites, as well as a large majority of unknown existing breeding sites, historic breeding sites, existing and historic migration and summer habitat, and potential future breeding, migration, and summer habitat; and (2) meeting Wyoming State Water Quality Standards is a coarse-filter objective that is required by the Forest Plan and Forest Service policy (FSM 2532) and that applies regardless of the needs of amphibians.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — Suitable conditions for streambank stability and sedimentation are important for meeting suitable conditions for water quality because (1) erosion of banks is an important contributor to reduced water quality where streambank stability is lower than desired levels, which results from streambank vegetation being less than desired, and (2) elevated sedimentation levels reduces water quality.

A.4. Herbaceous Species Composition — Suitable conditions for herbaceous retention are important for restoring and maintaining suitable water quality conditions because ground cover that is below desired levels contributes excessive amounts of sediments to streams and wetlands, especially when ground cover is less than 65%, and ground cover would meet suitable conditions where herbaceous plant species composition is at suitable levels. Additionally, suitable conditions for herbaceous species composition includes the lack of noxious weeds which, if attained, would minimize the potential for herbicide contaminants being introduced into breeding and summertime wetlands.

A.6. Habitat Connectivity and C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts) — To the extent that attaining suitable conditions for habitat connectivity (with respect to roads) and for survival as affected by vehicles (on roads) maintains lower road densities or the elimination of roads up-gradient of breeding sites, the lesser the potential for sediments from roads entering breeding wetlands.

B.2. Surface-Water Duration in Small Pools — To the extent suitable conditions for surface-water duration are maintained, this would not exacerbate any water quality issues. As water levels decline in wetlands, this increasingly concentrates contaminants and sediments.

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Suitable conditions for herbaceous retention are important for restoring and maintaining suitable water quality conditions for two main reasons. First, maintaining suitable retention levels for spotted frogs and boreal toads would help ensure that suitable ground cover and herbaceous species composition are being maintained, which is central to maintaining sedimentation rates within acceptable limits. Second, maintaining ≥70% retention of total herbaceous vegetation at breeding sites would maintain urination, defecation, and trampling within wetlands at relatively low levels in many cases. The "Water Quality" subsection in the ≥70% retention portion of Appendix A provides at least moderate support for the assessment that retaining ≥70% of total herbaceous vegetation in breeding wetlands would maintain suitable water quality for spotted frogs and boreal toads.

B.4. Soil Looseness and Maintenance of Overhanging Banks — Meeting suitable conditions for soil looseness in riparian areas would help in the process of restricting excessive amounts of sediment reaching streams and wetlands.

C.2. Reproduction and Survival as Affected by Lights and Noise — To the extent that meeting suitable conditions for artificial night lights and noise maintains larger distances between oil and gas developments and breeding wetlands, the lower the potential there would be of contaminants reaching these wetlands.

Risk Factors and Restoration Factors

The following risk factors have reduced water quality and have the potential to reduce water quality in the future, which directly limits the attainment of suitable water quality conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

The "Water Quality" section in Appendix A describes in detail the effects of reduced water quality on tadpoles.

***Livestock Grazing* —** Livestock effects on water quality, through urination, defecation, and trampling, can reduce dissolved oxygen levels, increase eutrophication of water, increase turbidity, and increase nitrates, nitrites, ammonia, and fecal coliforms (Maxell 2000, Keinath and McGeee 2005, Patla and Keinath 2005, Burton et al. 2009), although light to conservative levels of livestock grazing do not necessarily have biologically meaningful effects on frogs and toads (Adams et al. 2009, Roche et al. 2012). As an example, Maxell (2000:15) stated that "…eutrophication of waters fecal contamination may cause planorbid snail numbers to rise, thereby increasing the number of nematode parasites and the rate of parasite infection that subsequently lead to limb deformities in amphibians (Johnson 1999)." Additionally, "Veterinary products released into ponds and streams by the urine and manure of livestock may negatively affect amphibian health and survival (Bishop et al. 2003)" (Patla and Keinath 2005).

Water quality in wetlands used by livestock declines as intensity of use increases (Moore et al. 1979, Mosley et al. 1999, Scrimgeor and Kendall 2002, Hornung and Rice 2003, Holecheck et al. 2004, Schmutzer et al. 2008, Burton et al. 2009). Declining water levels through the summer can make water quality problems worse through increased concentrations of contaminants.

While most reported effects of livestock on water quality are negative, Maxell (2000:15) reported on one possible positive effect of livestock grazing: "…in some areas livestock defecation and subsequent eutrophication of waters may benefit some amphibian larvae via a bottom-up control of the food web (Reaser 1996)." Some studies have failed to detect significant adverse effects of livestock grazing on water quality in breeding ponds; livestock use in some of these studies was moderate to moderately high (Adams et al. 2009), but livestock use in other studies was very light (Roche et al. 2012b, McIlroy et al. 2013). Although Jansen and Healey (2003:213) concluded that "…water quality attributes scored significantly higher in less intensively grazed wetlands, their results with respect to water quality and livestock intensity were inconclusive, are difficult to interpret, and appear to be conflicting based on the limited information in their paper. Livestock intensity was categorized as "low" and "high," but they did not provide sufficient information to translate intensity levels into something that could be applied elsewhere. Also, while they categorized livestock use into these different categories, measured vegetation parameters did not vary significantly between low and high intensity grazing wetlands. Because livestock grazing intensity was approximated for each wetland based on "., dry sheep equivalent/ hectare/year," the only other apparent explanation is that sheep and cattle in the study wetlands may not have foraged on emergent vegetation to any large extent when they watered.

Another form of water quality impacts is elevated sedimentation caused in part by livestock grazing. Elevated sedimentation levels in wetlands and streams can originate from unstable streambanks and rangelands with lowered ground cover and lowered plant species composition. Lowered ground cover (especially when less than about 65%) contribute to elevated rates of overland flow, which typically increases erosion and, subsequently, sedimentation in down-gradient streams and wetlands (Thurow 1991, Satturlund and Adams 1992, National Research Council 1994, USFS 1997, Holechek et al. 2011; see also "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section, above). Lowered ground cover (especially lowered vegetation and litter cover) and lowered plant species composition are discussed in the "A.4. Herbaceous Species Composition" section, below. Keinath and McGee (2005), Patla and Keinath (2005), and other authors have discussed the implications of soil erosion and sedimentation to amphibian conservation, specifically as it pertains to reduced water quality. In fairly large parts of the BTNF have reduced plant species composition and ground cover (USFS 1997), which likely contribute to lower water quality in some places.

Direct effects of livestock-use on water quality are proportionate to the volume of water in ponds/wetlands and the intensity of livestock use, among other factors. Effects of livestock use on water quality, therefore, likely vary considerably across water bodies in BTNF allotments, depending on rangeland conditions, and from year-to-year. Direct effects of livestock grazing intensity on water quality are discussed further in the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section, below.

***Roads, Trails, and Motorized Recreation* —** Roads and motor-vehicle trails can be major contributors to reduced water quality in streams, wetlands associated with streams, and isolated wetlands (Satturlund and Adams 1992, Forman et al. 2003, Pilliod et al. 2003, Andrews et al. 2008, PARC 2008). Given the locations and conditions of roads on the BTNF, sedimentation from roads likely is an issue in some wetlands used by spotted frogs and boreal toads on the forest. Citing Anderson et al. (1976), deMaynadier and Hunter (1995:251) stated that "As much as 90% of the sediment runoff from some harvesting operations have come from logging roads." Satterlund and Adams (1992:325-326) contended that the potential impact of roads and trails "upon erosion and sediment often exceeds that of all other activities combined, especially in forests managed for timber," adding that "...the problems developed by off-road vehicle (ORV) users have grown explosively. Similarly, Maxell (2000:12) noted that "…it should be noted that many of the negative impacts associated with timber harvest may be associated with the building and maintenance of roads and road traffic," after which he cited several studies showing the negative effects of sedimentation on amphibians. "…In many wildland areas they have become a major source of watershed deterioration."

On some districts of the BTNF, like the Greys River Ranger District, the number and length of user-created ATV trails continues to grow and likely is a source of elevated sedimentation in places. Some user-created trails run straight uphill near streams and wetlands, which has the potential to contribute substantial amounts of sediment in localized areas during heavy rainstorms and during snowmelt. There likely has been a decline in sediments originating from motor-vehicle trails on the Jackson and Buffalo Ranger Districts due to the implementation of a new travel plan (D. Deiter, District Ranger, Jackson Ranger District, personal communication 2013). Road and trail design can offset some impacts, as compared to poorly designed roads and trails. Satterlund and Adams (1992:327) cited an example in which systematic planning of roads in a steep, forested basin in Oregon reduced road mileage by 11% and steep grades by 73%, as compared to when they were originally designed in a piecemeal fashion. PARC (2008) identified these issues as concerns for amphibians in general.

Increased sedimentation in streams, rivers, and wetlands due to soil erosion from roads/trails and increased turbidity due to roads and trails crossing through springs, seeps, and other wet areas has the potential to adversely affect amphibians (Keinath and McGee 2005, Patla and Keinath 2005, PARC 2008), and they have the potential to adverse impact amphibians in some places on the BTNF (Gomez 1994, Patla 2000). Sedimentation and turbidity can also affect aquatic insects in streams and wetlands, which in turn can affect amphibians that depend on them (Forman et al. 2003, PARC 2008, Andrews et al. 2008), and can affect the ability of tadpoles to locate food (Schmutzer et al. 2008). Management of soil in areas used by motor vehicles requires intensive on-site management to adequately mitigate impacts to soil (Douglass et al. 1999, USFS 1990b).

Roads, motor-vehicle trails, and associated motor-vehicle use can also reduce water quality by introducing contaminants from vehicles, including organic compounds like gas, coolants, hydraulic fluids, oil, and other lubricants; heavy metals from vehicle wear, combustion products, abrasives in brakes, catalytic converters, and uncombusted fuel additives; and rubber from tire wear (Forman et al. 2003, Andrews et al. 2008, PARC 2008). Sources of these contaminants include not only standard-size vehicles, but also ATVs, motorbikes, and snowmobiles. D. Deiter (D. Deiter, District Ranger, Jackson Ranger District, personal communication 2013) has done a considerable amount of this type of monitoring on other national forests, and felt this likely is not a big concern. Magnesium chloride is applied periodically to some of the roads on BTNF. Dust, comprised both of naturally occurring and contaminants listed above, also makes it into aquatic systems. Herbicides sprayed on noxious weeds — which are more abundant along roadways — can also contribute to contaminants in wetlands and streams if not properly applied. While seemingly non-significant compared to inputs along major highways and interstates, contaminants have the potential to contribute to reduced water quality in wetlands and streams. As traffic levels increase, the contaminant levels can increase due to tire wear, leaks, and spills resulting from malfunctions and accidents (e.g., gasoline, anti-freeze, oil, gear fluid). The types of contaminants addressed in this paragraph have been found to accumulate in food webs (Forman et al. 2003).

Creosote, which is a wood preservative and water-proofing agent for structures, and it has been shown to bio-concentrate in a range of invertebrate species and some muscle and fish species, and it has been shown to cause mortality in some of these species when exposed to high concentrations (Brooks 2000, Melber et al. 2004). Effects on amphibians do not appear to have been tested, but amphibians are typically more susceptible to contaminants than other species. However, bridges treated with creosote would only produce high concentrations of contaminants in a limited area. In streams, toxicity levels would decline with increasing distance below the bridge. While some existing structures on the BTNF were treated with creosote, it is not being used as a preservative any longer on structures used on national forests.

Beyond impacts of system roads and motor-vehicle trails on habitat in the immediate vicinity and downstream of the roads and trails, system roads and motor-vehicle trails provide a conveyance system that facilitates the spread of impacts to backcountry areas beyond these system roads and motor-vehicle trails due to the propensity for user-created motor-vehicle trails to extent beyond system roads and motor-vehicle trails in some non-wilderness parts of the BTNF. Not only does a new road facilitate these extensions of the user-created network of motor-vehicle trails in some places, widening and/or straightening of existing roads allows larger vehicles (e.g., RVs) with larger ATV trailers to go further into parts of the national forest previously inaccessible to them, which increases the chances that user-created motor-vehicle trails will be created in backcountry areas beyond these improved roads, which in turn can increase impacts to water quality in affected areas.

Fire Fighting — The largest risk to water quality from fire fighting is the use of ammonia-based fire retardents (e.g., ammonium phosphate and ammonium sulfate) and surfactant-based fire suppressant foams. Retardent compounds do not dissolve easily and move fairly readily into surface water and ground water.

Citing a range of scientific studies, Pilliod et al. (2003) explained that, when fire retardant chemicals make it directly into water, it often forms ammonium compounds that are slightly to moderately toxic to algae and invertebrates and moderately to highly toxic to fish. Based on cited science, USFS (2011c) assessed that fish are more sensitive to retardant than invertebrates. Thus, tadpoles likely are also more sensitive; tadpoles have been shown to be negatively impacted by ammonium (Appendix A). Citing several additional studies, Pilliod et al. (2003) added that prolonged exposure to elevated levels of ammonium compounds have been shown to have minimal to moderate affects on the survival and development of amphibian embryos and larvae. He, therefore, suggested that ammonium compounds may only be of concern in smaller lentic water bodies.

Pilliod et al. (2003:175) stated that “Possibly more important than ammonia toxicity is the release of yellow prussiate of soda (also known as sodium ferrocyanide), an ingredient of fire retardants and suppressants used as a corrosion inhibitor to minimize damage to equipment during storage and transport. This substance has been shown to be highly toxic to fish and amphibians at very dilute concentrations, especially upon exposure to sunlight,” for which he cited several papers. Pilliod et al. (2003:175) continued by explaining that “Fire retardants and foam suppressants with sodium ferrocyanide under natural light conditions were highly toxic to southern leopard frogs and boreal toads relative to treatments using the same chemical formulations, but without sodium ferrocyanide or without exposure to sunlight. Sodium ferrocyanide is oxidized in the presence of natural solar ultraviolet radiation, releasing higher concentrations of free cyanide.” Other chemicals (e.g., brominated diphenyl ether, cyanide), which are toxic at high enough concentrations, can bioaccumulate in the tissues of tadpoles and adults (Pilliod et al. 2003). Apparently, manufacturers had removed cyanide from retardants by 2004, which has reduced the level of adverse effects of retardants.

Brown et al. (2015:42-43) reported on one incident in which fire retardent was dropped on a small breeding pond of yellow-legged frogs. Although no cause-and-effect relationships were studied, there was a noticeable decline in tadpoles within the pond.

Soil disturbance resulting from the creation of fire lines (e.g., from hand lines to lines created by bulldozers) can increase sedimentation into breeding wetlands and other wetlands used by toads and frogs (Pilliod et al. 2003).

Wide fire breaks can be extensive and can result in similar habitat changes and biotic responses as those associated with roads and road construction, including elevated sedimentation of streams and wetlands (Pilliod et al. 2003); see the “Roads, Trails, and Motorized Use” section.

Timber Harvest and Fires — Sedimentation of streams and isolated water bodies, due to erosion from harvest units and roads, can be one of the largest impacts of timber harvest on amphibians if applicable Forest Plan standards and Wyoming and Forest Service best management practices are not properly followed. These impacts have the potential to affect boreal toads and spotted frogs most significantly during the larval life stage when they are limited to aquatic habitats.

Large, high-severity fires may result in sediment delivery to downstream breeding sites, which can affect tadpole survival (McMahon and deCalesta 1990, McNabb and Swanson 1990, Satturlund and Adams 1992, Maxell 2000, Patla 2001, Pilliod et al. 2003, Keinath and McGee 2005). In some small streams, sedimentation may increase to 10-100 times natural levels for 10 years or more (Pilliod et al. 2003). Sedimentation can also reduced the longevity of wetlands (see the “B.1. Water Quality” section), particularly as a consequence of large flushes of sediments which can occur with heavy rains following a severe fire.

As explained by Pilliod et al. (2003), post-fire surface runoff can result in nutrient loading in lakes and ponds or pulses in streams. Intense fire in watersheds can result in increased concentrations of nutrients such as soluble reactive phosphorus, ammonium, nitrate, and nitrite in streams, but the effects on amphibians is poorly understood and may benefit or adversely affect amphibians depending on the amphibian species, life history stage, and other factors. Some amphibian species are sensitive to elevated levels of nitrite, nitrate, or other nitrogenous compounds, but the increased productivity of aquatic systems can benefit some species of amphibians, especially during the tadpole stage (the “B.1. Water Quality” section of Appendix A addresses this in detail).

Oil and Gas Development — Oil and gas development has the potential to impact water quality in wetlands used by spotted frogs or boreal toads if occupied wetland habitat were to exist near developed sites (Loeffler 2001, Keinath and Patla 2005, Patla and Keinath 2005). Patla and Keinath (2005:54) reported that threats from oil and gas development and mineral extraction "…include environmental contaminants produced by tailings, released groundwater, mining/transport accidents, acid drainage, and leaching of additional metals from stream and soil substrates. Contaminated settling ponds can be used by toads (and presumably by frogs), exposing them to accumulated heavy metals, some of which (e.g., copper) are acutely toxic to tadpoles (Loeffler 2001). Lefcourt et al. (1998) describe the dramatic impact of heavy metals on the terrestrial and aquatic environment in northern Idaho, where soils, rivers, and lakes have high levels of metals. They report that "only remnant, nonrecruiting populations of anurans" occur in the upper reaches of the contaminated Silver Valley… Lefcourt et al. (1998) tested the effects of heavy metals (i.e., lead, zinc, cadmium, and combinations) on spotted frog tadpoles and found that they reduced the survival, growth, and fright response of tadpoles." PARC (2008) also discussed the impacts of developments on water quality and amphibians.

In addition to water quality impacts from normal operations (above), spills can occur, which would have major adverse impacts on toads and frogs.

Camping and Residences — Thomas et al. (1979a), Doppelt et al. (1993), and Brown et al. (2015:55) identified human waste as a contributing factor to reduced water quality. Given the large concentrations of people and frequency of use in some dispersed camp sites in parts of the BTNF, this has the potential to be a water quality issue where they occur in the vicinity of breeding and summer-long amphibian habitat, but the extent of the contribution is unknown. Leaks in the septic systems at recreation residences, guard stations, and Forest Service compounds can have the same impacts. Poorly designed and improperly located out-houses also can have similar potential effects. Also, a small percentage of campers on the BTNF that empty their camper waste-water tanks along roadways, which has the potential to contribute to reduced water quality.

Soaps, other cleaning ingredients and disinfectants, and other chemicals that may be dumped or spilled at developed camping areas, dispersed camping areas, guard stations, recreation residences, and building complexes can contribute to reductions in water quality where they exist near wetlands and riparian areas. Brown et al. (2015:55) identified sunscreen and insect repellent as having potential to negatively impact Yosemite toads where people swim in waters used by these toads.

Contaminants from motorized vehicles (See "Roads, Trails, and Motorized Recreation," above) have the potential to contribute to water quality issues in the vicinity of dispersed camping areas, developed campgrounds, recreation residences, guard stations, and Forest Service compounds.

Pesticide Spraying, Rotenone, and Other Chemicals — Concerns about pesticides and other contaminants include direct mortality; a variety of sublethal effects including behavioral changes, reduced disease resistance, and synergistic effects with other factors that may adversely affect toads and frogs; and risks from non-active components of supposedly safe insecticides and herbicides (Loeffler et al. 2001, Hogrefe et al. 2005, Patla and Keinath 2005, Relyea 2005). Even if contaminants do not lead to die-offs, they can affect amphibians to the point that sublethal effects, when combined with effects from other factors (e.g., loss of habitat, barriers to movements, road mortality, less-than-suitable herbaceous retention levels, altered hydrology), can act synergistically to reduce populations (see "Multiple Stressors and Viability" section for supporting literature).

Concern about chemical effects on amphibians is likely to continue escalating as information accumulates. For example, USGS recently announced that air-borne contaminants are playing an important role in declines of California amphibians (USGS 2000) and this was elaborated upon further in Brown et al. (2015) specifically with respect to Yosemite toads. Teton County's Weed and Pest Supervisor recently decided to discontinue aerial application of malathion due to findings by the EPA that the pesticide was present in water bodies of the county, where it may affect fish and tadpoles. Maxell (2000) recommends that, in the absence of information regarding the specific effects of a chemical on all life history stages of amphibians, herbicides and pesticides should not be sprayed within 100 yards of water bodies and wetlands.

Available information indicates that rotenone can have serious impacts on spotted frog and boreal toad tadpoles and there does not appear to be any information demonstrating its safe use in waters where and when tadpoles occur. The following quotes from conservation plans and assessments provide a good synthesis of available information:

- "Rotenone applications at typical concentrations may not seriously affect adult amphibians but would probably kill tadpoles and juvenile salamanders (California Department of Fish and Game 1985, Sousa et al. 1988). However, it is difficult to predict the effects of rotenone on any particular amphibian species because tolerances across taxa are highly variable (Hall and Henry 1992). Adult amphibians may avoid water when it becomes toxic. Although this behavior may prevent direct mortality from poisoning, it may subject amphibians to other threats such as predation and dehydration. Tadpoles cannot escape water and would experience high levels of mortality if a lethal dose was applied. The effect on hibernating adult amphibians is uncertain." (Hogrefe et al. 2005:12-13)
- "Rotenone and antimycin, two commonly used piscicides, are toxic to boreal toad tadpoles (Bruce Rosenlund, USFWS, pers. comm.). However, the use of these chemicals is closely regulated by the CDOW, and a fish reclamation project using these chemicals in boreal toad breeding sites would not be permitted." (Loeffler et al. 2001:13)
- "…The impacts of rotenone-containing piscicides on amphibians and turtles were recently reviewed by Fontenot et al. (1994) and McCoid and Bettoli (1996). They found the range of lethal doses of rotenone-containing piscicides for amphibian larvae and turtles (0.1-0.580 mg/L) to overlap to a large extent with lethal doses for fish (0.0165-0.665 mg/L), and to be much lower than the concentrations commonly used in fisheries management (0.5-3.0 mg/L). Furthermore, they reviewed a number of studies that noted substantial mortality of nontarget turtles and amphibian larvae. However, the effects of rotenone on turtles and newly metamorphosed and adult amphibians was found to vary with the degree of each species' aquatic respiration and their likelihood of exiting treated water bodies (Fontenot et al. 1994 and McCoid and Bettoli 1996). Nontarget mortality of amphibian larvae was reduced by Hockin et al. (1985) by providing several untreated refuge areas that could be accessed through Netlon fence divisions and by protecting one refuge area containing high densities of amphibian larvae by placing a sheet of hessian sacking soaked in a saturated potassium permanganate solution that neutralized the rotenone. The nontarget effects of another piscicide, antimycin, have apparently not been formally studied, but preliminary observations seem to indicate that antimycin is also toxic to turtles and amphibian larvae (Patla 1998). In Montana all amphibian larvae as well as tailed frog (*Ascaphus truei*) adults and highly aquatic spiny softshells and snapping turtles either use some sort of aquatic respiration or may be unlikely to exit treated water bodies depending on the time of day and presence/absence of humans (Daugherty and Sheldon 1982 and Ernst et al. 1994). Thus, all of these species are likely to suffer mortality through the application of piscicides." (Maxell and Hokit 1999:2.7)

There is increasing concern about herbicides such as Roundup due to lethal effects on amphibians (Relyea 2005). Relyea (2005:1121) stated that "The most striking result from the experiments was that a chemical designed to kill plants killed 98% of all tadpoles within three weeks and 79% of all juveniles within one day." Additional assessment is needed on herbicides being used on the BTNF and whether applications pose a threat to amphibians.

Brown et al. (2015) summarized the potential effects of several herbicides on Yosemite toads and described potential additive, multiplicative, and synergistic effects as follows: "Additive, multiplicative, or synergistic effects of herbicides with other risk factors have only recently begun to be studied among amphibians, and remain unstudied in Yosemite toads. Both Chen et al. (2004) and Edginton et al. (2004) found the Vision® formulation of glyphosate increased in toxicity to the embryonic and tadpole stages of green frogs (*Lithobates[Rana] clamitans*) and northern leopard frogs at higher pH treatments (^{3} 7.5). Relyea (2005b) also emphasized the importance of examining pesticide effects in a community context. In an outdoor mesocosm experiment using tadpoles of three anuran species (gray treefrog [*Hyla versicolor*], American toad [*Anaxyrus [Bufo] americanus*], northern leopard frog), zooplankton, and algae, where combinations of predators (no predators, red-spotted newts [*Notophthalmus viridescens*], larval diving beetles [*Dytiscus* spp.]) and pesticides (no pesticides, the insecticide Malathion®, the herbicide Roundup®) were manipulated, Roundup® (at a level of 1.3 mg of active ingredient/L) had substantial direct negative effects on the tadpoles, reducing total tadpole survival and biomass by 40 percent. However, Roundup® had no indirect effects on the amphibian community via predator survival or algal abundance."

Unnaturally High Populations of Native Ungulates — Grazing by unnaturally high population levels and unnatural concentrations of elk likely has altered herbaceous species composition, including a reduction in ground cover, in some parts of the BTNF (see "A.4. Herbaceous Species Composition"), which has potential to contribute to reduced water quality (as a result of increased sedimentation) where affected rangelands are situated above breeding wetlands and other wetlands used by spotted frogs or boreal toads. Differences between natural conditions (including natural population fluctuations of elk) and existing conditions (consistently high numbers of elk) likely have no more than minor effects on water quality. This is primarily because, in most situations, elk spend little time near and in water.

Unnaturally high concentrations of elk for extended periods at winter feedgrounds likely contribute to reduced water quality where they occur near streams and wetlands; i.e., where surface runoff from feedgrounds feeds streams and where groundwater under feedgrounds contributes to surface waters.

Atmospheric Depositions — Atmospheric nitrogen levels are currently artificially high in many parts of the U.S. due to a variety of reasons, including the burning of fossil fuels, and the deposition of inorganic nitrogen (mainly in the form of NO_3) contributes to elevated levels of nitrogen in some aquatic systems (Carpenter et al. 1998, Camargo et al. 2005). Atmospheric nitrogen levels are artificially high and are increasing in western states, including in western Wyoming. While Du et al. (2014) found that atmospheric nitrate levels in western states remained fairly constant between 1985 and 2012, they found that atmospheric ammonium had increased significantly during this period. Lehman et al. (2005) estimated that atmospheric nitrate levels increased 10-25% between 1985 and 2002 in a zone encompassing the BTNF and that atmospheric ammonium levels increased 25-50% and >50% between 1985 and 2002 in a zone encompassing the BTNF. Graphs in Du et al. (1985) show an increase in atmospheric nitrate from 1985 through the late 1990s and then an apparent decline between then and 2012, which may explain the differences in findings between their study and that of Lehman et al. (2005). However, Du et al. (2014:6) found there to be an overall increase in atmospheric nitrogen in western states, resulting from no upward or downward trend in nitrate combined with an upward trend in ammonium. Ingersoll et al. (2008) had similar findings for snowpack chemistry in the central Rocky Mountains, which encompasses the BTNF; they found significant increases in ammonium and nitrate concentrations between 1993 and 2004.

Upward trends are being documented on the BTNF (Grenon et al. 2010). Grenon et al. (2010:34) concluded the following from monitoring in the Wind River Range (1984-2008):

> "Analysis of the B-T NF air monitoring assessment documents a consistently increasing trend in nitrogen deposition. NH_{4+} showed an increasing trend at all NADP sites, bulk deposition sites, and in lake concentrations, but the trend was less pronounced. NO_{3-} showed a increasing trend in lake samples, primarily the inlets and at both bulk deposition sites. A sporadic increasing NO_{3-} trend also was detected in deposition at NADP sites for some seasons. An increasing trend in NH_{4+} is occurring over much of the western United States and may be partially due to increased agriculture emissions (feedlots, fertilizer, etc.)… This increasing deposition of nitrogen into the Bridger Wilderness is of concern."

Deposition of elevated levels of atmospheric nitrogen was identified in the *Yosemite Toad Conservation Assessment* (Brown et al. 2015) as a risk factor affecting the status of Yosemite toads, which is a close relative of the boreal toad.

Climate Change — Because climate change has increased aridity, reduced snowpack and stream discharge, and in most assessments, reduced precipitation levels (see the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section), climate change likely has reduced the amount of water in wetlands. McMenamin et al. (2008) specifically found a cumulative increase in percentage of permanently dry wetlands and decrease in the number of hydrated wetlands in Yellowstone National Park due to climate change. They also found indication that wetlands are desiccating earlier than what they did years ago.

Reductions in the volume of water in wetlands and accelerated desiccation rates contributes to lower water quality by further concentrating contaminants (i.e., the opposite affect of dilution).

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the “Suitable Condition Statements,” above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including USFS (1990), deMaynadier and Hunter (1995), Maxell (2000), Patla (2000), Forman et al. (2003), Keinath and McGee (2005), and Patla and Keinath (2005), Andrews et al. (2008), PARC (2008), WGFD (2010a,b), and recent allotment operating instructions, as well as publications cited earlier in this section and the “Buffer Zones and Levels of Protection” section.

I. General

1. Adhere to Forest Plan standards and guidelines for soil and water.

2. Adhere to State water quality standards, Wyoming Dept. of Environmental Quality.

II. Livestock Grazing

1. Implement minimum stubble height standards and limits on hoof action on streambanks, as described in the conservation action under the “1. Extent of Riparian Vegetation” section, above.

2. Ensure that livestock grazing is being managed to meet ground cover and plant species composition objectives reflective of healthy rangelands above breeding wetlands and other wetlands used by spotted frogs and boreal toads. If existing ground cover and/or plant species composition are below objective levels, take proper action to ensure appropriate adjustments are made to livestock management to maintain upward trends.

3. Place all salt and mineral supplements at least ¼-mile from live streams, springs, and wetlands.

4. Livestock carcasses must be moved to at least 100 feet from live streams, springs, and wetlands, and should be moved 200 yards or more from breeding wetlands to the greatest extent possible.

5. Implement other BMPs pertaining to livestock grazing, as necessary, to minimize excessive erosion.

6. Collect and analyze water samples where water quality in breeding wetlands has the highest potential to be negatively impacted by livestock grazing use. This would contribute information to the assessment of livestock grazing effects on water quality.

III. Roads, Trails, Motorized Use

1. All conservation actions identified for roads in the “2. Direct Habitat Loss” section would contribute to achieving suitable conditions in section A.1 and, therefore, apply here as well.

2. Adhere to the Road Maintenance in Riparian Areas Standard and Streamside Road Standard.

3. Make use of seasonal road and trail closures for portions of roads that are within 100 feet of toad and frog breeding sites or that are higher in the drainage that contribute sediments, with the purpose of reducing use of roads and trails are susceptible to accelerated erosion due to vehicle use when roads are wet.

4. Prior to any bridge construction that includes creosote-treated lumber within 200 yards of known existing breeding sites, evaluate the potential for contamination by creosote. Creosote apparently is not being used any longer.

IV. Fire Fighting, Fire-Use Fire, Prescribed Burning, and Timber Harvest

1. Avoid the use of aerial retardants within a minimum of 300 feet of breeding wetlands and over aquatic and riparian habitats used by boreal toads and spotted frogs. For each wildfire event, location of breeding

sites in the vicinity of wildfire, including it's potential paths, would need to be provided to the resource advisor, staff officer, and command center (as per USFS 2011b:3). To facilitate protection of breeding sites, maps showing the 300-ft. and 200-yard zones could be provided to the resource advisor.

2. Avoid the use of heavy equipment within 100 feet of known and suspected breeding sites and, inside of 1/3-mile of breeding sites, avoid the use of heavy equipment within 100 feet of riparian areas.
3. Avoid construction of fire lines with heavy equipment within 200 yards of breeding sites.
4. Avoid fuel storage, equipment staging, and equipment refueling facilities within 100 feet away of live stream channels and wetlands within 1½ miles of breeding sites.
5. Develop a contingency plan for spills over 25 gallons and for storage of 1,320 gallons or more.
6. Adhere to Forest Plan standards and guidelines and State of Wyoming and Forest Service best management practices with respect to logging and vegetation treatments, as needed, to ensure that logging, mechanical treatments, and prescribed burning to not accelerate erosion above breeding sites and above other ponds used by spotted frogs and boreal toads.

V. Oil, Gas, and Mineral Development

1. Provide a minimum buffer of 200 yards between mining sites and streams/wetlands within 1/3 mile of toad and frog breeding sites.
2. Provide a minimum buffer of 100 feet between solid waste pits and streams/wetlands within 1/3 mile of toad and frog breeding sites, and locate fuel storage caches and drilling fluid sumps a minimum of 330 feet from the high water mark of wetlands, lakes, and streams.
3. Avoid the use of tailings and holding ponds, but where these are absolutely necessary, manage them according to the State of Wyoming Best Management Practices and provide barriers to prevent access by boreal toads and spotted frogs.

VI. Camping, Recreation Residences, and Other Structures

1. Enforce the existing special order that prohibits dispersed camping within 100 feet of streams, and this should be extended to include frog and toad breeding wetlands as well.
2. Provide educational signs or pamphlets, at recreational sites near known breeding sites, about spotted frogs and how they could be impacted by recreationists and their pets.
3. In dispersed camp sites, prohibit and/or discourage human waste within 100 feet of wetlands and streams.
4. Take measures to ensure that septic systems are not leaking and that out-houses are properly placed and designed, especially where these facilities are within 1/3-mile of frog or toad breeding sites.
5. Wastewater from kitchens and water facilities, including that of camping trailers, need to be disposed of at least 100 feet from wetlands and streams.

VII. Pesticide, Rotenone, and Other Chemical Applications

1. Ensure that herbicides, insecticides, and piscicides are only applied as prescribed on label instructions.
2. For herbicides for which effects on amphibian have not been tested, avoid spraying within 100 yards of water bodies used by spotted frogs and boreal toads.
3. Avoid application of any insecticides within 200 yards of water bodies used by spotted frogs and boreal toads and minimize application of insecticides in spotted frog and boreal toad habitat within 1/3-mile of breeding sites.

4. Coordinate with weed and pest districts and weed-sprayer contractors to ensure they are abiding by necessary restrictions.

5. Avoid the use of piscides containing rotenone in any waters when occupied by spotted frog or boreal toad tadpoles. Thoroughly investigate potential effects of rotenone and other piscicides prior to approving their use in any water body that may be inhabited by spotted frogs or boreal toads, and avoid any application that may result in mortality of eggs, tadpoles, metamorphs, or adults.

Measures and Indicators

Currently Monitored Elements

Water quality is not currently monitored directly, except in limited situations. The following elements, already currently being monitored by BTNF hydrologists, fisheries biologists, and range management specialists, provide proxies in part for the suitable condition statements for water quality in streams:

- Streambank Stability – So long as streambanks are at suitable stability levels — as outlined in Suitable Condition Statement A.1— erosion along the stream channel should remain within acceptable limits. This element is being monitored at MIM sites on most or all districts, primarily on livestock allotments.

- Stream Channel Integrity – This element is being monitored at MIM sites on most or all districts, primarily on livestock allotments.

- Ground Cover and Plant Species Composition in Uplands –To the extent that desired conditions are being met for ground cover and plant species composition (Suitable Condition Statement A.4), erosion rates should be within acceptable limits. Monitoring of ground cover is well established on the BTNF, and herbaceous species composition is increasingly being monitored on rangeland and riparian monitoring sites.

- Streambank Shearing and Stubble Height on Green-line – These elements provide proxies for on aspect of water quality in streams (i.e., the extent to which banks are being eroded due to current-years' livestock use on streambanks). It is being monitored at MIM sites on most or all districts, primarily on livestock allotments.

The following elements currently being monitored by rangeland management specialists in can be used, depending on the location of monitoring sites relative to amphibian habitat, as a proxy for the Suitability Condition Statements for water quality in isolated basin wetlands and basin wetlands in riparian areas:

- Percent Retention of Herbaceous Vegetation – Corresponding with increases in grazing intensity in and immediately around a wetland are increases in urination, defecation, and trampling, which in turn incrementally reduces water quality. Percent retention of herbaceous vegetation provides an indicator of this (see B.3, below, for more detail). Percent use of key forage species and percent use of total herbaceous vegetation is being monitored to varying degrees on different districts.

Additional Monitoring Elements to Consider

- Water Quality – There currently are no plans to directly monitor water quality at spotted frog and boreal toad breeding sites and in streams used by these species because proxies (see above) would be used instead. However, there may be case-by-case needs. In these situations, pertinent water quality attributes would be selected and monitored. As data on water quality is collected, it should be collected in ways that will allow refinement of the way proxies are used.

- Sedimentation Rates Originating from Roads and Trails

B.2. SURFACE-WATER DURATION IN SMALL POOLS (RETENTION OF WATER INTO MID AND LATE SUMMER)

Introduction and Background

This element is important because frogs and toads, at a bare minimum, need water in breeding pools from just before the egg-laying stage until tadpoles metamorphose into their adult-form (Carey et al. 2005, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005). Metamorphosis occurs between mid July and late September, depending on species, elevation, snowpack in any given year, and other factors, meaning that a sufficient amount of standing water is needed in breeding pools through this period. Therefore, activities and facilities like drinking by livestock in small breeding wetlands, extraction of water from such pools for fire fighting, and livestock grazing that results in lowered water tables in riparian zones, have the potential to limit the achievement of Forest Plan Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

Whether a given wetland experiences declines in water levels and the rate of decline depend on a large number of variables, including the size of the wetland compared to the size of the basin, whether the wetland is directly and primarily affected by a stream system, geology, tectonic activity, soils, hydroperiod, seasonal changes in the difference between inflow and outflow/evapotranspiration rates, among many other factors (Laubhan et al. 2012).

The amount of time needed for metamorphosis is affected by other factors, including water temperature, availability of food for tadpoles, and densities of tadpoles (Wilbur and Collins 1973, Carey et al. 2005, Lind et al. 2007). Carey et al. (2005) found that boreal toad tadpoles grew most slowly at a constant water temperature of about 55 ºF, grew most rapidly at a temperature of about 87 ºF, and eventually died at a constant temperature of about 50 ºF. Lind et al. (2007) demonstrated that, with lower amounts of food, tadpoles of common frogs required as much as 6 more days to complete metamorphosis (or, 33% more time than 24 days with high food availability). Wilbur and Collins (1973) demonstrated that higher densities of tadpoles resulted in a longer period of time for tadpoles to complete metamorphosis. One implication of these results is that increasing densities of tadpoles (which in many natural settings can be caused by receding water levels through the summer) has the potential for some species to incrementally increase the amount of time needed to complete metamorphosis. This compounds the main effect of receding water levels which is the incrementally shorter time period that remains available for metamorphosis to be completed. Effects are further compounded to the extent that receding water levels reduce the amounts of available food, which further increases the amount of time required for metamorphosis. Reductions in available forage due to current and past livestock grazing can compound these effects even further.

Development of Suitable Condition Statements

Summary of Management Direction

Other than Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, there is limited management direction calling for the approximation of natural water-level declines as part of more general direction. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to surface-water duration through summer months.

> ***Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan)*** — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."
>
> ***Executive Order 13186 —*** Applicable provisions are summarized in the "A.1 Distribution and Amount of Wetland and Wet/Moist Riparian Habitat" section. In wetlands large enough for migratory birds, changes in water levels is an important issue, particularly for waterfowl and shorebirds.

There are no Forest Plan objectives, standards, prescriptions, or guidelines, or other management direction directly applicable and specific to this habitat element. And, given the high importance of preventing accelerated declines in surface-water levels in breeding wetlands that have potential for surface water to disappear before metamorphosis is completed, the absence of any management direction specific to this habitat element represents a potential gap. This makes it important to rely on the more general requirements of Objective 3.3(a) and the Sensitive Species Management Standard to provide an adequate amount of suitable habitat and to not allow for any declines in habitat conditions and populations of spotted frogs and boreal toads.

Estimated Natural Conditions

Optimum conditions with respect to the duration of surface water in small pools through the reproductive season of frogs and toads would be for surface water to remain until all tadpoles have metamorphose into adults. However, because frogs and toads use small, isolated wetlands for breeding and because water levels in many of these pools naturally decline during the summer, natural water-level declines need to be recognized in the definition of suitable conditions. Natural conditions for his element consist of (1) the seasonal surface-water patterns in small, isolated wetlands outside of riparian zones, especially the retention of surface water as far into the summer as precipitation levels, natural ground water/water table levels, evapotranspiration, and other natural outputs (e.g., drinking by native ungulates) allow; and (2) the seasonal surface-water patterns in isolated and semi-isolated wetlands within riparian zones, especially the retention of surface water as far into the summer as natural stream flows and natural water-table levels allow.

There are three main reasons why the natural surface-water duration in wetlands is an important contributor to suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, surface-water duration of wetlands is important to both species, especially for the successful metamorphosis of tadpoles. This element is important because frogs and toads absolutely require water in breeding wetlands from just prior to the egg-laying stage until tadpoles fully metamorphose into their adult-form, and because frogs and, to a lesser degree, toads need wetlands with standing or flowing water during the remainder of the summer season until hibernation, although they have the ability to move relatively short distances after metamorphosis to find new water sources (Keinath and McGee 2005, Patla and Keinath 2005); Bull (2009), on the other hand, found that numerous metamorph boreal toads moved as far as 0.7 to 1.7 miles from two breeding sites after metamorphosis. Metamorphosis occurs between mid July and late September, depending on species, elevation, snowpack in any given year, and other factors (Hammerson 1982, Patla 2000, Keinath and McGee 2005, Patla and Keinath 2005), meaning that a sufficient amount of standing water is needed in breeding wetlands through the end of this period.

Simply put, “If wetlands dry prior to metamorphosis, larvae die” (Laubhan et al. 2012:120). Reques and Tejedo (1997:831) asserted that “The duration of the pond is clearly a potential cause of mortality for amphibians (Shoop 1974, Smith 1983, Newman 1989, Tejedo and Reques 1994).” Lewis (2011:63) assessed that “Many breeding sites [of spotted frogs in Wyoming] fail to produce young because tadpoles fail to mature before the ponds dry up…,” recognizing this assessment is based on today’s conditions. Thus, regardless of the quality of any other habitat/survival element or all of these combined, if tadpoles consistently do not complete metamorphosis before breeding wetlands desiccate, populations will disappear. As with wetlands in general (Laubhan et al. 2012), many breeding pools naturally dry out during mid to late summer (e.g., through evapotranspiration and possibly percolation), but reduced water flows, reduced elevations of water tables, and direct removal of water, especially from small pools, can hasten the drying of some wetlands, thereby increasing the potential for pools to dry before metamorphosis is completed.

Laubhan et al. (2012:120) not only identified hydroperiod as the single most important factor controlling the establishment and maintenance of individual wetlands and wetland processes, in general, they also asserted that “Hydroperiod is often considered among the most critical factors associated with habitat conditions for amphibians because it directly affects other factors known to influence amphibian populations,” including the likelihood of larvae achieving metamorphosis, vegetation composition, and abundance of predators that feed on amphibians. They identified two sets of components that influence hydroperiod in any given wetland: those that affect the amount of water entering a wetland and those that affect the amount of water leaving a wetland. Laubhan et al. (2012:107) identified the following generalized equation for determining a water budget for individual wetlands and wetland complexes:

water volume = precipitation + surface water inflow + groundwater inflow – evaporation – transpiration – surface water outlflow – groundwater outflow

Second, a *natural* rate of surface-water retention (or, conversely, a natural rate of surface-water decline) contributes to satisfactory breeding wetland habitat and summer wetland habitat. It is recognized that surface water in some wetlands naturally went dry prior to metamorphosis of spotted frogs and boreal toads, which resulted in large die-offs of tadpoles including those in the process of metamorphosing. Laubhan et al. (2012:107) pointed out that all physiographic provinces in the Intermountain West typically experience "negative annual precipitation/evapotranspiration ratios," meaning that wetlands typically have temporary hydroperiods (e.g., as evidenced by drying-out of wetlands by the end of the summer). This is a natural characteristic. The majority of water inflow to wetlands results from precipitation occurring in the watershed (most importantly as snowfall) and not precipitation falling directly into the wetland. Where surface water inflow and groundwater inflow are insufficient to maintain surface-water levels in wetlands, summertime precipitation is not sufficient to offset evapotranspiration and percolation.

Nonetheless, however, there apparently were a sufficient number of wetlands prior to Euro-American settlement with sufficient surface-water retention in enough summers to maintain healthy, robust populations of spotted frogs and boreal toads within what is now the BTNF. As with other habitat elements, even though surface-water retention rates were less-than-satisfactory for some local populations in some years, natural surface-water retention rates likely represent the upper end of suitability *for this area* and, aside from direct management of water levels using water control structures or augmentation of water in certain breeding wetlands, it likely is not possible for surface-water in affected breeding wetlands to be maintained beyond the natural potential of the land. This means that, despite deficiencies of natural surface-water retention rates — from the standpoint of frogs and toads — natural surface-water retention rates likely are at the upper end of suitable conditions on the BTNF.

And because of the deficiencies of natural surface-water retention rates in parts of the BTNF (e.g., in breeding-wetland complexes in which it is not uncommon for surface water to disappear before successful metamorphosis), it is possible that natural surface-water retention rates are at or near the low end of suitability, which makes for a narrow range of suitable conditions. There is no reason to believe that natural surface-water retention rates were less-than-satisfactory across the BTNF for sustaining spotted frog and boreal toad populations.

Rather than providing estimates of a natural surface-water retention rates in this subsection, estimates are provided of relatively natural surface-water retention rates in the "Deviations from Estimated Natural Conditions to Accommodate other Uses" subsection, below.

Third, amphibian communities formed or developed in this area with natural levels of surface-water retention rates.

Deviations from Estimated Natural Conditions to Meet the Needs of the Species

Because natural surface-water patterns described above allowed healthy and fairly large populations of spotted frogs and boreal toads to persist prior to Euro-American settlement, these conditions are sufficient to maintain such populations on the BTNF today, so long as most or all other habitat and survival elements are maintained within the range of suitability. An argument could be made, however, given all of the other factors negatively affecting spotted frogs and boreal toads (along with strong indications of reduced population levels at the BTNF scale and likely disappearance of local populations), that a longer-than-natural surface-water retention be targeted in order to lessen this effect at least in dry years. This likely would be impractical in most situations.

So long as most if not all other habitat and survival elements are well within the range of suitability, there is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the natural level of water quality in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, and given some of the inherent limitations of attaining and maintaining fully natural surface-water duration while providing continued opportunities for livestock grazing, water extraction and storage, and accessing National Forest System lands using roads, it likely will be necessary to accommodate some degree of deviations from natural conditions caused by these uses. Factors that can affect either the amount or timing of inflow include ground cover in uplands (which affects infiltration, percolation to groundwater supplies, and overland flow), spring developments and other water diversions, reductions in water-table elevations relative to the surface of meadows, and roads (which can alter surface water and groundwater inflows and outflows). Livestock grazing can affect transpiration by reducing the surface area of herbaceous vegetation, but this likely is a minor affect. Factors that affect surface water outflow including drinking by livestock and extraction of water for fire management. Some reduction of water levels by livestock needs to be accommodated, and in some cases may merely emulate historic water-level reductions by bison and larger numbers of elk in low elevation wetlands. Each of these are discussed in more detail in the "Risk Factors and Restoration Factors" section, below.

However, some degree of reductions in surface-water in breeding wetlands can be accommodated but only to the extent surface-water is retained long enough for metamorphosis to be completed in a large majority of cases each year (i.e., allowance for only a very small increase in the mortality rate of tadpoles and metamorphosing frogs and toads), relative to what would have happened under natural conditions. Even though suitable conditions would allow for an increase in mortality (to accommodate other uses), only a "very small increase" would be accommodated because of the decline in number of breeding sites on the BTNF, the large number of other factors negatively impacted spotted frogs and boreal toads, and the critical importance of reproductive output to meeting Objective 3.3(a), Sensitive Species Management Standard, and higher-level authorities. On the other hand, it likely would not be possible to provide opportunities for uses like livestock grazing, spring-developments, and roads, and for fighting fires without allowing at least some negative effects on this habitat element.

Maintaining riparian areas in relatively natural conditions (see "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat") should sufficiently facilitate adequate retention of surface water in associated wetlands far enough into the summer in most years for this habitat element to remain within the range of suitability. So long as stream channels are at relatively natural condition, standing herbaceous vegetation is retained at suitable levels in and around pools used by amphibians, and substantive flows of springs are retained at water developments, surface-water retention in wetlands will probably be sufficient to contribute to meeting Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and Diversity of Wildlife Habitat Guideline with respect to these spotted frogs and boreal toads.

It will be imperative to critically evaluate all actions, activities, and facilities that have the potential to accelerate the seasonal decline in surface water in breeding wetlands (see "Risk Factors and Restoration Factors" for information on actions, activities, and facilities that can affect this element).

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages and in Appendix A, and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports.

1. Water level declines in breeding wetlands generally reflect natural rates of decline through summer months and are no more than minimally accelerated by artificial alterations in hydrology (e.g., due to overrepresentation of late-seral forestland, roads, historic livestock grazing, climate change) and direct water extractions (e.g., due to water developments, drinking by livestock), in combination.

Thus, suitable durations of surface water in small, isolated wetlands entails the retention of surface water in these small wetlands as far into the summer as precipitation levels, natural ground water/water table levels (e.g., when at potential functioning conditions), evapotranspiration, and other natural outputs (e.g., drinking by native ungulates) allow, while also accommodating up to a small acceleration in water-level declines.

Accommodating a small acceleration in water-level declines recognizes the multiple-use mandate of the Forest Service, and there is some amount of flexibility in natural systems because of the large variability among wetlands and from year-to-year in the initial volume of water in some small wetlands, rate of decline in ground water levels through the summer, and evapotranspiration rates. It also recognizes that bison probably periodically hastened the decline in surface water in some of the BTNF's low elevation ponds. However, if cattle use of small, isolated wetlands — that are being used for breeding by frogs and/or toads — is to the point that retention of herbaceous vegetation along the edges and within the wetlands has declined below suitable levels (see the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section, below) and/or herbaceous vegetation is beginning to be noticeably trampled, it is likely that the decline in water volume is moving outside the range of suitability, particularly during years of below-average precipitation.

The most critical period for retaining water in breeding pools would be the same as described in the water quality section, above. After adult frogs have left breeding pools and after young frogs and toads have metamorphosed, they typically gravitate and migrate to more permanent water bodies, streams, and springs (Pilliod et al. 2002, Keinath and McGee 2005, Patla and Keinath 2005, Pierce 2006).

The phrase "in combination" was added to make it clear that minimal deviations does not pertain to each artificial factor that accelerates water level declines. "Minimal" acceleration of water levels is in reference to the combination of factors, including climate change. To the degree that overrepresentation of late-seral forestland and/or climate change result in lower water levels in breeding wetlands and accelerated water-level declines in breeding wetlands, lesser deviations from natural water-level declines caused by other uses would be able to be accommodated.

Additionally, small accelerations in water-level declines, in combination with the many other deviations built into other suitable condition statements, has the potential to either negatively affect spotted frog and boreal toad populations or make populations more susceptible to impacts from disease. Coordination of the factors allowed to impact spotted frogs and boreal toads is needed.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

> A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — Water-table elevations in riparian areas that are at or near natural conditions would result in water level declines that reflect natural rates of decline through summer months as water tables naturally decline. To the extent stream channel integrity does not reflect suitable conditions and to the extent this results in premature and accelerated declines in the water table through the summer, this would hamper efforts to maintain suitable conditions for water levels in small pools within the riparian zone.
>
> B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Meeting suitable conditions for herbaceous retention levels in and around breeding wetlands would restrict livestock use of these wetlands thereby reducing the extent to which livestock drink from the wetlands, which in turn would limit the extent of accelerated water level declines. Also, maintaining suitable retention levels for spotted frogs and boreal toads would help to maintain satisfactory stubble heights on streambanks which in turn would help to meet suitable conditions for streambank stability and stream channel integrity (see A.1.) above.

Risk Factors and Restoration Factors

The following risk factors have the potential to accelerate the seasonal decline of water levels in wetlands, which in turn limits the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Natural, Background Factors — Several naturally occurring ecological processes act together to cause water levels in breeding pools to decline after an initial springtime or early summer peak, including reduced inputs (after the snowpack has melted), subsequent declines in water tables, and rising evapotranspiration rates. Periods of low precipitation are natural events that can reduce survival and reproductive rates of spotted frogs and boreal toads (Keinath and McGee 2005, Patla and Keinath 2005). Years when precipitation levels are well below average results in less water making it to wetlands, wetlands drying quicker during the summer, and likely results in some wetlands drying that do not go dry in years of average and above-average precipitation. When wetlands dry before tadpoles metamorphose, tadpole mortality can be substantially higher than in years of average and above-average precipitation. Spotted frogs and boreal toads evolved to be able to withstand these effects.

Carey et al. (2005:234) agreed with Burger and Bragg (1947:62) that boreal toads exercise little discrimination in the selection of breeding sites," adding that "While small puddles provide thermal advantages by warming rapidly during the day,… they commonly dry before the larvae can metamorphose unless summer rains are unusually frequent." They assessed that "Desiccation of egg masses appears to be the single largest source of egg mortality" in boreal toads.

Several human-related activities cumulatively compound the effects of below-average precipitation on the rate of decline of wetland water levels. These are outlined below. Because below-average precipitation and the extent of the low level of precipitation cannot be controlled, management of activities under the control of the Forest Service needs to be adjusted accordingly in order to meet resource objectives.

Climate Change — As temperatures rise and summer-time precipitation declines as a result of climate change (Schoennagel et al. 2004; Kaufmann et al. 2008; Rieman and Isaak 2010; Glick et al. 2011:39-40, 46; Saunders et al. 2011) or as temperatures rise and precipitation rises slightley, with a result of increasing aridity (Chang and Hansen), some wetlands will dry out earlier, which will result in artificial factors (e.g., altered stream channels, overrepresentation of late-seral forestland, drinking by livestock grazing, and water developments) compounding the acceleration of water-level declines even further. PARC (2008:39) concluded that "…subtle changes in climatic conditions in combination with habitat alteration may be enough to push some at-risk species over the edge. To reduce the potential effects of climate change on amphibians, PARC (2008) emphasized taking action to reduce the extent to which human-related activities and facilities reduce moisture, cover, and water in amphibian habitat.

As pointed out by Patla and Keinath (2005:44), "Because climate change so strongly influences the survival and reproductive success of amphibians, climate change is consistently cited as one of the main potential causes of amphibian population declines (Alford and Richards 1999, Matoon 2001)," including in areas where habitat remains intact.

McMenamin et al. (2008) specifically assessed changes in desiccation rates of wetlands in Yellowstone National Park due to climate change and found a cumulative increase in percentage of permanently dry wetlands and decrease in the number of hydrated wetlands. They also found indication that wetlands are desiccating earlier than what they did years ago. McMenamin et al. (2008) concluded that drying of wetlands over the long term has contributed to declining distribution and abundance of amphibians in Yellowstone National Park.

Because climate change cannot be controlled at the local level, management of activities under the control of the Forest Service needs to be adjusted accordingly in order to meet resource objectives.

See the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section for additional discussion of climate change.

Altered Stream Channels — Where water tables are substantively lower than proper functioning condition due to livestock grazing along streambanks and/or in uplands, water levels in off-channel wetlands and oxbows have the potential to disappear prior to completion of metamorphosis (Maxell 2000 and sources therein, Munger et al. 2002, as cited by Patla and Keinath 2005). This compares to riparian zones that have water tables at or near proper functioning conditions, which would tend to retain water levels in off-channel wetlands further into the summer (Ohmart 1996). Water tables in riparian areas naturally recede through the course of a summer, after peak flows in June, but they recede more quickly and to lower levels in riparian zones in which stream channels are lower than potential functioning condition (Chaney et al. 1993, Elmore and Kaufman 1994, Ohmart 1996, Wyman et al. 2006).

While the elevation of the water table in relation to the elevation of the meadow/floodplain is not a metic used in assessing proper functioning conditions (PFC), it is recognized in PFC assessment documents that the elevation of a water table varies with seral stage in riparian zones and that it has a major influence on valley bottom vegetation (Prichard 1998:13, 17, 90, 91).

As explained in a little more detail in the "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section, above, livestock grazing can cause streambanks to erode at unnaturally high levels (Clary and Webster 1989, Thurow 1991, Hall and Bryant 1995). Over time, accelerated bank erosion in some stream types results in vertical down-cutting, which can include down-cutting as a stream cuts laterally, of stream channels, which in turn lowers water tables (Chaney et al. 1993, Elmore and Kaufman 1994, Ohmart 1996, Wyaman et al. 2006).

Overrepresentation of Late-seral Forestland and Expansion of Conifer Forestland — The overrepresentation of late-seral forestland and increased abundance and canopy cover of conifer trees in meadows and rangelands, due to fire suppression and other human-related activities, has likely contributed to lower discharge rates from springs and lower flows in streams. This has resulted from the factors outlined below.

The rate of water discharge from springs in and below late-seral forestland can be less than the discharge volume in and below early-seral communities on the same site, and the rate of water discharge from meadows and rangelands on which conifer trees have become abundant oftentimes is less than that of meadows and rangelands without conifer trees (Beschta 1990, Satturlund and Adams 1992). Whether the degree of conifer cover influences discharge rates depends on geology and a host of other factors. Similarly, the rate of water discharge from springs in and below aspen stands dominated by conifer trees is less than that of aspen stands with minimal or no conifer trees. Additionally, the decline in forest acreage dominated by aspen trees has declined, which has reduced the occurrence of beaver in some drainages (see "Reduced Occurrence and Extent of Beaver Pond Complexes," below).

Conversion of late-seral forestland and disclimax rangelands to early-seral communities has the potential to increase the volume of water in streams and wetlands and the duration of moderate to high water levels (Beschta 1990, Satturlund and Adams 1992).

Water Developments — Water developments, including water diversions, extract water from springs and streams and, therefore, reduce the amount of water in these systems (Kindschy 1996). Bull (2009:243) documented that "…more than 20,000 dead [boreal toad] larvae on the dry reservoir in 2008 after it was drained for irrigation just prior to transformation."

Drinking by Livestock in Small Pools — It is possible for drinking by livestock to accelerate the drying of small breeding wetlands, thereby reducing reproductive output, which ultimately has the potential to contribute to reductions in small populations. Removal of water by cattle, sheep, and horses as mentioned by Patla and Keinath (2005) can affect the retention of surface water in breeding pools during mid to late summer. This likely is a factor in at least some of the smaller breeding pools on the BTNF. The degree to which drinking by livestock shortens the length of time that a given small pool maintains surface water for developing tadpoles is a simple function of the number of livestock and amount of time they spend at the pool, all other factors (e.g., air temperature, day length, groundwater inflow) being equal.

This is discussed further in the "Surface Water in Small Pools" section in Appendix A, which includes calculations demonstrating that the drinking of water in small pools by livestock very likely speeds up the desiccation of some breeding pools and wetlands used by summering frogs and toads.

Duration of surface water in small pools in relation to livestock grazing intensities is discussed further in the "Appendix A."

Reduced Occurrence and Extent of Beaver Pond Complexes — One of the roles that beaver pond complexes play in stream hydrology is that they capture and store water some of which is "released" later into the summer than would have occurred without the beaver ponds (Collins 1993, Ohmart 1996). Therefore, the absence of beaver pond complexes in drainages that formerly had beaver ponds could mean that less water is flowing later into the summer, which has the potential to reduce, earlier in the summer, the extent of wetlands lower in the system. Reduced occurrence of beaver ponds in a range of drainages has been documented on the BTNF (Gruell 1975).

Altered Hydrology due to Roads — Even if a given road has not resulted in the elimination of a wetland or part of a wetland, it can alter hydrology sufficiently to reduce the flow of water, which can affect the size of the wetland or the duration of surface water in the wetland into the summer. Where a road contributes to a reduced duration of surface water, this can reduce tadpole survival if the wetland dries before tadpoles metamorphose.

Water Withdrawals for Managing and Fighting Fires — Summer-time declines in water levels in small ponds can be accelerated through the pumping of water for fighting fires. Water withdrawals have the potential, depending on the pond, wetland, or stream use for withdrawals, to adversely impact toads and frogs because this could reduce the duration of surface-water in these wetlands which in turn could prevent tadpoles from metamorphosing. As highlighted below, drawing water from wetlands can also increase direct mortality.

The *Yosemite Toad Conservation Assessment* (Brown et al. 2015:42) made the following assessment of this risk factor:

> "Water drafting from ponds and streams and application of water have the potential to directly impact aquatic habitat quality or its occupant amphibians. During the severe 1987-1991 drought in California, fire suppression personnel in the Sierra Nevada were forced to take water from locations where aquatic amphibians and reptiles concentrated. Large removals of water from those locations had the potential to stress the occupant species present by further reducing available aquatic refuge habitat and/or making it accessible to aquatic-edge foraging predators (Holland 2005). In one particular instance, a variety of aquatic amphibians and reptiles were concentrated in a pond from which water was being drafted for fire suppression in 1994, and many animals were taken up by the helicopter water bucket and subsequently rained onto the fire site when it was emptied (Holland 2005)."

Conservation Actions to Consider

The following conservation actions would contribute to achieving and maintaining suitable conditions outlined in the "Suitable Condition Statements," above and, therefore, achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads.

I. General

1. Conduct surveys to locate any existing breeding sites and other capable amphibian wetland habitat that could be adversely impacted by proposed activities.
2. Critically evaluate all actions, activities, and facilities that have the potential to accelerate summertime surface-water decline in breeding wetlands and, for any action, activity, or facility that more than minimally accelerates surface-water declines at any known existing breeding site, take action to alleviate this acceleration (see below, as appropriate).

II. Stream Channel Integrity

1. See conservation actions affecting stream channel integrity in the "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat" section.

III. Water Developments

1. When installing water developments and when applying for water rights for these developments, ensure that sufficient water remains available in the spring area and in down-gradient wetlands the springs may sustain, and ensure that livestock cannot access the spring area and associated wetlands (e.g., through the use of exclosures). Where springs feed breeding wetlands for spotted frogs or boreal toads, ensure that sufficient water remains available through the summer for metamorphosis to be completed and, where there is potential for a spring development to accelerate surface-water declines sufficient for water to disappear before metamorphosis to be completed, ensure that an adequate amount of "in-stream" water is retained. Where the point of use is on private land, this must be done prior to the State Engineer approving the water right.

2. Ensure that water rights on National Forest System lands are filed in the name of the Federal Government.

IV. Livestock Grazing

1. Limiting grazing use such that a minimum of 70% of herbaceous vegetation at breeding sites (as outlined in suitable condition statements in section B.3, below) would limit the amount of drinking by livestock to levels that would help limit the degree to which drinking by livestock accelerate declining water levels in small pools.
2. Exclusion of livestock from breeding sites using fences would be a last option.
3. Breeding wetlands that are susceptible to having livestock watering accelerate water-level declines should be identified and, if limiting grazing use to a minimum of 70% retention is not sufficient, consider additional restrictions that would reduce the accleration in water-level declines.

V. Fire Fighting

1. Avoid, to the greatest extent possible, drawing water from breeding sites prior to about late August (low elevations and mid to late September (high elevations). This is based on dates provided in Keinath and McGee (2005), Patla and Keinath (2005), and Patla et al. (2008).

Conservation actions for this habitat element are listed in the "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation;" "Wetland, Stream, and Riparian Habitat Retention;" and "B.3. Height and Structure of Lie Herbaceous Vegetation, Thatch, and Litter" sections. In the latter section, the conservation actions for retaining the objective level of herbaceous retention are most pertinent.

Measures and Indicators

Currently Monitored Elements

Surface-water duration currently is not monitored directly or indirectly, but the following currently monitored elements could be used as proxies for surface-water duration depending on the location of monitoring sites:

- Percent Retention of Herbaceous Vegetation – Corresponding with increases in grazing intensity in small pools and other wetlands is a reduction in water levels as a consequence of drinking by livestock. Percent retention of herbaceous vegetation provides an indicator of this (see B.3, below, for more detail). Percent use of key forage species and percent use of total herbaceous vegetation is being monitored to varying degrees on different districts.
- Stream Channel Integrity – So long as stream channels are at suitable integrity levels — which occurs as a consequence of banks being satisfactorily stable over the long term (as outlined in Suitable Condition Statements A.1) — surface-water duration should be suitable in off-channel wetlands and in beaver ponds. This element is being monitored at MIM sites on most or all districts, primarily on livestock allotments.
- Streambank Stability – Streambank stability is a prerequisite to having stream channels of satisfactory integrity, as discussed above. This element is being monitored at MIM sites on most or all districts, primarily on livestock allotments.
- Spring Flow Volumes – The volume of water flowing from springs, although not monitored over time, is assessed at the time that special-use permits for water developments are being considered.

Additional Monitoring Elements to Consider

Seasonal changes in surface-water duration in small pools can also be directly monitored in various ways, but there currently are no plans for this given the additional time commitments and because proxies exist. If this element were to be monitored, the following attributes could potentially be monitored:

- Water depth at set points.
- Water-surface acreage.
- Water volume, which would require several attributes to be monitored.

B.3. HEIGHT AND STRUCTURE OF LIVE HERBACEOUS VEGETATION, THATCH, AND LITTER

Introduction and Background

The height and structure of herbaceous vegetation in an area — including the extent of tall, bent-over, and short vegetation after being grazed or recreated-upon — is important for two key reasons. First, terrestrial habitat is increasingly being shown to be important in the conservation of amphibian populations (Skelly et al. 1999, Marsh and Trenham 2001, Pilliod et al. 2002). After emphasizing the importance of terrestrial habitat to amphibians, Marsh and Trenham (2001:47) concluded that “Management plans that focus only on preserving ponds or wetlands will probably fail to maintain viable amphibian populations.” They cited eight or more studies showing that terrestrial conditions between breeding wetlands strongly influenced amphibian populations in areas in which this was evaluated.

Second, herbaceous height and structure are the key attributes of the non-water, non-soil habitat of spotted frogs and boreal toads in non-forest and non-willow habitats and contributes to habitat in willow communities (Hammerson 1982, Maxell 2000, Engle 2001, Keinath and McGee 2005, Patla and Keinath 2005, Pierce 2006, Shovlain 2006, Bull 2009). In forestlands, overstory/midstory canopy, shrub canopy, herbaceous canopy (where this exists), large woody material, the duff layer, and moist/wet soils provide — individually or in combination — a range of conditions for moist/humid microsites, protection from the sun, hiding/escape cover, and foraging for invertebrates. In contrast, the only the herbaceous canopy, litter layer, and moist/wet soil contribute to these functions. Herbaceous vegetation can supplement habitat functions in forestlands provided in part by trees, shrubs, and large woody material. Thus, retaining an adequate amount of suitable herbaceous vegetation is central to meeting Objectives 3.3(a) and 4.7(d) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads.

The height and structure of herbaceous vegetation is also an important habitat element to address in objectives because the Forest Service is responsible for managing human-related activities that affect the height and structure of herbaceous vegetation, including livestock grazing, recreation (e.g., dispersed camping, off-trail motorized use, grazing and trampling by recreation-based horses; Douglas et al. 1999), and noxious weed control. Livestock grazing is the most widespread human-related factor that affects such a large number of frog and toad habitat elements on the BTNF. Of the 13 habitat/other elements addressed in this report, 10 are affected by livestock and several of these are affected by livestock use in many different ways.

Additionally, most of the other threats posed by livestock (e.g., reduced water quality due to defecation and trampling, increased soil compaction, reduced surface water retention, increased mortality due to trampling) are proportional to the level of use by livestock and (1) retention of herbaceous vegetation is inversely related to these other threats and (2) retention of herbaceous vegetation is readily measured or estimated, compared to the difficulty of measuring or estimating the many other factors related to livestock grazing. Patla and Keinath (2005:47) concluded that “All the available summaries of threats faced by spotted frogs list livestock grazing as a major concern” (see Appendix A for more detail on impacts). The distribution of habitats used by cattle and by spotted frogs and boreal toads overlap to a large degree, and sheep water at wetlands used by these species. This makes percent retention of herbaceous vegetation a central component of habitat quality of spotted frogs and boreal toads with respect to livestock grazing. Individually dealing with the large number of potential impacts associated with livestock grazing intensity would be unwieldy, but this can be overcome by concentrating on satisfactory retention levels that sufficiently account for all of these factors.

This section of the report has an accompanying appendix (Appendix A) — i.e., this habitat/survival element is covered in greater detail than any other in the report— for several reasons, including (1) livestock grazing directly affects more acres of spotted frog and boreal toad habitat than any other activity on the BTNF especially compared to activities like timber harvest which affects relatively small acreages, (2) wetlands and meadows are important for both amphibians and for livestock, (3) areas favored by foraging cattle overlap to a large degree with habitat of spotted frogs and boreal toads, (4) minimum herbaceous retention levels have not been worked out for these species in the literature, (5) several of the habitat elements summarized previously in this report are addressed in more detail in this section, and (6) there is considerable resistance to any objectives that could lead to reductions in herbaceous utilization levels and discussions on this topic routinely lead to statements that scientific information is needed before any such objectives are adopted. With these considerations in mind, not to mention the professional need to use scientific information to develop objectives, this section outlines in some detail the scientific information that supports the assessment that 70% retention of total herbaceous vegetation would maintain suitable habitat for spotted frogs and boreal toads.

Appendix A discusses differences and the relationship between objectives and standards with respect to retention in range management and wildlife management.

Discussions primarily address cattle grazing use, but also pertain to sheep grazing use to some extent. Because of the differences in behavior and management between these two classes of livestock, they can affect amphibian habitat and amphibian survival in different ways. Additional assessment of sheep grazing use and adjustments to suitable condition statements and objectives may be needed based on this assessment.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan require the Forest Service to retain an adequate amount of suitable forage and cover for sensitive species and other wildlife. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to herbaceous retention levels.

Desired herbaceous retention levels have not yet been defined for the BTNF. Defining desired herbaceous retention levels will be a multi-disciplinary effort.

> ***Goal 4.7 (Forest Plan) —*** "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreational values or experiences."
>
> > ***Objective 4.7(d) —*** "Require that suitable and adequate amounts of forage and cover are retained for wildlife and fish."
> >
> > The Forest Challenge Statement for minimizing impacts of livestock grazing is as follows: "Overuse of the range by livestock, including pack and saddle stock, can cause unacceptable loss of other resources. The challenge is to manage the levels and locations of grazing livestock to maintain or enhance resource values. If the challenge is not met, resources valuable to the livestock industry and other National Forest users will be lost" (USFS 1990b:82).
>
> ***Vegetation: Range Prescription (Forest Plan)*** — "Forage is provided on a sustained-yield basis that protects rangeland values, wildlife habitat, and meets other resource needs. All practices available can be used to improve forage supplies and quality."
>
> ***Forage Utilization Standard (Forest Plan)*** — "The following utilization standards will be maximum utilization levels allowed for all herbivores on key vegetative species:

Upland Range Sites

Season-Long Grazing*		**Rotation Grazing**	
Unsatisfactory Condition	Satisfactory Condition	Unsatisfactory Condition	Satisfactory Condition
40%	50%	50%	60%

Riparian Range Sites

Season-Long Grazing*		**Rotation Grazing**	
Unsatisfactory Condition	Satisfactory Condition	Unsatisfactory Condition	Satisfactory Condition
45%	55%	55%	65%

* Season-long grazing only exists on a few allotments and will be changed to rotational grazing as AMPs are revised.

The standard continues with the following requirements:

> "During AMP revision, the Interdisciplinary (ID) Team and livestock permittees will prescribe site-specific utilization levels needed to meet Forest Plan objectives[N]."
>
> "The maximum forage utilization guidelines[O] apply to all types of grazing use including wildlife, livestock and recreational stock."
>
> "During monitoring and evaluation a Utilization Guideline may be changed if the prescribed level is not accomplishing planned objectives."
>
> "Site-specific utilization levels on key wildlife ranges will be established by an ID Team."
>
> "ID Teams will prescribe other proper-use standards to achieve site-specific objectives for the rangeland being managed. The standards will be a combination of forage utilization, ground cover, plant vigor, soil disturbance, or streambank stability. For example, on domestic sheep range, an objective of minimizing soil disturbance will be more important than forage utilization."

Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan) — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."

Fish; Wildlife; and Threatened, Endangered, and Sensitive Species Standard (Forest Plan) — "Range improvements, management activities, and trailing will be coordinated with and designed to help meet fish and wildlife habitat needs, especially on key habitat areas such as crucial winter range, seasonal calving areas, riparian areas, sage grouse leks, and nesting sites. Special emphasis will be placed on helping to meet the needs of Threatened, Endangered, and Sensitive Species."

Estimated Natural Conditions

Natural conditions for this element consist of height and structure of live herbaceous vegetation, thatch, and litter that existed prior to Euro-American settlement and that would exist today in the absence of human-caused changes in the herbivore community, including the absence of domestic livestock. The range of natural conditions for this element is within the range of suitable conditions for spotted frogs and boreal toads, recognizing that suitable conditions may extend beyond the natural range of variability.

There are three main reasons why the natural height and structure of herbaceous vegetation is an important contributor to suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, the height and structure of herbaceous vegetation is important to both species in at least three settings: (1) within and at the

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[N] Including Objectives 3.3(a) and 4.7(d).

[O] Apparently, the Forage Utilization Standard originally was drafted as a guideline but was not changed when the Forest Plan was finalized.

edges of pools and ponds (e.g., sedge dominated) used for breeding and summer-long habitat; (2) in wet meadow, moist meadow, silver sagebrush, and open willow communities for migration habitat for both species and summer-long habitat for boreal toads; and (3) in upslope rangeland, aspen, and some open forestland communities (e.g., where large woody material is sparse) for migration habitat for both species and summer-long habitat for boreal toads.

Important contributions of herbaceous vegetation — especially where willows and large woody debris are absent or relatively low in occurrence — are listed and described in the "Estimated Natural Conditions" subsection of "A.3. Herbaceous Species Composition." The critical importance of height and structure of herbaceous vegetation is illustrated by the relatively steep decline in functions performed by herbaceous vegetation with reductions in height and structure.

Second, a *natural* height and structure of herbaceous vegetation provided or contributed substantively to high quality habitat for spotted frogs and boreal toads in marsh, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, meadow-willow, rangeland, aspen, and open conifer communities in the BTNF area. A natural height and structure of herbaceous vegetation in these communities likely represents the upper end of what can realistically be produced and sustained in the BTNF area, given a site's elevation, soils, aspect, slope, climate conditions, and natural populations of herbivores. There likely are no sites grazed by livestock today that provide taller or denser herbaceous vegetation and that provides better hiding cover, humidity retention, temperature moderation, forage for tadpoles, and invertebrate habitat than would occur under a natural height and structure of herbaceous vegetation.

There were marsh, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities in the BTNF area that likely received fairly high grazing and trampling pressure, at times, by native ungulates prior to Euro-American settlement (e.g., resulting in 40-50% retention or lower). However, there were likely far more acres of each of these communities in which retention would have visually appeared to be 95-100% through the summer period, with a likely average of ≥90% in most years (Appendix A). Even now in areas inhabited by elk, many moist meadow and silver sagebrush communities are in the <5% utilization category of the landscape appearance method (BLM et al. 2008) just prior to the onset of livestock grazing each year. Therefore, even though some spotted frog and boreal toad habitat likely periodically had low retention levels prior to Euro-American settlement, amphibian communities formed under relatively high herbaceous retention levels, on average, across what is now the BTNF. Appendix A discusses estimated natural conditions further.

Natural conditions do not equate to ungrazed conditions, but most marsh, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities on the B TNF received little grazing prior to Euro-American settlement, and these are part of the conditions under which the native amphibian-community formed in this area. Grazing by native ungulates in most wet meadows/wetlands, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities on the BTNF likely is not substantively different now than what it was prior to Euro-American settlement. Even today with high elk populations, it is difficult to detect grazing activity on a large majority of the acreage of these types prior to the onset of livestock grazing on a year-to-year basis. Three differences in native-ungulate grazing intensities are (1) grazing by elk likely was higher historically in low elevation valley bottoms than occurs today due to today's human activity, (2) overall grazing pressure by elk in these communities likely is higher now than it was historically given consistently high elk numbers, and (3) parts of the BTNF that likely were intermittently or sporadically used by bison (e.g., low elevation valley bottoms) (see DeLong 2009b for the Greys River RD). However, this likely involved small acreages of moist meadow, silver sagebrush, and shrubby cinquefoil communities relative to the total acreage of these communities across the BTNF.

Third, amphibian communities formed or developed in this area with a natural height and structure of herbaceous vegetation.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

No adjustments are needed to the approximation of natural herbaceous retention levels (i.e., coarse-filter conditions) to meet Forest Plan Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, Diversity of Wildlife Habitat Guideline, and higher-level management direction with respect to spotted frogs and boreal toads, with one possible exception. While it is recognized that light grazing (e.g., 10-20% use of total herbaceous vegetation[P]) in dense, contiguous herbaceous communities can benefit spotted frogs and boreal toads (Watson et al. 2003, Bull 2005), there is insufficient need to make a fine-filter adjustment based on this potential benefit in isolated situations. Also, there is no scientific information demonstrating that an approximation of natural herbaceous conditions or herbaceous communities ungrazed by livestock would not adequately meet the needs of spotted frog and boreal toads or that these conditions would negatively affect these species.

Also, succession in some wetlands progresses naturally progresses toward domination by emergent vegetation with few if any openings, which reduces or eliminates suitable habitat for egg and tadpole development. No studies on spotted frogs and boreal toads were found that examined this, but scientific information from a range of sources supports it (Appendix A). Even though this is a natural process, breeding is critical and providing openings in these situations may be needed in light of all of the multiple stressors acting on spotted frogs and boreal toads. Wetlands in which created openings are needed are likely limited on the BTNF.

Lastly, there are many things we do not know about specific habitat needs of spotted frogs and boreal toads under different circumstances, and this is another reason why erring on the side of the conditions under which amphibian communities formed in this area — when there is question — would best contribute to meeting Objective 3.3(a), Sensitive Species Management Standard, and other higher level direction with respect to these species.

Therefore, if the needs of spotted frogs and boreal toads were the only consideration and if livestock grazing and other non-wildlife uses did not influence retention levels, natural retention levels would encompass the extent of suitable retention levels.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Constraining livestock grazing (as well as grazing by horses of livestock permittees/herders and outfitters) to the point that natural herbaceous retention levels are retained or to the point that spotted frogs and boreal toads would not be impacted to any degree would result in little if any livestock grazing except in limited situations. To allow for livestock grazing use, the "approximation of natural conditions," as a target, needed to be adjusted somewhat, and this was the main reason for evaluating a minimum of 80%, 70%, 60%, and 50% retention; i.e., how far down can the retention level be taken to accommodate livestock grazing while being able to demonstrate that suitable habitat conditions would be provided for spotted frogs and boreal toads and while not unduly impacting these species due to livestock grazing use (e.g., impacts to things like water quality, survival as affected by trampling, and surface-water duration)? The analysis detailed in Appendix A was undertaken to determine the extent to which herbaceous retention levels can be adjusted to accommodate livestock grazing while at the same time maintain habitat conditions and survival elements at suitable levels for spotted frogs and boreal toads.

≥80% Herbaceous Retention (within the range of suitability)

There is moderately-strong evidence that ≥80% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads (i.e., retention is high enough such that suitable habitat is retained and they are satisfactorily protected from direct impacts of livestock on frogs and toads), assuming that sites are at or near healthy, functioning condition. At 80% retention, an estimated 70% or more of the pre-grazed canopy cover would remain (Table A.14 of Appendix A). Eighty percent retention of total herbaceous vegetation equates to 25-40% utilization of key forage species (and possibly higher where composition of key forage species is low), which means this could minimally provide for livestock grazing especially where actual utilization of key forage species is as high as 40%.

The moderately-strong support for the above assessment is based on ≥80% retention of herbaceous vegetation in plant communities with suitable plant species composition providing, on average, suitable:

[P] 90% retention of total herbaceous vegetation retains only about 85% or less of the weight of the vegetation above 2 inches and equates to an estimated 10-25% use of key forage species.

1. Cover that retains humidity and moderates temperature near the gound surface on shorelines, in migration habitat, and in summer-long habitat (moderate to moderately-strong support, as high as strong support for boreal toads).
2. Shading and protection from the sun for metamorph, juvenile, and adult frogs and toads in their respective habitats (strong support).
3. Hiding and escape cover for tadpoles, metamorphs, and adults (moderate to moderately-strong support);
4. Forage for tadpoles (moderate to strong support).
5. Forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat (moderate support for native invertebrate communities and moderate to strong support for diverse habitat for invertebrate communities).
6. Shallow waters exposed to the sun and open patches for basking (no and strong support, respectively, with "no" support since 20% use would be too low).
7. Water quality, as related to urination, defecation, and trampling in wetlands and inputs from adjoining uplands (moderately-strong support).
8. Water retention in small breeding pools; i.e., limited acceleration of the decline of water levels in small breeding wetlands (moderately strong support).
9. Survival rates as affected by trampling of juveniles and adults (moderate to moderately-strong support) and tadpoles and metamorphs (moderate support).
10. Soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health (strong support).
11. Integrity of near-surface burrows used by frogs and toads (moderate to moderately-strong support).

The basis for each of these is outlined in Appendix A.

≥70% Herbaceous Retention (lower end of the range of suitability)

There is moderate evidence that ≥70% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads (i.e., retention is high enough such that suitable habitat is retained and they are satisfactorily protected from direct impacts of livestock on frogs and toads), assuming that sites are at or near healthy, functioning condition and that substantive parts of spotted frog and boreal toad habitat retain ≥80%[Q] of total herbaceous vegetation. A retention level of ≥70%[R] should satisfactorily "…minimize impacts to species whose viability has been identified as a concern," as required by FSM 2670.32 (WO Amendment 2600-2005-1), while also providing for substantive livestock grazing in spotted frog and boreal toad habitat. Seventy percent retention of total herbaceous vegetation equates to an estimated 30-50% utilization of key forage species (and possibly as high as 80% where composition of key forage species is low). Thus, the associated level of livestock grazing is higher than recommended maximum utilization levels in some range textbooks (Vallentine 1990, Holechek et al. 2011).

The moderate support for the above assessment is based on ≥70% retention of herbaceous vegetation in plant communities with suitable plant species composition providing, on average, suitable:

[Q] Maintaining ≥80% retention of total herbaceous vegetation in parts of spotted frog and boreal toad habitat is important given the relatively large reductions in biomass above 2 inches and in relatively intact canopy cover at 70% retention (e.g., canopy cover declines to an estimated 50-67% of what it was prior to being grazed).

[R] Including substantive areas of ≥80% retention of total herbaceous vegetation within 1/3 mile of breeding sites.

1. Cover that retains humidity and moderates temperature near the ground surface on shorelines, in migration habitat, and in summer-long habitat (moderately low to moderate support, possibly as high as moderately-strong support for boreal toads).
2. Shading and protection from the sun for metamorph, juvenile, and adult frogs and toads in their respective habitats (moderate support) and toads (moderately-high support).
3. Hiding and escape cover for tadpoles, metamorphs, and adults (moderate support).
4. Forage for tadpoles (moderate support).
5. Forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat (moderately low to moderate support for native invertebrate communities and moderate to moderately strong support for diverse habitat for invertebrate communities).
6. Shallow waters exposed to the sun and open patches for basking (low to moderate support, respectively, with low support since 30% use would be too low).
7. Water quality, as related to urination, defecation, and trampling in wetlands and inputs from adjoining uplands (moderate support).
8. Water retention in small breeding pools; i.e., limited acceleration of the decline of water levels in small breeding wetlands (moderate support).
9. Survival rates as affected by trampling of juveniles and adults (moderate support) and tadpoles and metamorphs (low to moderate support).
10. Soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health (strong support).
11. Integrity of near-surface burrows used by frogs and toads (moderately-low or moderate support).

The basis for each of these is outlined in Appendix A.

Retained herbaceous canopy cover is an important part of herbaceous habitat, which directly indicates or contributes to the habitat elements 1-6 and indirectly indicates changes in survival/habitat elements 7-11 (i.e., as an indicator of livestock grazing intensity). At 70% retention, an estimated 50-65% of the pre-grazed canopy cover would remain (Table A.14 of Appendix A). This is a fairly large reduction in canopy cover, especially at the 50% end of the range. This large a reduction in percent canopy cover allows substantial amounts of near-ground humidity to escape, for near-ground temperatures to be more like ambient temperatures, and for invertebrate communities to be altered (see Appendix A for discussion and citations). The associated grazing-use intensity also has the potential to reduce water quality, increase trampling mortality, and accelerate declines in surface water, particularly in and around small wetlands. However, a sufficient density of suitably humid, shady, and temperature moderated patches should remain available, particularly assuming that a portion of the area retains on ≥80% of total herbaceous vegetation, and the intensity of livestock use should be low enough to maintain suitable water quality, maintain trampling mortality within acceptable limits, and to not unduly accelerate declines in water levels in small pools (this is discussed in more detail in Appendix A).

The assertion that there is insufficient scientific information to support lowering the retention threshold from current limits (e.g., 35/40% retention of key forage species in riparian areas, 50% retention of key forage species) to 70% retention of total herbaceous vegetation continues to be made (see Responses to Comments). As can be seen in Appendix A, the scientific information from several angles shows that 70% provides a balance between providing suitable conditions for spotted frogs and boreal toads (albeit at the low end of suitability for many habitat and survival elements) and providing for livestock grazing use. The preponderance of scientific information shows that a minimum of 80% retention (i.e., 80% to near-100% retention) would be the most supportable herbaceous retention level, with the minor exception of the creation and maintenance of open shallow-water areas in a limited proportion of wetlands in which emergent vegetation would become too dense. Also, it is questionable whether we have the option of erring on the side of livestock grazing when dealing with sensitive species, even in DFC areas emphasizing livestock grazing (e.g., DFC 1B areas). In possible contrast to 1B areas, DFC 10[S] and 12 areas emphasize wildlife and, where there is some question on effects, the agency should err on the side of maintaining suitable conditions for sensitive species and minimizing impacts to sensitive species in order to achieve Objectives 3.3(a) and 4.7(d) with respect to sensitive species. Again, there is moderate evidence that ≥70% retention of herbaceous vegetation is sufficient to support the attainment of Objectives 3.3(a) and 4.7(d); there is less-than-moderate evidence that 60% retention of herbaceous vegetation is sufficient; and the preponderance of scientific information shows that 60% retention is insufficient to provide suitable habitat and to maintain survival elements within acceptable limits for spotted frogs and boreal toads.

≥60% Herbaceous Retention (less than suitable)

There is low to moderately-low evidence that ≥60% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads (i.e., retention is high enough such that suitable habitat is retained and they are satisfactorily protected from direct impacts of livestock on frogs and toads), assuming that sites are at or near healthy, functioning condition. There is only limited scientific information demonstrates that 60% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the assessment. The associated level of livestock grazing is at or higher than recommended maximum utilization levels in range textbooks (Vallentine 1990, Heady and Child 1994, Holechek et al. 2011).

The low to moderately-low support for the above assessment is based on ≥60% retention of herbaceous vegetation in plant communities with suitable plant species composition providing, on average, suitable:

1. Cover that retains humidity and moderates temperature near the gound surface on shorelines, in migration habitat, and in summer-long habitat (moderately-low to low support, possibly as high as moderate support for boreal toads).
2. Shading and protection from the sun for metamorph, juvenile, and adult frogs and toads in their respective habitats (moderate support).
3. Hiding and escape cover for tadpoles, metamorphs, and adults (moderately-low support);
4. Forage for tadpoles (low support).
5. Forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat (low support for native invertebrate communities and moderate support for diverse habitat for invertebrate communities).
6. Shallow waters exposed to the sun and open patches for basking (moderate and no support, respectively).
7. Water quality, as related to urination, defecation, and trampling in wetlands and inputs from adjoining uplands (low support).
8. Water retention in small breeding pools; i.e., limited acceleration of the decline of water levels in small breeding wetlands (low support).
9. Survival rates as affected by trampling of juveniles and adults (low support) and tadpoles and metamorphs (low support).

[S] While DFC 10 speaks of attaining a balance between meeting wildlife needs and other uses, it clearly states that ground-disturbing activities cannot negatively affect wildlife. It is recognized that “no negative effect” on wildlife is not possible with respect to a livestock grazing program, but it is clear that negative effects should be minimized.

10. Soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health (moderate support).
11. Integrity of near-surface burrows used by frogs and toads (low support).

The basis for each of these is outlined in Appendix A.

≥50% Herbaceous Retention (less than suitable)

There is low evidence that ≥50% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads (i.e., retention is high enough such that suitable habitat is retained and they are satisfactorily protected from direct impacts of livestock on frogs and toads), assuming that sites are at or near healthy, functioning condition. There is little to no scientific information demonstrates that 50% retention of herbaceous vegetation in and around breeding wetlands, summering wetlands, and in other summering and migration habitat is sufficient to support the assessment. The associated level of livestock grazing is at or higher than recommended maximum utilization levels in range textbooks (Vallentine 1990, Heady and Child 1994, Holechek et al. 2011).

The very low support for the above assessment is based on ≥50% retention of herbaceous vegetation in plant communities with suitable plant species composition providing, on average, suitable:

1. Cover that retains humidity and moderates temperature near the gound surface on shorelines, in migration habitat, and in summer-long habitat (no support).
2. Shading and protection from the sun for metamorph, juvenile, and adult frogs and toads in their respective habitats (no support) and toads (low).
3. Hiding and escape cover for tadpoles, metamorphs, and adults (low support).
4. Forage for tadpoles (no support).
5. Forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat (no support for native invertebrate communities and low support for diverse habitat for invertebrate communities).
6. Shallow waters exposed to the sun and open patches for basking (moderate and no support, respectively).
7. Water quality, as related to urination, defecation, and trampling in wetlands and inputs from adjoining uplands (no support).
8. Water retention in small breeding pools; i.e., limited acceleration of the decline of water levels in small breeding wetlands (low support).
9. Survival rates as affected by trampling of juveniles and adults (low support) and tadpoles and metamorphs (no support).
10. Soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health (low support).
11. Integrity of near-surface burrows used by frogs and toads (no support).

The basis for each of these is outlined in Appendix A.

Other Adjustments

Other adjustments (beyond a minimum limit of 70% retention of total herbaceous vegetation) may need to be made to adequately accommodate livestock grazing while still maintaining suitable conditions for spotted frogs and toads:

- *Restriction of ≤70% herbaceous retention to 80% of Area* **—** By applying a minimum of 70% retention to 80% of the area within 1/3 mile of a breeding sites (rather than 100% of these areas), this would help to accommodate livestock grazing in frog and toad habitat since it would be impractical to attempt to maintain herbaceous retention across 100% of any area. With commercial livestock grazing comes at least some amount of overuse (see the next section, "Extent of Suitable Retention Levels" for more detail).
- *Minimum 50% Retention on Nonnative Bluegrass and Smooth Brome Sites* **—** Even with the addition of the 80% criteria (previous paragraph), riparian areas and meadows with extensive acreages dominated by nonnative bluegrasses will make it very difficult to meet the minimum 70% retention on ≥80% of each vegetation category within 1/3 mile of breeding sites. Retention levels as low as 50% (key forage species) may need to be accommodated on more than 20% of the acreage of moist meadow, silver sagebrush, shrubby cinquefoil, and/or meadow-willow communities that are dominated by nonnative bluegrasses and/or smooth brome. This accommodation may need to be made for several reasons:
    - Cattle are attracted to sites with heavy components of Kentucky bluegrass, bulbous bluegrass, Canada bluegrass, and other bluegrasses and there is a high propensity of cattle to make high use of these areas given the favorability of the forage (Youngblood et al. 1985), and requiring retention of ≥70% could place an unworkable restriction into the objective with respect to meeting requirements for providing for livestock grazing use. Cattle typically graze these sites before grazing other plant communities.
    - It is critical, from the standpoint of spotted frogs and boreal toads (and other meadow wildlife), that herbaceous layers dominated by nonnative bluegrass and/or smooth brome do not increase in size or distribution, and it is important that the existing distribution and size of herbaceous layers dominated by nonnative bluegrasses or smooth brome declines to the greatest extent possible. The focus of management should be on preventing increases in the acreage and distribution of sites dominated by nonnative bluegrasses and, to the extent possible, increasing the composition of more desirable plant species within areas dominated by nonnative bluegrasses. This requires limiting grazing pressure to a level that allows native and other desirable species within and around these sites to maintain plant vigor and, on sites where vigor is depressed, to restore vigor. Some range experts have identified a maximum 50% as the threshold for allowing adequate plant vigor (Heady and Child 1994). A study by Crider (1953) showed that defoliation of individual Kentucky bluegrass plants at ≤50% allows these plants to remain vigorous, but that defoliation levels of ≥60% result in reductions in root mass, and this study only involved one defoliation event per plant. In some allotments, multiple defoliations currently occur between mid June and mid October. These results have been extrapolated to other grass species. Because Kentucky bluegrass is more tolerant of grazing than many other graminoid species (e.g., slender wheatgrass, Columbia needlegrass, Nebraska sedge, tufted hairgrass, and Idaho fescue), 50% utilization represents an absolute upper end. Furthermore, research by Crider (1953) was done on individual plants. Applying a maximum 50% utilization to a plant community allows a majority of plants to be grazed at more than 50%. This all means that great care needs to be taken to limit utilization on these sites to 50%, as an absolute maximum.
    - In the absence of adequate control over grazing use in areas dominated by nonnative bluegrasses (i.e., actual use that is greater than 50%), this can perpetuate low vigor of nonnative bluegrasses and native species, lead to overgrazing of adjoining plant communities, excessive grazing of streambanks, and excessive browsing of willows.

Several principles, concepts, and pieces of natural history information, summarized in the "Introduction and Background" discussion of the "Suitable Conditions with Respect to Herbaceous Retention" section of Appendix A provide context and reasons for carrying out the process as it was carried out, including background information on the range or span of consideration; implications of limited monitoring data; why percent retention is the subject of suitable conditions and not height, biomass, and structural density; plant material above a 2-inch height; herbaceous species composition; and near-100% herbaceous retention as a starting point.

Extent of Suitable Retention Levels

Spotted frogs and boreal toads use a variety of habitats during spring, summer, and fall months and this involves inhabiting favored habitat for extended periods and movement between favored habitats. Two geographic spatial scales are important for retaining herbaceous vegetation: immediate vicinity of breeding pools and an area that encompasses a majority of breeding and summer-long habitat. Placing minimum retention levels on herbaceous vegetation within the area encompassed by a perimeter that is 10 feet beyond the high-water mark and on herbaceous vegetation within 1/3-mile of breeding pools would be sufficient to provide for the needs of most individuals of both species. The basis for these "buffer zones" is outlined in the "Buffer Zones and LEvels of Protection" section near the beginning of the report.

By applying a minimum retention level of 70% of total herbaceous vegetation at breeding sites (i.e., within the area encompassed by a perimeter that is 100 feet beyond the high-water mark), this would provide a reasonably high probability that livestock use is low enough to (1) retain hiding cover and structure within wetlands for tadpoles; (2) retain hiding cover and protection from the sun for metamorphosed and adult frogs and toads on the shoreline; (3) retain suitable habitat conditions for insects within the wetland and on the shoreline; (4) maintain water quality (as related to urination, defecation, and trampling) within acceptable levels, (5) minimize soil compaction on the shoreline, (6) minimize the potential of trampling adult and juvenile frogs and toads in and adjacent to breeding pools; (7) minimize the extent to which livestock drinking in small pools speeds the disappearance of surface water in these pools. Where extensive stands of dense sedge canopy cover exist with no open patches, the minimum retention level would allow open patches to be created, which could benefit both species. However, at the other end of the spectrum, where pre-grazing canopy cover of herbaceous vegetation in a wetland is relatively low, a retention of 70% on 80% of the wetland area could result in a higher-than-anticipated impacts.

By applying a minimum retention level of 70% of total herbaceous vegetation across at least 80% of each plant community type (wetland, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities) within 1/3 mile of breeding sites, this would provide a reasonably high probability that livestock use is low enough to (1) retain a suitable level of hiding cover, protection from the sun, ground-level humidity, and temperature moderation for juvenile and adult frogs and toads in the summer-long habitat, including permanent water sources; (2) retain suitable forage, cover, and structure for a diverse insect community; (3) maintain water quality (as related to urination, defecation, and trampling) within acceptable levels; (4) maintain soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (5) minimize the potential of trampling adult and juvenile frogs and toads in and adjacent to wetlands and in migration habitat; (6) minimize the extent to which livestock break through the soil surface and cave-in burrows or crush frogs or toads in shallow burrows; (7) minimize the extent to which livestock drinking in small pools speeds the disappearance of surface water in these pools; (8) minimize impacts to streambanks where frogs or toads may otherwise use for hibernation; and (9) contribute to the following year's residual thatch and litter which in turn contributes to hiding cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities. The retention level would also allow for small parts of the summer-long habitat to be more heavily impacted, thereby allowing for commercial livestock grazing use.

Also, where important summer habitat is identified for either species beyond the 1/3 mile perimeter and if livestock grazing is permitted in these areas, retention levels should be applied to these areas. This is where the recommendation of Pilliod et al. (2002) to protect groups of diverse water bodies and surrounding uplands within about 2/3-mile of breeding ponds could be taken into consideration.

Suitable Condition Statements

The following suitable condition statement is based on Forest Plan objectives and standards, Forest Service policy and legal requirements on sensitive species, the scientific information provided in Appendix A and summarized above, as well as information provided in the “A.4. Herbaceous Species Composition” section. Suitable condition statements define conditions that must be provided in order to meet portions of Objective 3.3(a), Objective 4.7(d), and the Sensitive Species Management Standard requiring that adequate amounts of suitable habitat be provided for spotted frogs and boreal toads.

1. Retain a minimum of approximately 60% of the pre-grazed herbaceous canopy cover (i.e. retain ≥60% of the canopy cover of intact and relatively intact herbaceous vegetation). This is a central intent of statements 2 and 3, below, and it more than provides for basking sites for frogs and toads.

2. Of the total herbaceous biomass produced within the area encompassed by a perimeter 10 feet above the high-water mark (as meaured horizontally) of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of the vegetated portion of the area except in wetlands in which emergent and shoreline vegetation cover less than half this area; then 70-100% is retained across ≥95% of the vegetated footprint.

3. Of the total herbaceous biomass produced within 1/3 mile of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of each major vegetation type grouping (wetland/wet meadow/moist meadow; meadow-willow/willow-herb; and silver sagebrush/shrubby cinquefoil communities), except where important summer habitat is identified for either species beyond the 1/3 mile perimeter and if livestock grazing is permitted in these areas, a minimum of 70% retention of herbaceous vegetation should be applied to 80% of each major vegetation type grouping within the larger area.

   Given the strong push from livestock interests to reduce the low-end herbaceous retention threshold from 70% to something lower, it is important to recognize that **retaining ≥70% of herbaceous vegetation across ≥80% of frog and toad habitat is consistent with principles of multiple-use management**. While areas ungrazed by livestock are more suitable for spotted frogs and boreal toads (and riparian wildlife overall) than areas grazed by livestock, with a minor exception, (1) the low-end threshold of suitable herbaceous retention was lowered to accommodate livestock grazing under the concept of multiple use; (2) there is only a moderate amount of scientific information that supports a minimum threshold of 70% for spotted frogs and boreal toads (and for riparian wildlife overall), and there is little information supporting a lower low-end threshold (e.g., ≥60%); (3) the ≥70% retention threshold is within limits established by contemporary range management (Figure 3); and (4) the suitable condition statement allows for as much as 20% of habitat to have <70% herbaceous retention to further accommodate livestock grazing use.

   This suitable condition statement generally would not apply to small patches of the identified vegetation types in wide valley bottoms where (1) dense willow communities are extensive and comprise ≥90% of the acreage, (2) willow canopy cover is at natural levels or relatively natural levels, (3) herbaceous species composition in the understories is at or near the potential species composition, and (4) extensive trail networks in willows do not exist.

   Where nonnative bluegrass species such as Kentucky bluegrass dominate plant communities and/or understories across more than 20% of any given major vegetation type grouping within 1/3-mile of a breeding site, additional measures may be needed to ensure that habitat remains suitable for spotted frogs and boreal toads while also accommodating livestock grazing in the area to the extent possible.

4. Of the total herbaceous biomass produced within 1/3 mile of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of the area encompassing grassland, big sagebrush, mountain shrubland, aspen, and open conifer forestland communities.

The four suitable condition statements are listed in priority order, recognizing that upland habitats are increasingly being recognized as important for restoring and sustaining amphibian populations (Skelly et al. 1999, Marsh and Trenham 2001, Pilliod et al. 2002). Attainment of suitable condition statements 2-4 would result in suitable condition statement 1 being attained.

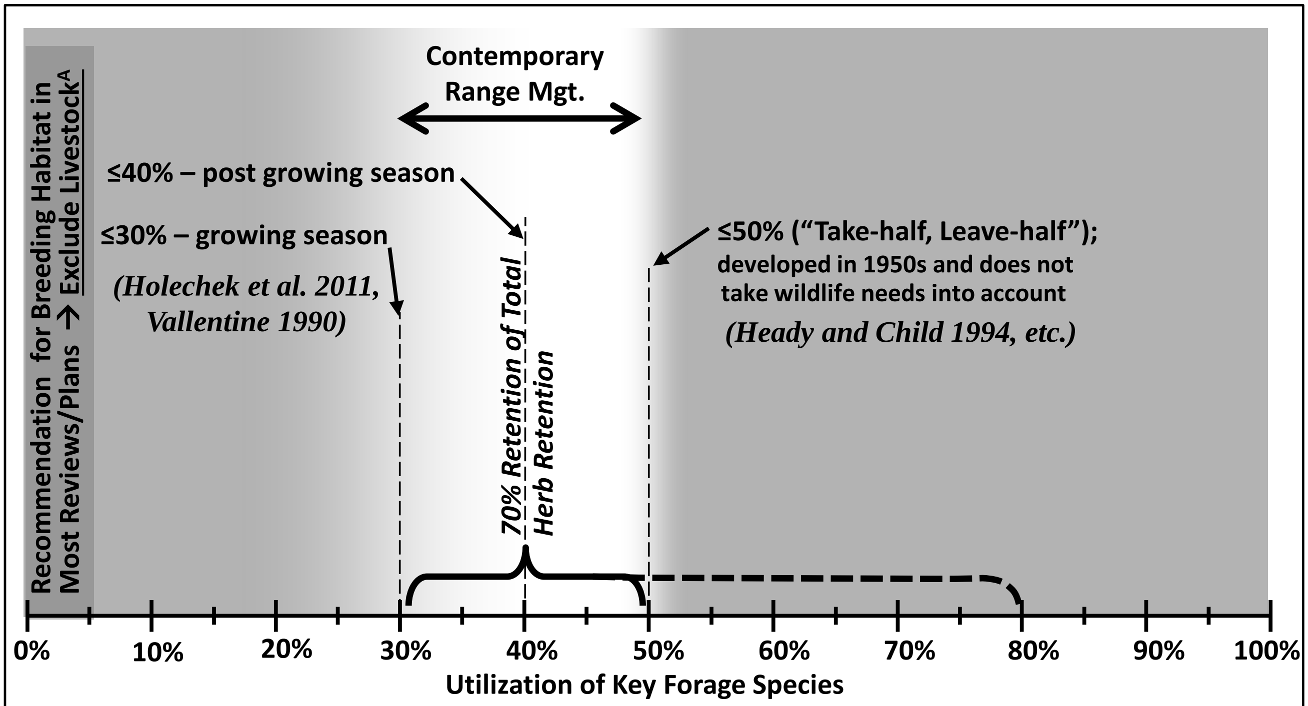

Figure 3. Conceptual illustration showing the relationship between 70% retention of total herbaceous vegetation and (1) exclusion of livestock grazing (i.e., near 0% utilization as measured in the fall) and (2) utilization limits being applied in contemporary range management. The dashed line extending from 50% to 80% use of key forage species indicates that 70% herbaceous retention can equate to as high as 80% use of key forage species, but these high use rates of key forage species are unlikely where use of total herbaceous vegetation is limited to 70%.

[A] Use of fencing to exclude livestock from habitat of spotted frogs, boreal toads, and related species was identified as a possible management action in several documents (*Bartelt 2000, Maxell 2000, Engle 2001, Loeffler et al. 2001, Patla 2001, Hogreffe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Schmutzer et al. 2008, Pilliod and Scherer 2015*).

The two geographic scales identified in suitable condition statements (breeding wetlands/shorelines and habitat within 1/3 mile of breeding sites) are important for several reasons. First, if 70% retention across 80% of the area is only applied at the 1/3-mile scale, the 20% of the area allowed to drop below 70% retention could include breeding wetlands, which is unacceptable. The 1/3-mile scale is important because this encompasses habitat for three-quarters or more of the frogs and toads in individual populations following breeding. It also has the potential to include additional breeding areas that have not yet been discovered.

The suitable condition statements are tied to "known existing and historic breeding sites having capable wetland habitat" because it is important to apply the objectives to existing breeding sites and potential future breeding sites, but it also needs to be recognized that applying the part of the objectives dealing with herbaceous retention across all capable habitat may be stretching the requirements for sensitive species since no determinations have been made at the BTNF level that these or similar retention levels are needed for native wildlife-communities as a whole.

Suitable herbaceous species composition is paramount to the identified minimum retention level of 70%. To the extent that pre-grazed herbaceous species composition (as driven by plant species composition, as well as plant vigor and soil moisture) does not approximate a natural height and density for the given site, retention levels would need to be incrementally higher than 70%.

Because dry years compound the effects of multiple stressors, it is particularly important to meet suitable conditions in all years in the lower 25 percentile of growing-season precipitation.

The retention levels identified in suitable condition statements are most directly applicable to emergent marsh, wet meadow, moist meadow communities, silver sagebrush, shrubby cinquefoil, meadow-willow (meadow with low percent canopy cover of willows) communities, and short-willow communities. Herbaceous retention is of relatively little importance where canopy cover of moderately tall to tall willows is high (e.g., ≥80% canopy cover) because willow canopy cover retains humidity and helps moderate ground-level temperatures. Furthermore, herbaceous vegetation is naturally limited under such willow canopies and it is virtually not possible for cattle to venture into stands that are this thick (i.e., herbaceous retention levels have little applicability).

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

Meeting other suitable condition statements would not help meet suitable retention levels. While meeting suitable conditions for surface-water duration (B.2), soil looseness (B.4), and survival as affected by livestock trampling (C.1) may mean that suitable retention levels are being maintained in some situations, this is likely would not always occur. There likely will be situations where suitable conditions for B.2, B.4, and C.1 are being maintained but suitable retention levels are not maintained.

Risk Factors and Restoration Factors

Of the large number and variety of ways in which livestock grazing and trampling affect spotted frogs and boreal toads, nearly all cause negative effects and a small minority have the potential to benefit these species. There is no indication **—** including no scientific studies **—** that livestock grazing and trampling that opens extensive stands of dense emergent vegetation or that creates small opening for basking even remotely offsets the large number and variety of negative impacts of livestock grazing and trampling.

Landscape Context

Just as it is important to recognize the overrepresentation of late-seral conifer forestlands in assessing risks of logging, fire, and forest management on wildlife, it is important to recognize the underrepresentation of herbaceous vegetation at a wide range of scales when assessing the risks of livestock grazing on wildlife that depend on or are associated with herbaceous vegetation.

At that landscape scale, herbaceous and shrub-herb habitat has been lost to agricultural cropland, seeded pastureland, housing developments, reservoirs, roads, and changes in hydrology. Most habitat loss has occurred on private lands. Overrepresentation of late-seral forestland and shrubland has further reduced the amount of herbaceous communities. On lands that still support native or relatively native herbaceous and shrub-herb communities, several factors have reduced herbaceous species composition and herbaceous production, including increased shrub canopy cover, increasing conifer canopy cover, conversion to lower-producing communities like Kentucky bluegrass, and reduced vigor due to factors such as a history of heavy grazing pressure. Compounding these factors further is the removal of herbaceous vegetation through mowing and grazing.

Reductions in Height and Structure of Herbaceous Vegetation

The following are among the things that can reduce the height and structure of herbaceous vegetation, which in turn limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

- ***Depleted Herbaceous Species Composition* —** Herbaceous species composition produced during the growing season is what drives the height and structure of herbaceous vegetation that is provided on any given site. The “A.4. Herbaceous Species Composition” section, above, addresses this in detail.

- ***Reduced Plant Vigor and Precipitation Levels* —** Plant vigor is affected by the history of grazing patterns and by other activities that break or damage vegetation (e.g., a pattern of repeated off road/trail motorized use and camping). Vigor affects annual production and, therefore, the height and structure of vegetation that is produced during the growing season. Precipitation levels are not affected by activities on the BTNF.

- ***Livestock Grazing Use* —** Livestock grazing use is the main factor on the BTNF, beyond those listed above, that affects herbaceous height and structure after the growing season (see Appendix A).
- ***Camping and Off-trail Motorized Use* —** Spotted frogs and boreal toads may be adversely impacted within and in the immediate vicinity of campgrounds and dispersed camping areas located within riparian zones since vegetation is smashed down, grazed (by horses), or nonexistent in heavily used areas. Thomas et al. (1979a) noted that camping areas in riparian zones reduces the amount of habitat due to loss of vegetation, trampling, and soil compaction.
- ***Grazing by Recreational, Outfitter, and Livestock Herder Horses* —** Grazing by horses have similar affects as those of livestock grazing, except in more limited areas. However, because horses associated with outfitters, sheep herders, and recreationists many times are grazed in meadows, and because some areas can be heavily grazed, potential exists for substantive effects in some places. Brown et al. (2015) identified grazing by packhorses as a major risk factor for Yosemite toads, and the potential may exist in parts of the BTNF for this to be a substantive risk factor for boreal toads and spotted frogs.
- ***Unnaturally High Populations of Native Ungulates* —** Grazing by native ungulates have similar affects as those of livestock grazing, except in more limited areas and a much smaller degree of effect. Concentrations of elk on feedgrounds, where they occur in riparian wet meadow, moist meadow, shrubby cinquefoil, and silver sagebrush communities, likely compress herbaceous vegetation, thereby reducing contributions of herbaceous vegetation to humidity retention, shading, and hiding cover in early summer. However, once vegetation begins to grow (after elk have left the feedgrounds), the only potential effect of elk concentrations on herbaceous height and structure is the effect they have on soil compaction.
- ***Fire* —** Fire greatly reduces the height of herbaceous vegetation, but the effects are short term, typically only one season. However, somewhat longer lasting effects of fire can result from effects on plant vigor, which in turn affects plant height and vegetation structure.
- ***Climate Change*** — Climate change (see the "C.5. Survival and Reproduction as Affected by Climate Change and UV Radiation" section) likely will contribute to reduced vigor and ultimately to (1) depleted herbaceous species composition (or the ability of herbaceous species composition to recover) and (2) reductions in herbaceous height caused by livestock grazing, grazing by native herbivores, camping, off-trail motorized use, and grazing by horses.

The remainder of this section focuses all factors except for the first two. Of the latter four factors, livestock grazing is the one that affects herbaceous height and structure in habitats used by spotted frogs and boreal toads to the largest degree across the BTNF and, therefore, receives the most attention in this section. Livestock grazing, camping, off-trail motorized use, grazing by horses, and unnaturally high populations of native ungulates affect the following attributes of herbaceous vegetation related to height and structure of the vegetation and livestock grazing intensity:

Height and Structure of Herb Vegetation

Retaining herbaceous vegetation is central to meeting Objectives 3.3(a) and 4.7(d) and the Sensitive Species Management Standard from the standpoint of meeting herbaceous habitat needs of spotted frogs and boreal toads. In wet meadows and moist meadows (graminoid and forb dominated) **—** i.e., where shrubs are no more than minor components **—** herbaceous vegetation constitutes the entirety of frog and toad habitat, outside of water and soil components. In silver sagebrush, shrubby cinquefoil, and meadow-willow communities, herbaceous vegetation is a major component of their habitat.

Live, upright herbaceous vegetation, when tall enough and dense enough — in combination with residual vegetation and mulch — provides for the following habitat attributes. Each of these is discussed in detail in the "Roles of Herbaceous Retention" section of Appendix A).

- ***Humidity Retention, Temperature Moderation, and Protection from the Sun*** — Moist and humid environments are important to frogs and toads because their bodies have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist (Schwarzkopf and Alford 1996, PARC 2008, Rittenhouse et al. 2008).

- ***Hiding and Escape Cover*** — Live and dead herbaceous vegetation provides visual and structural barriers that hide frogs, toads, and tadpoles from predators, increases the difficulty of predators catching frogs, toads, and tadpoles where they rest or forage, and it provides structure within which they can escape from predators.

- ***Forage for tadpoles*** — Tadpoles appear to be omnivorous, with an apparently large portion of their diet coming from decaying vegetation, making herbaceous retention in wetlands important to this phase of the life history of spotted frogs and boreal toads.

- ***Litter and Mulch*** — Another important feature of spotted frog and boreal toad habitat in herbaceous communities is the presence of well-developed litter layers and mulch. This is important in the provision of moist microsites. Lower retention levels bring with it reduced accumulations of litter, which in turn reduces the amount of mulch.

- ***Habitat for Invertebrate Prey*** — Spotted frogs and boreal toads feed on invertebrates, making suitable habitat for invertebrates a necessity for these species. As a general rule in meadows, grasslands, and shrub-herb communities, reductions in herbaceous height and structural density decline through grazing or cutting result in reductions in a wide range of invertebrate taxa, including but not limited to leafhoppers and planthoppers, leaf-miners, dragonflies and damselflies, butterflies, moths, bees, and spiders.

Other Factors Directly Related to Grazing Intensity

Percent retention of herbaceous vegetation can also play an additional role as an indicator of the extent to which the following survival/production factors are maintained at suitable or acceptable levels. This is because all of these factors are impacted proportional to the intensity of livestock use and because intensity of livestock use is highly correlated with percent retention of herbaceous vegetation, as summarized below for each factor. The importance of each factor and suitable conditions of each are discussed in more detail in pertinent sections of this report and in the “Roles of Herbaceous Retention” section of Appendix A. Monitoring each of the factors listed below, in addition to monitoring percent retention/utilization of herbaceous vegetation, would be a large time commitment compared to only monitoring percent retention/ utilization of herbaceous vegetation.

- ***Water Quality*** — Water quality is important to egg and tadpole survival, as well as to the health of juvenile and adult spotted frogs and boreal toads. As a general rule, water quality declines with increasing livestock grazing intensity in and near wetlands as a result of urination, defecation, and trampling. (See the “B.1. Water Quality” section of this report and Appendix A for more detail.)

- ***Surface Water Duration in Small Pools*** — Surface-water retention in breeding pools is critical to the successful metamorphosis of frogs and toads. If breeding wetlands dry before metamorphosis occurs, complete generations of individual populations can be lost. Drinking by livestock can artificially shorten the length of time that a given small pool maintains surface water, which has the potential to cause surface water to disappear before metamorphosis occurs. (See the “B.2. Surface Water Duration in Small Pools” section of this report and Appendix A for more detail.)

- ***Direct Mortality*** — Crushing of adults, metamorphs, and tadpoles by livestock has the potential to be a major source of mortality, depending on timing of different phases of the life history phases of individual populations and the timing of livestock use of breeding pools. (See the “C.1. Survival, as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)” section of this report and Appendix A for more detail.)

- ***Soil Compaction*** — This is an important habitat element because it affects the degree to which amphibians can burrow into soil, the degree to which small mammals can burrow into the soil (with their burrows providing possible habitat for frogs and toads), the ability of the soil to absorb water and retain soil moisture, and it also affects plant vigor and long-term herbaceous species composition. As a general rule, soil compaction increases with increasing livestock grazing intensities and the intensity of other uses such as camping and off-trail motorized use. (See the "B.4. Soil Looseness, Burrows, and Overhanging Banks" section of this report and Appendix A for more detail.)

- ***Integrity of Near-Surface Burrows and Streambanks*** — Burrows and streambanks are important for boreal toads, and the potential for burrows near the ground surface to be caved in and the potential for streambanks to collapse as a consequence of livestock traveling on banks, stepping up onto banks, and stepping down from banks is a function of the intensity of livestock use, all other factors being equal. The larger the number of livestock in a riparian area and the greater the period of time they spend in the riparian area, the greater the propensity for streambanks to become damaged. (See the "B.4. Soil Looseness, Burrows, and Overhanging Banks" section of this report and Appendix A for more detail.)

Too Much Relatively-Tall, Dense Vegetation

In a limited number of spotted frog or boreal toad breeding wetlands on the BTNF, it is possible for relatively-tall, dense emergent vegetation to become too extensive in shallow waters to allow for successful reproduction due to excessive shading and reduced growth rates of tadpoles (see the "Openings Providing Sun Exposure" section of Appendix A). Although this is a natural process (one of numerous natural factors that has the potential to negatively affect spotted frogs and boreal toads), addressing this issue in affected breeding wetlands can contribute to offsetting, by a minor degree, the many human-related and natural factors currently impacting these species.

Also, basking microsites may not be available to spotted frogs and boreal toads in extensive stands of relatively-tall, dense herbaceous vegetation. However, no scientific studies were found in which overly dense herbaceous vegetation reduced survival or reproduction in spotted frogs or boreal toads.

Conservation Actions to Consider

The following conservation actions would contribute to achieving and maintaining suitable conditions outlined in the "Suitable Condition Statements," above and, therefore, achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads.

The Forage Utilization Standard of the Forest Plan requires site-specific utilization levels to be developed during allotment management planning that are needed *to meet* Forest Plan objectives. The standard requires this be done "During AMP revision," meaning that available information (i.e., this report with respect to sensitive amphibians) must be used to define utilization limits rather than taking an approach like starting with an etxisting utilization limit or setting a utilization limit based on criteria other than meeting Forest Plan objectives relative to DFC direction, and then adapting based on planning monitoring.

I. Livestock Grazing and Horse Grazing — Actions to Reduce or Minimize Negative Effects

1. If utilization is measured or estimated in terms of total herbaceous vegetation, limit utilization to a maximum 30% use of total herbaceous vegetation, as measured at the end of the grazing period for each pasture or, if season-long grazing, as measured periodically through the season (e.g., late July, early September) and the end of the livestock grazing season. See the "Measures and Indicators" section for more detail.

2. If utilization is measured or estimated in terms of key forage species, the comparable maximum utilization limit for key forage species will need to be determined for each site (as described in the "Measures and Indicators" section), and this would need to applied at the end of the grazing period for each pasture or, if season-long grazing, as measured periodically through the season (e.g., late July, early September) and the end of the livestock grazing season. A minimum 70% retention of total herbaceous vegetation translates broadly to a maximum 30-50% utilization of key forage species (possibly up to as high as 80% use), but this is a wide range. If composition of key forage species and percent utilization of non-key-forage species are not known, a maximum of 30% utilization of key forage species should be

applied in sedge communities where sedge species are identified as key forage species, and a maximum 35% utilization of key forage species should be applied where there is a diversity of grasses, sedges, and rushes. For horses, a maximum 30% utilization should be used since they have larger impacts at comparable utilization levels.

<u>Important</u> — If the relationship between retention of total herbaceous vegetation and utilization of key forage species is not determined with site-specific data or if the composition of key forage species is not determined on a site-by-site basis, a maximum of 35% or 40% use of key forage species should be implemented until such relationships are determined. The latter should only be used if it can be reasonably assured that the composition of key forage species, in terms of biomass, is at least 50% of the total biomass of annual herbaceous production. Risks involved are illustrated by the following example. If a maximum of 40% utilization of key forage species is implemented without calibrating based on composition and utilization of non-key forage species, this could result in retention levels as low as 60% or 50%, respectively, for total herbaceous vegetation in some situations (Appendix B).

3. If minimum stubble heights are used as a means to meet the objective in wet meadows, height-weight information needs to be consulted (e.g., Kinney and Clary 1994, BLM et al. 1999) to ensure that 70-100% retention of total herbaceous vegetation is maintained. As examples, information in Kinney and Clary shows that a minimum average stubble height of about 8-10 inches would be needed to maintain a minimum retention of 70% of total herbaceous vegetation where pre-grazed heights of beaked sedge and/or water sedge is about 15-20 inches (DeLong 2009b:84). This needs to be measured at the end of the grazing period for each pasture or, if season-long grazing, measured periodically through the season (e.g., late July, early September) and the end of the livestock grazing season.

4. If utilization limits based on suitable retention levels are exceeded in a given year, district personnel will need to meet with the permittee(s) to discuss reasons for not meeting the utilization limit and what would be done differently to ensure that it is met.

5. Herding, fences, developed water sources away from breeding sites, and salt placement can be used to reduce use of streambanks by livestock. However, some of these (more intensive herding and development of water sources) can have adverse impacts on spotted frogs and boreal toads and, therefore, would need to be carefully considered. Place all salt and mineral supplements at least ¼-mile from live streams, springs, and wetlands.

6. Livestock grazing systems can be adjusted. For example, changes from season long grazing to deferred rotation, rest rotation, or other system.

7. Where sheep water in wetlands used by spotted frogs or boreal toads for breeding, ensure they only use the water source no more than one time each season.

8. Additional measures may need to be taken to ensure that no more than 20% of area occupied by herbaceous vegetation in and around breeding wetlands (<70% retention of herbaceous vegetation) for watering is impacted by watering sheep.

9. Fenced exclusion of livestock from breeding pools may need to be implemented where suitable retention levels are not being maintained through the management of livestock grazing use. This should be used as a last resort. Where breeding sites are fenced, a minimum 100 ft. buffer around wetlands needs to be included within the fenced exclosure (100 ft. from the edge of the wetland to the fence). An alternative could be to make the fenced area to manage it as a riparian pasture where grazing can be more closely managed.

10. Especially in areas dominated by nonnative bluegrasses and smooth brome, limit livestock grazing to one time period each season and limit the season of use in each area to a small number of weeks (e.g., no more than 2-4 weeks). The purpose of this is to reduce the re-grazing of native grasses and sedges (e.g., Nebraska sedge; Youngblood et al. 1985) that may otherwise increase in abundance and canopy cover.

Without this conservation action, cattle will revisit and re-graze vegetation in these sites many times, which can reduce vigor and survival of native grasses and sedges.

11. In breeding wetlands with relatively low percent canopy cover of herbaceous wetland vegetation or relatively short herbaceous vegetation, the minimum of 70% retention across at least 80% of the area may need to be adjusted to reduce the use of vegetation. Given the already low percent canopy cover and/or short stature, a minimum of 75%, 80% or 85% retention may be needed.

II. Creating Openings to Allow Sun Exposure

1. In breeding wetlands in which relatively-tall emergent vegetation is determined to be too extensive in shallow waters — especially on northern shorelines — to allow sufficient egg and tadpole development (due to excessive shading), consider options, including a-c below. Prior to implementation, a prescription to meet site-specific objectives would be needed, just like is done for any other vegetation treatment project on the BTNF.
    a. No action, as the expansion of emergent vegetation in shallow water is a natural process and grazing and trampling by native ungulates likely was limited in most breeding wetlands prior to the era of livestock grazing.
    b. Mowing or use of gas-powered weed-eaters in parts of breeding wetlands identified as favorable to egg-laying and tadpole development that are overgrown with relatively-tall, dense emergent vegetation. Repeated mowing/clipping likely would be needed during the growing season. Trampling by workers while mowing/clipping would likely help to retard growth on the designated sites.
    c. Periodic heavy livestock grazing and trampling. Because of the large number of negative impacts that can occur with this use, its use needs to be highly prescriptive, including the implementation of design features to minimize adverse effects. Fencing would best assure that grazing and trampling impact the portion of the wetland needing the treatment. Note: no scientific studies were found in which the effects of livestock grazing and trampling on opening emergent stands were studied.
2. Periodic light livestock grazing can create small open patches exposed to the sun, for basking by frogs and toads, in otherwise dense herbaceous vegetation. Prior to implementation, however, existing conditions would need to be evaluated on a case-by-case basis to determine if this action is needed and to develop a prescription to meet objectives (just as is done for any other vegetation treatment on the BTNF). A utilization rate of about 20% of herbaceous vegetation would be sufficient to create small open patches. Note: no scientific studies were found in which the effects of livestock-created open patches on spotted frogs or boreal toad survival were studied.

III. Recreation

1. Enforce the existing special order that prohibits dispersed camping within 100 feet of streams, and this should be extended to include frog and toad breeding wetlands as well.
2. Provide educational signs or pamphlets, at recreational sites near known breeding sites, about spotted frogs and how they could be impacted by recreationists and their pets.
3. In some situations, breeding sites may need to have stronger restrictions to prevent trampling and matting of vegetation near breeding sites and in other habitat used by spotted frogs and boreal toads.

Measures and Indicators

This section identifies monitoring to address suitable conditions outlined in the "Suitable Condition Statements," above. The suitable condition statements identify a range of retention levels that would provide suitable habitat conditions in and immediately around breeding wetlands. Even though no numbers are provided for suitable conditions for herbaceous retention within 1/3-mile of breeding sites, it calls for suitable herbaceous retention levels. Because there is no information showing that 50% retention of total herbaceous vegetation provides suitable habitat for spotted frogs and boreal toads and because little or no information shows that 60% retention provides suitable habitat, a minimum of 70% retention of total herbaceous vegetation is needed to provide suitable habitat conditions for these species.

Another possible way to express the retention of suitable herbaceous vegetation conditions and survival elements is the percent change in Robel pole readings before and after grazing. Because of the tight connection between percent retention and the percent change in Robel pole readings, it would be possible to determine a minimum percent change in Robel pole readings that reflects a minimum of 70% retention of total herbaceous vegetation. This would also allow for two or three different categories of minimum percent change, which would help address the reduced applicability of a minimum of 70% retention in short communities (i.e., it would be more meaningful to have a higher retention level and lower percent change in Robel pole readings in shorter communities).

There has been strong encouragement to come up with a minimum stubble height or a minimum Robel pole reading rather than using percent retention. No attempt is made in this report to identify such a minimum measure. This is discussed further in Appendix A.

The following monitoring methods address percent retention/utilization.

Currently Monitored Elements

Range management specialists currently monitor the following retention/utilization elements, but locations of monitoring sites may need to be adjusted and establishment of additional sites may be needed. Measuring or estimating herbaceous utilization (or, actual use) is the flip-side of measuring or estimating retention.

- <u>Percent Retention or Utilization of Total Herbaceous Vegetation</u> – Monitoring retention or utilization of total herbaceous vegetation is preferred, from the standpoint of spotted frogs and boreal toads, because no conversions or crosswalks are needed with respect to determining whether retention is above or below 70%.

  Clipping and weighing is a standardized method for measuring percent retention/utilization of total herbaceous vegetation and the landscape appearance method is a standardized approach to estimating percent retention/utilization of total herbaceous vegetation (BLM et al. 1999, BLM et al. 2008). Even though output of the landscape appearance method described in BLM et al. (1999) and BLM et al. (2008) is utilization, the criteria for estimating percent utilization are all based on characteristics of retained vegetation. In other words, the most direct output of the landscape appearance method actually is percent retention of total herbaceous vegetation.

  Note that suitable condition statements 2-4 are expressed as minimum percent retention, not as minimum average percent retention. This means that no part of the 80% portion of breeding wetlands and no part of the 80% portion of the 1/3-mile buffer can have a retention level of less than 70%. "Part" is not specifically defined in the suitable condition statements and it depends on the geographic scope. As a starting point, "part" in the context of breeding areas should be looked upon as no larger than roughly 300 square feet (a radius of about 10 ft.) and in the context of the surround 1/3 mile as no larger than roughly 10,000 square feet (i.e., a radius of roughly 60 ft.). An *average* of 70% herbaceous retention within the 80% portion would allow for some sites to be have <70% retention, which conflicts with the intent of the suitable condition statements. All parts of the 80% portion must retain 70-100% of the herbaceous vegetation.

  Several adjustments need to be made to the landscape appearance method outlined in B LM et al. (1999) and BLM et al. (2008):

  - In the landscape appearance method, the percent of seedstalks remaining in the 21-40% and 41-60% use categories were (1) inconsistent with available information, some of which was cited in BLM et al. (2008); and (2) had a large, unexplained gap between the two categories. Remaining seedstalks in the 21-40% category was identified as 60-80%, and for the 41-60% category remaining seedstalks was identified as 15-25%, which is a gap of nearly 50%! Resolving this problem is important in being able to accurately estimate utilization levels. Percent of seedstalks remaining is a key characteristic used in estimating utilization.

For 21-40% utilization, remaining seedstalks should be 35-80%.

For 41-60% utilization, remaining seedstalks should be 15-50%.

- ▫ For spotted frogs and boreal toads (and a range of other wildlife species), there is a need to be able to distinguish between sites having ≥70% retention of total herbaceous vegetation and sites having <70% retention. This could involve splitting the 21-40% use (60-79% retention) category into two categories each having a range of about 10%, or creating two categories having a range of about 20% each: 11-30% use (70-89% retention) and 31-50% use (50-69% retention).
- ▫ For spotted frogs and boreal toads (and a range of other wildlife species), there is a need to be able to distinguish between sites having ≥50% retention of total herbaceous vegetation and sites having <50% retention (e.g., nonnative bluegrass sites). This could involve splitting the 41-60% use (40-69% retention) category into two categories each having a range of about 10%, or creating two categories having a range of about 20% each: 31-50% use (50-69% retention) and 51-70% use (30-59% retention).

- Percent Retention or Utilization of Key Forage Species – If utilization is measured or estimated solely in terms of key forage species, results will need to be converted to percent retention of total herbaceous vegetation. Without site-specific data on the percent composition of key forage species (relative to the total herbaceous biomass), the estimated percent retention of total herbaceous species based on crosswaks will necessarily be expressed in a fairly wide (Appendix B). To narrow this range will mainly require accurate estimates of the composition of key forage species relative to the total herbaceous composition and the range can be further narrows with accurate estimates of the utilization rate on non-key plant species as a whole. With this information, Appendix B can be used to estimate percent utilization of total herbaceous vegetation, which then translates directly to percent retention of total herbaceous vegetation.

  If only one plant species is designated as a key forage species (e.g., Idaho fescue) and if other species are preferentially eaten by livestock in addition to the one selected key forage species for monitoring, the relatively high percent utilization rate of species not designated as key forage species needs to be accounted for. This can be done by either (1) re-estimating percent use of *all* key forage species, or (2) elevating the estimated percent use of "non-key" forage species in order to more accurately account for the total average use of all species not designated as key forage. Assurance must be made that the maximum utilization level of key forage species results in a minimum of 70% of total herbaceous vegetation being retained.

  Two examples help to illustrate the crosswalk between key forage species and total herbaceous vegetation. If composition of a designated key forage species is 50%, by dry weight, of the plant community as a whole, and if 15% of the total dry weight of non-key forage species (the combination of all species not designated as key forage) is consumed, a maximum 45% use of key forage species would be needed to retain a minimum of 70% of total herbaceous vegetation (Appendix B). If, on the other hand, composition of designated key forage species is as high as 90% (e.g., if beaked and water sedge are designated key forage species in a sedge meadow) of the plant community, and if 20% of the total dry weight of non-key forage species is consumed, a maximum of about 30% use of key forage species would be needed to retain in a minimum of 70% of total herbaceous vegetation.

  Note that the landscape appearance method in the *Wyoming Rangeland Monitoring Guide* (BLM et al. 2008) does not provide an estimate of percent utilization of key forage species; rather, it provides an estimate of the percent utilization of total herbaceous vegetation. If the landscape appearance method is used, no conversion is necessary to estimated percent use/retention of total herbaceous vegetation. Also, if all herbaceous species are clipped and weighed in an effort to estimate percent use/retention through clipping-and-weighing, no conversion is needed because this technique would result in an estimate of percent use/retention of total herbaceous vegetation.

- Stubble Height on the Green-line – While this is a possible proxy for percent retention of total herbaceous vegetation, changes in stubble height on streambanks appears to change at different times and rates than in plant communities away from streambanks (e.g., for some plant communities, retention levels can be relatively low by the time sedges along the green-line are grazed to any appreciable extent). Therefore, stubble height on the green-line does not appear to be a meaningful proxy.

Additional Monitoring Elements to Consider

The following methods have potential for use in monitoring changes in the height and structural diversity of herbaceous vegetation:

- Visual Obstruction – Visual obstruction can be monitored in a variety of ways, including through the use of a Robel pole (BLM et al. 1999). Pre-grazed and post-grazed horizontal cover would be needed in order to determine the percent change. Given available information (see Appendix A), there currently are no identified minimum thresholds for visual obstruction or Robel pole readings, and there are some important limitations to taking this approach (see the "Why Percent Retention is the Subject of Suitable Conditions and not Height, Biomass, and Structural Density" section in Appendix A for more details).

- Stubble Height away from the Green-line – Monitoring stubble height away from the green-line currently is not being done on the BTNF. The percent change from pre-grazed to post-grazed stubble height in and surrounding breeding wetlands and other wetland habitats, as well as in wet meadow, moist meadow, and silver sagebrush habitat (i.e., not on the green-line), can be used in place of monitoring percent retention of total herbaceous vegetation. This has particular application to sedge communities, which typically are grazed in a "top-down" process. Height-weight ratios have been developed to aid in this approach (Kinney and Clary 1994).

  In contrast, percent change in the pre-grazed and post-grazed height of vegetation may have limited application in graminoid communities, as cattle typically bite near the bottom of plants (McKinney 1997), which results in large differences in the heights of grazed and ungrazed parts of plants where cattle graze in these plant communities. Patchworks of short and tall vegetation results. This in turn makes it difficult to determine average stubble heights. More importantly, averages in these types of situations have little biological relevance (e.g., 50% of the basal area of plants grazed to 3 inches and 60% left ungrazed or lightly grazed at 12 inches produces an average height of 7.5 inches).

B.4. SOIL LOOSENESS, BURROWS, AND OVERHANGING BANKS

Introduction and Background

Boreal toads and spotted frogs, especially the former, make use of small mammal and other burrows, are known to self-excavate shallow depressions, and use overhanging banks (Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006). These features can be important for thermoregulation and for maintaining body fluids, and for hiding from predators. Soil looseness also influences herbaceous species composition and height (see the "A.4. Herbaceous Species Composition" section). Of all locations of boreal toads in Bull's (2006) study, 18% were located in burrows, and another 8% were in self-excavated depressions; she also found that toad locations were significantly closer to burrows (average of 32 yards) than random locations (average of about 405 yards). In a study by Bartelt (2000 as cited in Patla 2001), boreal toads inhabited underground burrows over 26% of the time. Similarly, in a study by Long and Prepas (2012), 23% of refugia (humid microsites) used by boreal toads consisted of burrows, and nightly straightline distances from refugia ranged from 26 to 59 feet per night.

Soil compaction resulting from livestock grazing, recreation, and logging can prevent frogs and toads from burrowing underground to prevent desiccation or freezing (Douglass et al. 1999, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006), has the potential to hinder movements of spotted frogs (Engle

2001), and can reduce the availability of rodent burrows used by toads for summer microclimates (Bull 2006) and as over-winger hibernacula (Keinath and McGee 2005, Bull 2006). Soil compaction also contributes to reduced water infiltration and soil moisture and increase daytime soil temperatures and evaporation (Thurow 1991, Yates et al. 2000), which can contribute to reductions in near-ground humidity levels in herbaceous vegetation already reduced by depleted vegetation cover, which in turn can reduce the suitability of microsites for amphibians. Other factors that can contribute to drying of the ground — for example, major reductions in the shade-bearing canopy of herbaceous vegetation, whether due to a decline in plant species composition over time or to motorized use or livestock grazing in any particular year — has the potential to compound this effect, especially during dry, hot summers.

Overhanging banks are used by some spotted frogs and boreal toads for shade and for hibernation (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005). The prevalence of overhanging banks is a function of streambank stability (a long-term attribute) and streambank shearing (an annual indicator). Streambank stability indicates the overall degree to which overhanging banks are provided and sustained over the long term, and the extent of streambank shearing in any given year indicates the degree to which existing overhanging banks may have been caused to collapse.

Development of Suitable Condition Statements

Summary of Direct and Indirect Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan and Forest Service policy require the Forest Service to restore and maintain satisfactory soil looseness and to protect streambanks, and to conserve habitat of sensitive species and to protect sensitive species from harm. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to soil looseness, burrow habitat, streambank habitat. Desired levels of soil looseness have not yet been defined for the BTNF.

> ***Goal 4.7 (Forest Plan) —*** "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreation values or experiences."
>
> > ***Objective 4.7(a) —*** "Retain or improve forage and overall range condition."
> >
> > ***Objective 4.7(b) —*** "Retain or enhance riparian vegetation, stream-channel stability, sensitive soils, and water quality where livestock are present."
>
> ***Vegetation: Range Prescription (Forest Plan)*** — "Forage is provided on a sustained-yield basis that protects rangeland values, wildlife habitat, and meets other resource needs. All practices available can be used to improve forage supplies and quality."
>
> ***Riparian Areas, Wetlands, and Floodplains Prescription (Forest Plan)*** — "These areas are managed as basic resources for forest management, key to the future productivity of the Bridger-Teton National Forest."
>
> ***Avoidance of Productivity Loss Standard (Forest Plan) —*** "Analysis will be made ."
>
> ***Livestock Grazing of Riparian Areas Standard (Forest Plan)*** — "Livestock grazing in riparian areas will be managed to protect streambanks. This may be achieved through the use of gravel crossings, tree-debris barriers, fencing, riparian pastures, development of alternative watering sites out of the riparian area, longer allotment rests, or improved livestock distribution..."
>
> ***Streambank Stability Guideline (Forest Plan)*** — "At least 90 percent of the natural bank stability of streams that support a fishery, particularly Threatened, Endangered, and Sensitive species, and all trout species, should be maintained. Streambank vegetation should be maintained at 80 percent of its potential

> natural condition or an HCI rating of 85% or greater. Streambank stability vegetation and fish numbers and biomass should be managed by stream type."
>
> ***Restoring Stream Channel Guideline (Forest Plan)*** — "Areas where human activities have resulted in adverse impacts such as channel widening, aggradation, or lowering of the water table should be restored."
>
> ***FSM 2550.2*** — "Maintain or improve soil quality on National Forest System lands to sustain ecological processes and function so that desired ecosystem services are provided in perpetuity."
>
> Soil quality is defined as "The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation and ecosystem health. There are two aspects of the definition: inherent soil quality and dynamic soil quality" (FSM 2550.5).
>
> ***FSM 2550.3*** — "Responsible soil stewardship promotes and sustains biological and hydrologic function on National Forest System lands" and policy requires that forest and range ecosystems are managed "…to maintain or improve soil quality."

Estimated Natural Conditions

Natural conditions for his element consist of the soil looseness and prevalence of burrows and overhanging banks that existed prior to Euro-American settlement and that would exist today in the absence of human activities that affect these elements. While the range of natural conditions for this element does not encompass the entirety of suitable conditions for spotted frogs and boreal toads (e.g., suitable conditions also encompass soils of higher compaction), natural conditions are encompassed within the range of suitable conditions for these species since these are the conditions under which amphibian communities formed or developed in this area.

There are three main reasons why natural levels of soil looseness, burrows, and overhanging banks are important contributors to suitable habitat conditions for spotted frogs and boreal toads on the BTNF. First, relatively loose soils, burrows, and prevalence of overhanging streambanks are important to boreal toads and possibly spotted frogs. Soils that have loose enough structure to accommodate small mammal burrowing is important to boreal toads and soils and a litter/mulch layer that have loose enough structure to accommodate shallow burrowing by spotted frogs and boreal toads helps prevent desiccation and allows them to better regulate body temperature (Maxell 2000, Bartelt 2000, Keinath and McGee 2005, Bull 2006). It is not uncommon for a boreal toad population to spend as much as 18-26% of their time in burrows created by small mammals (Bartelt 2000, Bull 2006). Compacted soils can hinder burrowing by small mammals. Overhanging/undercut streambanks provide important hibernacula for spotted frogs and possibly boreal toads (Maxell 2000, Keinath and McGee 2005), and overhanging banks likely also provide moist micro-sites and protection from the sun and from predators during the summer.

Second, a *natural* level of soil looseness, burrows, and overhanging banks contributed to high quality habitat for spotted frogs and boreal toads in the BTNF area. A natural level of soil looseness, burrows, and overhanging banks likely represents the upper end of what can realistically be produced and sustained in the BTNF area, given a site's elevation, soil types, natural production of vegetation, aspect, slope, climate conditions, and natural populations of small mammals and herbivores. There likely are no sites that currently provide looser soils or more burrows or overhanging banks than occurred prior to Euro-American settlement.

No attempt was made to estimate a natural level of soil looseness/porosity or a natural amount or density of burrows and overhanging banks, in part given the wide range of natural soil conditions among the large number of soil types , natural variability within soil types, wide range of natural amounts/densities of overhanging banks relative to stream type and other factors, and the close ties between this element and streambank stability, which was addressed in detail in "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat." Also, indices of soil looseness are provided in the "Deviations from Estimated Natural Conditions to Accommodate Other Uses" subsection, below.

Third, amphibian communities formed or developed in this area with a natural level of soil looseness, burrows, and overhanging banks.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the coarse-filter approach of approximating the soil looseness, burrows, and prevalence of overhanging banks that existed naturally in order to meet Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to these species. This is because (1) natural soil looseness, burrows, and prevalence of overhanging banks represents conditions under which amphibian communities formed or developed in the BTNF area; (2) natural soil looseness and prevalence of burrows and overhanging banks would be favorable to spotted frogs and boreal toads compared to existing conditions where soil compaction is more prevalent and burrows and overhanging banks are less prevalent than existed naturally; and (3) upward trends toward a natural soil looseness and prevalence of burrows and overhanging banks, where they currently are below natural levels, would not adversely affect spotted frogs and boreal toads relative to existing conditions.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, and given some of the inherent limitations of attaining and maintaining fully-natural soil looseness and prevalence of burrows and overhanging banks under uses like livestock grazing, motorized use, dispersed camping, and timber harvest, it likely will be necessary to accommodate some degree of deviations from natural conditions caused by these uses. However, lowering the bar on soil looseness and prevalence of burrows and overhanging banks can only be accommodated to the extent suitable soil looseness, burrows, and overhanging bank conditions are still provided for spotted frogs and boreal toads.

Some level of compaction above-and-beyond natural levels is acceptable (e.g., compaction elevated by a minor amount and higher compaction on small localized sites), so long as this does not inhibit small mammal burrowing and the ability of toads and frogs from being able to get under duff and loose soil, does not inhibit plant growth and vigor, and does not measurably reduce percolation except possibly on small localized sites.

The total amount of walking/running that is done by livestock, which directly affects soil compaction and extent of burrow collapsing, is proportional to the intensity of grazing (utilization rates)[T] and, therefore, is inversely related to the amount of herbaceous vegetation retained, as well as the amount of herding that is used to manage livestock distribution. Retention of herbaceous vegetation in a given area is mostly a function of the number of livestock and the amount of time they spend in the area. Therefore, the degree of soil compaction is managed concurrently with vegetation retention levels and, in fact, can be managed through the management of retention levels. Retention of ≥70% of total herbaceous vegetation should alleviate soil compaction issues, compared to lower retention levels, for example ≤60% retention (see the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section). Furthermore, reduced litter cover, reduced organic content of soils, and reduced moisture-holding capacity of soils — all of which decline with lower retention levels (Thurow 1991, Molinar et al.2001) — can compound the effects of livestock walking and running. Retaining ≥70% of total herbaceous vegetation would minimize these compounding factors, as compared to lower retention levels (e.g., ≤60% retention). Areas that receive higher levels of grazing pressure, especially >40% utilization of total herbaceous vegetation (<60% retention) would have a higher probability of less-than-satisfactory soil looseness and porosity. The basis for this is discussed further in the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section.

The targeted amount or proportion of overhanging streambanks also needs to be adjusted downward to accommodate livestock grazing use while making sure the targeted level meets the needs of spotted frogs and boreal toads. This can be done by using streambank stability and streambank shearing as indicators of the

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[T] It is recognized that the degree of soil compaction is dependent on soil type, soil moisture, and other factors; e.g., effects of walking/running are greater at high moisture levels. Nonetheless, effects are proportional with any given soil type, soil moisture level, etc.

prevalence of overhanging banks, and by using suitable streambank stability levels identified in Table 3 and a maximum streambank shearing guideline of 20%.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions of suitable conditions are written qualitatively and are founded primarily on the concept of managing livestock grazing use, horse grazing, and dispersed camping (and uses with similar impacts on soil looseness and prevalence of burrows and overhanging banks) in ways that minimally affect soil looseness, burrow availability, and prevalence of overhanging banks.

1. Soil that has a sufficiently loose and crumbly structure to not inhibit plant growth and that allows infiltration of water, relative to the natural potential of the site (i.e., the potential of the site when at natural conditions) and while accommodating small deviations (e.g., within 90% of natural) to allow for some level of use. Some level of compaction above-and-beyond natural levels is acceptable (e.g., compaction elevated by a minor amount and higher compaction on small localized sites), so long as this does not inhibit small mammal burrowing and the ability of toads and frogs from being able to get under duff and loose soil, does not inhibit plant growth and vigor, and does not measurably reduce percolation except possibly on small localized sites.

2. Within 1/3-mile of known boreal toad breeding sites and known historic breeding sites with capable habitat, an relatively-natural density of small mammals burrows is maintained through summer and fall months into the winter, relative to habitat conditions that would naturally exist for small mammals. This includes retaining a large majority of small mammal burrows through summer months (i.e., not collapsed by recreationists, livestock, horses).

3. Amount or proportion of overhanging streambanks that would occur when streams are at proper functioning condition, including when bank stability is ≥90% of natural[U] (i.e., minimum streambank stabilities outlined in Table 3) and when streambank shearing is ≤20%.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat — Where stream channels have the potential to cut vertically or have cut vertically (or at a downward angle), conditions outlined in these suitable condition statements are important because stable streambanks maintain stream channels at properly functioning levels which in turn maintains water tables at their natural potential elevation, which in turn maintains higher soil moisture at higher levels than would occur with lowered water tables. Moist soils contribute to a looser soil structure when not walked on or trampled by large animals or driven on by vehicles.

A.4. Herbaceous Species Composition — Meeting suitable conditions for herbaceous species composition would help limit the degree to which stream channels are unnaturally scoured due to excessive overland flows and the extent to which water tables are lowered. Depleted ground cover (especially when less than about 65%) contributes to elevated rates of overland flow, which in turn can contribute to increased scouring of stream channels lower in the watershed, which in turn can result in lowered water tables or a narrower width of productive riparian vegetation.

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Retaining a minimum of 70% of the annual production of herbaceous vegetation in riparian areas and around wetlands would

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[U] This is nearly identical to the Streambank Stability Guideline of the 1990 Forest Plan.

maintain soil looseness at higher levels than at lower retention levels (it likely would allow suitable conditions for soil looseness to be met), and would reduce the potential of impacting overhanging banks, compared to what would happen at lower retention levels.

C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts) — To the extent suitable conditions with respect to survival as affected by crushing by heavy equipment are achieved, suitable conditions for soil looseness should also be achieved.

Risk Factors and Restoration Factors

The following risk factors have the potential to increase soil compaction and cave-in overhanging banks, which in turn limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

The following activities and conditions (risk factors) have the potential to increase soil compaction and adversely impact overhanging banks.

Livestock Grazing — Soil compaction is a well-documented effect of livestock in riparian areas, and it generally increases with higher levels of grazing intensity (Moore et al. 1979, Kaufman and Krueger 1984, Thurow 1991:149, Leffert 2002:24-25). Furthermore, the intensity of grazing pressure that would make soil compaction unfavorable could also contribute to trampling of streambanks under which frogs and toads hibernate. Overhanging banks are used by some frogs and toads for shade and for hibernation, and the collapsing of overhanging banks caused by livestock can impact these amphibians (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005). Soil compaction in relation to livestock grazing intensities is discussed further in the “B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter” section, below.

Several experts have expressed concern about trampling of burrows by livestock, making fewer burrows available for use by boreal toads, and about crushing boreal toads while they are in burrows (Maxell 2000, Keinath and McGee 2005).

Recreation — Dispersed camping along roads and in campgrounds, and motorized use in the vicinity of dispersed camp sites and campgrounds are other important sources of soil compaction (Douglass et al. 1999). Soil compaction resulting from camping and associated activities like off-trail motorized use and horse grazing (cumulative with livestock grazing use and other activities) can prevent frogs and toads from burrowing underground to prevent desiccation or freezing (Douglass et al. 1999, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005) and can reduce the availability of rodent burrows used by toads as over-winger hibernacula (Keinath and McGee 2005). Soil compaction also contributes to reduced soil moisture, which can reduce near ground humidity levels in herbaceous vegetation which in turn can affect the suitability of micro-sites for amphibians. Douglass et al. (1999) provides extensive documentation of off-road vehicle impacts on soils.

Dispersed camping along roads and the motorized use that accompanies this camping (e.g., cars, trucks, campers, recreational vehicles, ATVs), which oftentimes takes place in riparian areas, contributes to soil compaction in many localized places on the BTNF.

Off-road and off-trail motorized vehicles can contribute to soil compaction (Adams et al. 1982, Douglass et al. 1999, Lei 2004, Marion and Olive 2006) and can crush small mammal burrows (Luckenbach and Bury 1983).

Logging — Keinath and McGee (2005) noted that soil compaction resulting from logging operations can reduce the availability of rodent burrows used by toads as over-wintering hibernacula. Heavy equipment can crush burrows.

Altered Vegetation Composition and Vegetation Height — Dispersed camping along roads and the motorized use that accompanies this camping, which oftentimes takes place in riparian areas, contributes to altered vegetation composition and structure in these areas (Federal Interagency Stream Restoration Working Group 1998, Douglass et al. 1999). Contributing factors include motorized vehicle use (e.g., RVs, standard-sized vehicles, ATVs, motorbikes) in and around dispersed camping areas, tenting, walking, and horse grazing use.

Douglass et al. (1999) provides extensive documentation of off-trail vehicle impacts on vegetation. Widening and straightening of roads invites increased traffic and larger campers and RVs further into the national forest, which in turn can increase the amount of riparian and adjoining plant communities that are altered by intensive, localized camping pressure.

Conservation Actions to Consider

Conservation actions identified for the streambank stability portion of "A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat," and many of those identified for "C.1. Survival as Affected by Vehicles, Heavy Equipment, and Livestock" would contribute to achieving and maintaining desired conditions for soil looseness and porosity, burrows, and streambank stability.

In addition to these conservation actions, the following need to be considered:

1. Implement the Logging Method Guideline (USFS 1990b:136) and best management practices that to timber harvest projects to minimize soil compaction. These would result in potential effects on soil looseness and porosity being within an acceptable range.

Measures and Indicators

Currently Monitored Elements

Soil compaction currently is not monitored directly or indirectly, but the following currently monitored elements could be used as proxies for soil compaction, depending on the location of monitoring sites:

- Herbaceous Retention Levels – Herbaceous utilization levels (the flip-side of retention) provide a general indication of the intensity of livestock use of a site and, therefore, provides a general indication of the degree of walking and running by livestock and the potential for compacting soils and breaking-off overhanging banks. (See the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section.) Percent use of key forage species and percent use of total herbaceous vegetation is being monitored to varying degrees on different districts.

- Stubble Height on Green-line and Streambank Shearing – These elements have the potential to indicate the degree of soil compaction taking place away from streambanks, but increasingly it is being recognized that cattle can make relatively high use of sites away from streambanks before they make much use of streambanks. By the time streambanks receive substantial use, adjoining plant communities can be heavily used, making these element relatively poor indicators of soil compaction.

- Footprint of Skid Trails and Landings – The percent of the land in a harvest units occupied by skid trails and landings provide a reliable indicator of the extent of soil compaction caused by heavy equipment in harvest units and mechanical treatment units. Because one of the design criteria for timber harvest and mechanical treatment projects addresses skid trails and landings on many projects, this currently is monitored on a project-by-project basis.

The following elements related to the maintenance of streambanks are currently monitored:

- "Streambank Stability"[V] – This element is currently being monitored as part of MIM, albeit for other purposes (i.e., streambank stability and stream channel integrity, not to ascertain the degree to which cover is maintained for boreal toads). However, the degree to which banks have broken off, slumped, fractured, etc. also provides information directly applicable for assessing the maintenance of overhanging streambanks that have potential to be used by boreal toads.

[V] "Streambank Stability" is in quotes because it refers specifically to the meaning of streambank stability provided in Burton et al. (2011), which is different than streambank stability as defined in many other riparian publications. It specifically refers to stable streambanks as having the absence of breakdowns, slumping banks, bank shearing, fractures, and vertical erosion, but does not take into account unstable banks (e.g., banks with non-streambank vegetation) that do not yet show any of these signs.

- Stubble Height and Streambank Shearing – Additionally, minimum stubble heights and maximum levels of streambank shearing should also contribute to maintaining overhanging banks. Both of these elements are being monitored by hydrologists, fisheries biologists, and range management specialists on the BTNF as part of MIM.

Additional Monitoring Elements to Consider

There are no plans to directly monitor soil compaction on the BTNF, but on a case-by-case basis it could be monitored in a number of ways including:

- Water Infiltration Rates

C. HABITAT EFFECTIVENESS AND SURVIVAL ELEMENTS AFFECTED BY HUMAN ACTIVITIES

These are important elements to achieving Objective 3.3(a) with respect to spotted frogs and boreal toads, but suitable conditions for spotted frogs and boreal toads also comprise suitable conditions for a wide range of other native wildlife species.

C.1. SURVIVAL AS AFFECTED BY VEHICLES, HEAVY EQUIPMENT, LIVESTOCK, AND RECREATIONISTS (DIRECT IMPACTS)

Introduction and Background

Of all human-related factors negatively affecting spotted frogs and boreal toads on the BTNF, motorized routes, motorized use, livestock grazing, and recreation likely pose the greatest threats to these species, and crushing by vehicles and livestock are among the top reasons for this. These threats are listed in all or nearly all conservation assessments, literature reviews, and plans for spotted frogs and boreal toads.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan require the Forest Service to minimize road building in riparian areas, relocate existing roads in riparian areas outside of riparian areas where possible, limiting the footprint of heavy equipment during logging, limit livestock grazing, all of which help reduce the potential for increased crushing mortality of amphibians. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to crushing of frogs, toads, tadpoles, and eggs.

> ***Goal 4.1 (Forest Plan) —*** "Road management preserves wildlife security, soil, visual resource, and water-quality values."
>
> > ***Objective 4.1(a) —*** "Minimize new road building and downgrade or close existing roads and motorized access trails to maintain or increase wildlife security."
> >
> > ***Objective 4.1(b) —*** "Design roads and structures to retain soil, visual resource, and water-quality values."
> >
> > The Forest Challenge Statement for minimizing impacts of roads is as follows: "Wildlife security, soil values, and water quality are often affected by poorly designed or maintained roads. Frequently, BTNF users create their own "roads" by simply driving off highway. The challenge is to manage roads and their use to minimize wildlife security, soil, and water value losses. If the challenge is not met,

irretrievable loss of resources will occur through increased hunting and human-presence pressures on wildlife, soil erosion, and stream sedimentation" (USFS 1990b:80).

Goal 4.5 (Forest Plan) — "A natural or slightly modified appearance for trails and concentrated dispersed recreation is achieved and areas are capable of sustaining human use without unacceptable resource loss or jeopardy to human health and safety."

Objective 4.5(a) — "Close, reconstruct, or relocate trails."

Objective 4.5(b) — "Close, rehabilitate, or relocate concentrated dispersed campsites, or make developed improvements to protect basic resources."

Goal 4.7 (Forest Plan) — "Grazing use of the National Forest sustains or improves overall range, soils, water, wildlife, and recreational values or experiences."

Objective 4.7(d) — "Require that suitable and adequate amounts of forage and cover are retained for wildlife and fish."

By calling for suitable herbaceous habitat to be retained for spotted frogs and boreal toads in and adjacent to breeding ponds, this objective will help to limit the potential for crushing by livestock.

Streamside Roads Standard (Forest Plan) — "Wherever possible, roads will avoid riparian areas or drainageways. Where riparian areas or drainageways cannot be avoided, location and design of roads will apply sediment-reduction practices to prevent degradation of riparian or stream quality. Roads presently within riparian areas will be relocated outside riparian areas where possible."

Road Maintenance in Riparian Area Standard (Forest Plan) — "Maintenance, improvement, and repair of roads within riparian zones would mitigate impacts of the road to water quality, but would not avoid impacts because erosion and sedimentation would continue, albeit at a lower rate, and roads would continue to be a source of contaminants."

Log Skidding Standard (Forest Plan) — "Logs will not be skidded across live streams except where temporary crossing structures are in place. These structures will not impede water flow or irreversibly change the stream channel. Structures will be removed and the channel or channels restored immediately following completion of skidding."

Not allowing skidding in riparian areas limits the potential for crushing of amphibians by logging equipment because most amphibians are located within riparian zones.

Fish; Wildlife; and Threatened, Endangered, and Sensitive Species Standard (Forest Plan) — "Range improvements, management activities, and trailing will be coordinated with and designed to help meet fish and wildlife habitat needs, especially on key habitat areas such as crucial winter range, seasonal calving areas, riparian areas, sage grouse leks, and nesting sites. Special emphasis will be placed on helping to meet the needs of Threatened, Endangered, and Sensitive Species."

In part, because of the major negative effects crushing by livestock can have on local populations of amphibian species, this standard requires livestock grazing be managed in a way that minimizes crushing.

Estimated Natural Conditions

The contribution of crushing (e.g., by native ungulates) to mortality rates of spotted frogs and boreal toads prior to Euro-American settlement constitute the natural conditions for this element. Because there likely is little difference in the rate of mortality caused by native ungulates prior to Euro-American settlement and the present time, with a few exceptions, natural conditions for this element consist of the absence of any mortality resulting from crushing or injury by human-related factors such as motorized vehicles, heavy equipment, livestock, and horses.

One exception is that the rate of crushing by native ungulates likely is currently lower in and around some of the low-elevation wetlands on the BTNF than what occurred prior to Euro-American settlement because bison periodically grazed the lower elevations of the BTNF area and elk were more prevalent during summer at low elevations prior to Euro-American settlement (DeLong 2009b), and each of these species would likely have drank from wetlands used by spotted frogs and boreal toads for breeding. It is likely that the contribution of crushing to the natural mortality rate was negligible across the area now encompassed within the BTNF, but there undoubtedly were situations in which large numbers of metamorphs and possibly tadpoles and adults died as a result of crushing, for example, when the timing of bison concentrations near breeding wetlands coincided with high concentrations of metamorphs or tadpoles. Bison spend substantively less time grazing and loafing near water sources than cattle and, of the time they spend at water holes, they probably spend less time in the water than cattle due in part to lower metabolic rates in bison and their ability to better cope with heat than cattle (Van Vuren 1981, Steuter and Hidinger 1999, Van Vuren 2001, Fuhlendorf et al. 2010). This in turn means there were fewer chances bison in a herd of a given size stepping on tadpoles, metamorphs, and adults near breeding wetlands, compared to a cattle herd of the same size. Furthermore, bison in the intermountain West are thought to have had a sporadically grazing pattern across landscapes, in which they moved and grazed through a given area and then did not return to the same area for one to several years (Haines 1965, Van Vuren 1981, Miller et al. 1994, Van Vuren 2001), which further reduced the potential for crushing of frogs and toads by bison.

Natural conditions are within the range of suitable conditions for spotted frogs and boreal toads since these are the conditions under which amphibian communities formed or developed in this area and because they represent ideal conditions with respect to survival as affected by vehicles, heavy equipment, livestock, or horses.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

With one possible exception, there is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the natural contributions of crushing (e.g., by native ungulates) to mortality rates and lack of any additive artificial mortality due to vehicles, heavy equipment, livestock, or horses. This is because meeting Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to spotted frogs and boreal toads can be accomplished with the minimal amount of crushing that occurred under natural conditions any increase in morality caused by crushing (above natural levels) would not benefit spotted frogs and boreal toads. Amphibian communities in this area developed in the absence of any additive or compensatory mortality resulting from crushing by vehicles, heavy equipment, livestock, and horses.

The possible exception is that a lower mortality rate than occurred naturally could help offset some of the cumulative and synergistic artificial stressors currently acting on spotted frog and boreal toad populations on the BTNF. On the other hand, the contribution of crushing by native ungulates prior to Euro-American settlement likely was minor, and reducing long-term crushing levels below this natural level would likely have no more than negligible population-level effects (compared to a natural mortality rate) and would be impractical.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, and given the impracticality of completely avoiding any mortality caused by vehicles, heavy equipment, livestock, and horses in the process of providing for vehicle access, timber harvest, livestock grazing, horseback riding, and other uses, it will be necessary to accommodate some degree of deviations from natural conditions for this element. Restated, because these uses cause direct mortality from crushing and because these uses are built into the multiple-use mandate of the agency, some level of mortality will need to be accommodated in some places… so long as local populations are sustained over the long term and so long as the elevated mortality does contribute to a trend toward federal listing.

It is not practical to quantify the degree to which survival rates are reduced, as a consequence of increased additive[W] mortality caused by crushing, and still attain upward trends where upward trends are needed and to

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[W] Additional compensatory morality is immaterial because this does not detract from survival rates. It is likely that mortality due to crushing by vehicles, heavy equipment, livestock, and horses is both additive and compensatory. Additive mortality is the key issue.

maintain population levels where populations levels are satisfactory, particularly in light of all of the other non-quantified factors negatively affecting spotted frogs and boreal toads on the BTNF (e.g., loss of habitat, habitat fragmentation, low herbaceous retention levels, chitrid fungus). Few studies have been done on the effects of vehicle-caused mortality on local amphibian populations (Andrews et al. 2008), and no studies have been conducted on the effects of livestock-caused mortality (crushing) on amphibian populations. However, sufficient information exists demonstrating that crushing by vehicles, heavy equipment, and livestock can be major to severe in places and can contribute substantively to mortality rates (see "Risk Factors and Restoration Factors" for scientific literature supporting this), meaning there is high potential for crushing mortality to greatly exceed natural levels in many local populations on the BTNF.

Determining acceptable levels of mortality for each of a wide range of possible situations on the BTNF would require intensive research and follow-up monitoring, requiring unrealistic funding levels. Furthermore, control measures would likely be applied at a coarse scale anyhow. The best that can be done in the absence of a major research project (e.g., costing many hundreds of thousands of dollars or more) is to focus on minimizing the potential for crushing by vehicles, heavy equipment, livestock, and horses at increasingly restrictive levels as distance to breeding sites declines:

- *Within 100 feet of Breeding Sites* **—** Because of the large number of life history stages affected at breeding sites (eggs, tadpoles, metamorphs, juveniles, and adults), the high densities of individuals in each of these life stages at breeding sites, and the high vulnerability of being crushed by vehicles, livestock, and horses, there is high potential to directly adversely affect production through crushing eggs, tadpoles, and metamorphs in breeding wetlands and in the immediate vicinity of these wetlands and crushing adults that would otherwise reproduce in coming years (see the "Buffer Zones and Levels of Protection" section). In some cases, reproductive output can be greatly impacted or nearly eliminated (Bartelt 2000, Andrews 2008, Bull 2009). Of any of the zones surrounding breeding sites, impacts within the 100-ft. buffer zone has the greatest potential of impacting populations. Directly impacting production is of particular concern because reproductive output has potential to offset or partially offset cumulative negative effects on populations resulting from a large number of factors that have impacted and continue to impact spotted frogs and boreal toads. Therefore, at most, only minor increases in mortality can justifiably be accommodated within 100 feet of breeding sites. Facilities and activities that result in or can result in crushing can be readily controlled (except possibly livestock in some situations), in part because breeding sites comprise such a small minority (<0.01%) of the landscape and they are easily identifiable.

  Therefore, suitable conditions for spotted frogs and boreal toads with respect to survival as affected by vehicles, heavy equipment, and livestock within 100 ft. of breeding wetlands consists of no more than small increases (e.g., on the order of <20%) in natural levels of mortality due to crushing, recognizing that crushing naturally contributed only a minor amount to mortality; roughly 20% of a minor amount equates to a very low level of mortality caused by artificial means of crushing. Because natural mortality rates and percent contribution of natural crushing rates to overall mortality are not known, the presence of facilities and activities are used as proxies for elevated mortality due to crushing. (The "<20%" figure is only provided to give an idea of the order of magnitude of an acceptable increase in mortality caused by crushing.) To provide suitable conditions, therefore, would require the absence or near absence of facilities and activities in this zone that cause or contribute to crushing of eggs, tadpoles, metamorphs, juvenile, and adult spotted frogs and boreal toads. This translates to no open roads or motor-vehicle trails, no more than negligible use of motorized vehicles and heavy equipment, and no more than incidental use by livestock and horses within 100 ft. of breeding wetlands during the breeding season. For all practical purposes, this means near-100% protection at known breeding sites from the time eggs are laid until metamorphs move away from breeding wetlands. Because livestock are more difficult to control than motorized vehicle use, maintaining very levels of crushing likely means the absence of any mortality resulting from crushing or injury by motorized vehicles and heavy equipment.

- *Within 200 yards (but beyond 100 feet) of Breeding Sites* **—** Because densities of metamorphs, juveniles, and adults can be high along travel corridors within 200 yards of breeding sites (see the "Buffer Zones and Levels of Protection" section), the potential exists for high mortality rates. Although fewer adults than metamorphs are likely killed by crushing on roads and by livestock along migration routes, the mortality of each additional individual adult has comparatively greater impact than the mortality of each additional individual metamorph. On the other hand, metamorphs have the greatest potential of being killed in large numbers (Bartelt et al. 2004, Bull 2009). While the potential to kill large numbers of metamorphs is lower than it is within 100 feet of breeding wetlands, the potential still exists to cause high levels of mortality where metamorphs travel en mass in any given direction (Bull 2009). A periodic high mortality rate of a given cohort can, especially in conjunction with a large number of other negative cumulative effects on local populations, have substantive negative effects on local populations.

Most movements from breeding wetlands through this zone occurs along riparian zones and drainage bottoms, making protective measures in these corridors of greatest importance. The most critical time periods — when the greatest potential for impacts occurs — are when adults are traveling from hibernation sites to breeding sites, when adults are traveling from breeding sites to summer habitat, when metamorphs are dispersing from breeding sites, and when resident adults and juveniles are summering within about 200 yards of breeding wetlands (for those individuals that remain close to breeding sites).

Therefore, while some level of use can be accommodated within this zone, artificial elevation of mortality rates needs to be minimized to the greatest extent possible in order to meet Objective 3.3(a), the Sensitive Species Management Standard, and the higher-level authorities upon which these requirements are founded.

- *Within 1/3 mile (but beyond 200 yards) of Breeding Sites* **—** Habitat beyond 200 yards and within 1/3 mile of breeding sites is of central importance to spotted frogs and boreal toads, since up to an estimated 75% or more individuals remain within this distance of breeding sites (see the “Buffer Zones and Levels of Protection” section). While densities and numbers may be lower than they are within about 200 yards, densities and numbers of metamorphs, juveniles, and adults in this zone can be high, particularly along riparian zones and drainage bottoms used as travel corridors (Pilliod et al. 2002, Bull 2006, Schmetterling and Young 2008, Bull 2009). As such, motorized travel on roads crossing or within riparian zones during migrations and dispersals within this zone has the potential to result in substantial mortality depending on timing; and cattle also have potential to contribute to mortality through trampling where large numbers of metamorphs, juveniles, or adults are traveling in narrow riparian zones when they are concurrently being grazed by cattle (see Appendix A). The discussion on timing in the 200-yard discussion, above, applies to this zone as well. Artificial elevation of mortality rates should be minimized to the greatest extent possible.

- *Within1½ miles (but beyond 1/3 mile) of Breeding Sites* **—** Minimizing the artificial elevation of mortality rates should be easier to attain in this zone given the lower numbers of individuals moving out this far from breeding sites, most movements occurring within relatively narrow travel corridors, and the much larger acreage base. However, in reality, it is only “easier” if travel corridors are known. Substantive numbers of metamorphs, juveniles, and adults migrate and disperse along riparian zones within this zone (1/3 to 1½ miles) for some populations (Pilliod et al. 2002, Bull 2006, Schmetterling and Young 2008, Bull 2009). Although mortality rates from vehicle and livestock crushing likely are lower than occurs within 1/3 mile, the potential still exists for fairly substantive mortality in localized areas where metamorphs, juveniles, and adults must cross roads and where concentrations overlap in time and space with livestock grazing use.

  Localized protections within this zone along migration and dispersal corridors can be particularly important to genetic interchange with adjoining or nearby metapopulations and the establishment of new breeding sites or complexes (Marsh and Trenham 2001, Smith and Green 2005). This requires, however, that movement corridors at this distance from breeding complexes can be estimated.

- *Beyond 1½ miles of Known Breeding Sites* **—** Only a small proportion of individual spotted frogs and boreal toads move beyond 1½ miles from breeding sites, meaning that activities in this zone are much less likely to result in the crushing of frogs and toads and, therefore, are less likely to impact the metapopulation. On the other hand, it is these movements that may be contributing to genetic interchange between metapopulations (beyond 1½ mile but within maximum travel distances), making it necessary to consider protective measures beyond 1½ miles. This in recognition of the difficulties of knowing where to apply protective measures.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous 6 pages, Appendix A, as well as information provided in the section entitled “B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter,” and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section (they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that must be met in order to meet the “suitable habitat” portions of Objective 3.3(a), Objective 4.7(d), and the Sensitive Species Management Standard.

1. Suitable conditions for this element — in order to meet Forest Plan Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads — entail environmental conditions in which mortality from crushing by vehicles, livestock, and horses contributes no more than minimally to mortality in local populations of spotted frogs and boreal toads, especially during the breeding season and immediately afterward when metamorphs, juveniles, and adults are migrating and dispersing. A quantitative objective for survival relative to the effects of vehicle and livestock crushing is premature at this time, and may not be realistic or possible.

2. Survival rates of local populations of spotted frogs and boreal toads are not lowered at all or remain largely unaffected by crushing by vehicles, heavy equipment, livestock, horse, and people within 1½ miles of known existing breeding sites and historic breeding sites having capable amphibian wetland habitat during the reproductive season (e.g., April-August). Artificially-high mortality rates caused by crushing are problematic regardless of the distance to known breeding sites. What changes with the distance to breeding sites is the potential for such mortality to occur and, ultimately, the degree to which conservation actions are needed. (Given the higher potential for large numbers of individuals to be crushed at shorter distances to breeding sites, especially within 200 yards of breeding sites and even more so within 100 feet of breeding sites, restrictions on activities are greatest within 100 feet and 200 yards and least between 1/3 mile and 1½ mile from breeding sites.)

3. Survival rates of juveniles and adults moving between metapopulations of spotted frogs and boreal toads are not lowered at all or remain largely unaffected by crushing by vehicles, heavy equipment, livestock, horse, and people.

“Existing breeding sites and known historic breeding sites having capable amphibian wetland habitat” is identified as the geographic scope because restrictions on activities that has potential of increasing mortality through crushing are most critical where breeding sites exist, but restrictions can only be imposed around breeding sites that are known. Existing and known historic breeding sites only comprise a portion of the capable amphibian wetland habitat, and applying restrictions over such a large area would be overly restrictive. This highlights the importance of conducting thorough pre-development surveys to ascertain whether any existing or capable breeding sites would be affected. Objective 3.3(a) and the requirement to avoid or minimize impacts to sensitive species (FSM 2670.32) must be met regardless of whether locations of breeding sites are known. Pre-development surveys and appropriate changes to any development proposal would account for this.

No numbers are provided for “minimally” because it will not be measured, but the intent is to limit mortality from these activities to no more than 5-10% of the annual mortality by age class.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat and A.6. Habitat Connectivity — To the extent new road and motorized-trail construction is prevented in areas used by spotted frogs and/or boreal toads and to the extent roads and/or motor-vehicle trails are eliminated in areas used by these species (e.g., as a result of A.1 and A.6), conditions outlined in suitable condition statements under C.1, above, will be met to a greater degree.

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter — Retaining 70% of total herbaceous vegetation would help to maintain livestock use at breeding sites and in other habitats at low enough levels such that trampling by livestock should be a minor mortality factor.

Risk Factors and Restoration Factors

Several human activities **—** described below **—** that result in the crushing of spotted frogs and boreal toads and that reduce survival of these amphibians work against the attainment of suitable conditions and, ultimately, the achievement of Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads. Sufficient constraints need to be placed on these human activities in order to be able to achieve Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species.

Crushing of metamorphs by vehicles and livestock is of particular concern due to the large numbers of metamorphs that can be killed in any given episode with relatively low traffic levels and with low number of livestock and due to the combined effects of this and disease effects that may require high recruitment rates to offset disease impacts (see “C.4. Survival as Affected by Disease” for more supporting references).

Crushing of adults by vehicles and livestock is also of particular concern because females do not reproduce until they are 5-6 years old and males until they are about 4 years old and life expectancy naturally is high once they reach breeding age, meaning that small increases in mortality of breeding-adults has the potential to have population-level effects (see “Survival as Affected by Trampling” in Appendix A for supporting references).

Motor Vehicles — Use of motorized vehicles by the public on and off system roads and motor-vehicle trails, and use of motorized vehicles for timber harvest, fire fighting and other fire management activities, oil and gas operations, and for other uses has the potential to elevate the mortality of spotted frogs and boreal toads in a range of settings. Roads and motorized vehicles commonly have negative impacts on amphibian populations (numerous studies in several literature reviews deMaynadier and Hunter 1995, Maxell and Hokit 1999, Maxell 2000, Jochimsen et al. 2004, Patla and Keinath 2005, Andrew et al. 2008, PARC 2008, Beebee 2013). Use of motorized vehicles by the public has the greatest potential for impacts due to the widespread use of vehicles on system roads and motor-vehicle trails as well as off these roads/trails and in dispersed camping situations. Effects of motorized vehicles associated with timber harvest and fire management are much more limited, localized, and short-term (this is addressed more below in subheadings), with the exception of vehicles used for patrols which can be widespread and recurring.

Maxell and Hokit (1999) cited 11 published reports of mortality of amphibians by motor vehicles. Amphibians are particularly susceptible to being crushed by vehicles where roads parallel riparian areas, where they are located adjacent to or near wetlands, and where roads exist in migration habitat. summarized a large number of published studies showing high mortality rates where amphibians crossed roads to access breeding sites and when dispersing away from breeding sites. Gomez (1994) reported that mortality from vehicle traffic along roads and trails near wet areas and that bisect wetlands may be a mortality factor of spotted frogs. Patla and Keinath (2005) identified the crossing of roads by amphibians as a mortality factor applicable to spotted frogs. Therefore, even when roads are placed outside of riparian areas — as directed by the Streamside Roads Standard — roads still have the potential to impact frogs and toads. Carr and Fahrig (2001) found that roads near breeding wetlands adversely impacted a frog species with greater movement patterns (leopard frogs) than a frog species that was more sedentary (green frog), and Beebee (2013) reported on similar results for a range of other amphibian species. Both spotted frogs and boreal toads move fairly extensively within about 1/3 mile of breeding pools and a small portion of individuals move beyond this to as far as about 2 miles or more (see the discussion on 1/3 mile in the “Buffer Zone and Levels of Protection” section). Because movements by spotted frogs and boreal toads to and from breeding wetlands oftentimes occurs within riparian zones, it is especially important to avoid road construction and upgrades to roads (e.g., road widening) in riparian zones.

Results of Carr and Fahrig (2001) indicated that traffic can influence the population abundance of leopard frogs out at least about 0.9 miles (1.5 km), which was seen as similar to the traffic-effect distance of just under 1/2 mile (750 m) found by Vos and Chardon (1998). These distances may be applicable to spotted frogs and boreal toads based on distances they move (see the discussion on 1/3 mile in the "Buffer Zone and Levels of Protection" section). As a general rule, Forman (2000; as cited by Carr and Fahrig 2001) estimated that the road-effect zone varies from about 220 yards to 1/2 mile in the United States, presumably for all wildlife species assessed. While Beebee (2013) did not enumerate any buffer zones, they cited many examples of populations that declined substantially or disappeared due to roads in proximity to breeding sites.

Von and Chardon (1998:45) reported that "In several studies, a negative correlationw as found between traffic density and the probability of survival of amphibians crossinga road (Van Gelder 1973; Berthoud & Muller 1983; Heine 1987; Kuhn 1987; Munch 1989). A model by Heine (1987) predicts almost zero survival probability for individuals that cross roads with more than 26 cars per hour." Substantive effects can occur at considerably lower traffic volumes.

The potential for amphibian mortality caused by individuals being crushed by vehicles is particularly pertinent to many of the roads and motor-vehicle trails on the BTNF since many roads and motor-vehicle trails closely follow stream courses and are located within riparian zones that encompass an abundance of oxbows, pools, marshes, and other wetlands. deMaynadier and Hunter (1995) and Pilliod et al. (2003) surmised that impacts of most forest roads are relatively low because they have low volumes and traffic volumes are particularly low at night when amphibians typically migrate, although they did not present supportive data. In contrast, several specific instances on forest roads and roads similar to forest roads demonstrate that impacts can be high on these roads, especially when located near breeding sites:

- Bull (2009) found that vehicles on forest roads killed thousands of metamorph boreal toads near 2 of 3 breeding sites she studied in Oregon. Bull (2009:243) found that "Vehicles killed thousands of toadlets at Balm [breeding site] in 2006 when toadlets crossed roads traveling away from the reservoir." There were three road crossings near this breeding site, but she did not identify distances between the breeding site and the roads. She also found that vehicles killed thousands at another breeding site that had roads nearby. These roads appear to be similar to roads on the BTNF.
- Bull (2009:243) also found that "All terrain vehicles appeared to be responsible for killing hundreds of toadlets near the breeding sites at Balm and Pine based on vehicle tracks."
- Patla (2001:10) reported that "Bartelt found 6 adult toads, probably females, killed by vehicles on unpaved forest roads in the course of his study on the [Targhee National Forest], and he noted that the removal of females can have large effects on population persistence."
- The estimated 80% reduction (and possibly a 100% reduction) in a local spotted frog population in Yellowstone National Park (Patla 2001, detailed in the "Habitat Connectivity" section) was primarily attributed to reduced connectivity, but it is likely that mortality from crushing played a role as well.
- Wind and Dupuis (2002:21) noted that "Wind (unpublished data) observed large numbers of toadlets trapped in road ruts 20-30 cm deep that were heavily used by all-terrain vehicles. The toads either entered the ruts when they were attempting to cross the road, using the road for basking, or they were attracted to the water trapped inside the ruts.
- The author has observed several adult spotted frogs in puddles of ATV trails; it is likely, therefore, that frogs are being crushed on ATV trails on the BTNF.
- Brown et al. (2015:54, 59) reported on live Yosemite toads being observed on roads and off-road vehicle routes, and on three toads that had been crushed on a road entering a campground.

Where forest roads on the BTNF are being used at night during amphibian migrations (e.g., in support of early phases of oil and gas development), mortality rates could be elevated. This may be particularly true of situations in which traffic volumes are high due to large numbers of trucks using roads during early phases of oil and gas development, especially where roads are close to breeding sites. While the potential for mortality may be reduced during daylight hours, the creation of puddles in roads and motor-vehicle trails can contribute to higher mortality.

Puddles in two-track roads and motor-vehicle trails, can increase mortality of frogs and toads along these routes since frogs and toads in these puddles would be susceptible to being crushed by vehicles, as noted in some of the examples above. Also, PARC (2008:20) noted that "Amphibians are often attracted to water-filled tire common along rural roads or to roadside pools for hydration or breeding, which exposes them to the risk of injury or death from passing vehicles."

Motorized use on non-system roads and motor-vehicle trails, including user-created trails, can compound the impacts outlined above. In some places, the number and length of user-created and other non-system roads and motor-vehicle trails are considerably greater than that of system roads and motor-vehicle trails, meaning non-system roads and motor-vehicle trails have a greater potential for impacts in some places.

Two other mortality factors along roads are exposure to predation (PARC 2008) and desiccation (Andrews et al. 2008). In addition to increased exposure to predation, it is not uncommon for species like common ravens to concentrate their search efforts along roadways, further compounding the potential for predation. As traffic levels increase, the potential for wildlife in general to be killed by vehicles increases, which increases the propensity for ravens and other scavengers to spend more time searching for carcasses along roadways, which in turn increases the potential that a toad or frog crossing a road to be captured and eaten. Raven numbers have increased ten-fold in Wyoming since the late 1960s (based on data analysis from Sauer et al. 2014, for common raven). Andrews et al. (2008) noted that increased desiccation rates due to crossing roads can become an especially important factor where adjoining habitats are altered and not providing the moist conditions they did prior to their alteration (e.g., due to livestock grazing or camping, lowering of water tables).

Given the close proximity of roads to spotted frog and boreal toad breeding sites on the BTNF and given the common occurrence of roads paralleling riparian corridors (within and adjacent to these riparian zones) and crossing riparian corridors within 1/3 mile and 1½ miles of breeding sites, there likely is infrequent high mortality rates of both species and high frequency of low mortality rates forest roads. The stage is set for substantive contributions to mortality rates of frogs and toads in local populations. In some situations, mortality of amphibians on roads can have a major impact on localized populations (Maxell and Hokit 1999, Maxell 2000, Carr and Fahrig 2001, Patla 2001, Jochimsen et al. 2004, Andrew et al. 2008).

The widening of existing roads — which often goes hand-in-hand with road straightening and improved road surfaces — has the potential of increasing mortality rates in areas inhabited by boreal toads and spotted frogs in several ways: (1) wider roads result in a wider corridor that toads and frogs need to negotiate in order to cross the road; (2) wider roads, along with other improvements in road conditions, tend to increase traffic rates, which tends to increase mortality rates; (3) wider roads and other improvements increases the potential for higher traffic rates on spur roads and the creation of a larger number of user-created roads, which in turn can elevate mortality rates; and (4) wider roads may increase the susceptibility to predation, especially given the tendency for increased traffic rates and resultant increased mortality of other wildlife, which in turn can increase predation of amphibians.

Motorized vehicles using roads that access oil, gas, and mineral developments and building complexes have the potential to crush amphibians that attempt to cross these roads. The potential danger to toads and frogs depends in part on the phase of construction, maintenance, and use of the sites, and depending on the placement of roads relative to habitat-use patterns of boreal toads and spotted frogs. Increased traffic on roads during oil and gas (and timber harvest) operations increases the hazards to toads and frogs if the road bisects movement patterns, e.g., especially where roads bisect, straddle, or parallel riparian areas.

The absence or low number of records of frog and toad carcasses observed along motorized routes does not mean that crushing by motorized vehicles is not an important mortality factor. This is because, with few exceptions, drivers typically do not notice small, obscure objects along roadways unless they are specifically looking for them. Even when concerted effort is put into looking for roadkill frogs and toads, numbers seen typically is lower than what actually are killed along roadways due to dead frogs and toads on motorized routes can be difficult to see, especially once they have dried or have been driven over several times, and scavengers (e.g., ravens, magpies) can remove them fairly quickly (Beckman and Shine 2015). Also, where a road has been in place for a long period and where this adjoins or bisects high-quality frog or toad habitat, it is possible that a low mortality rate at present (and thus low potential to see carcasses along the roadway) could be a result of high mortality rates in the past having driven the population to low levels (Eberhardt et al. 2013).

Heavy Equipment — Skidders and other logging equipment have the potential to crush frogs and toads (Keinath and McGee 2005, PARC 2008). Implementation of timber harvest projects in compliance with the Logging in Riparian Areas Standard, Log Skidding Standard, and Streamside Road Standard of the Forest Plan (USFS 1990b) would reduce potential mortality since it would likely only affect individual frogs or toads away from riparian areas and wetlands. However, Keinath and McGee (2005:37) assessed that "Boreal toads may be particularly vulnerable to impacts of timber harvesting when harvest activities occur within their dispersal range from breeding sites, and during the late summer when adults migrate into upland forested habitats."

Engines, bulldozers, pick-up trucks, and other vehicles and heavy equipment used in fire management operations have the potential to crush toads and frogs in staging areas, on fire lines, and other places used by these vehicles.

Heavy equipment at oil, gas, and mineral development sites and building complexes present hazards to amphibians, especially during the construction phase when sites are in the vicinity of breeding sites or are located in migration or dispersal zones. Once construction is completed, the potential for heavy equipment to crush amphibians declines substantially, but continues to persist.

Logging Trucks and Oil and Gas Trucks — Logging trucks and trucks associated with oil and gas developments have the potential to increase mortality rates where haul routes pass near breeding sites and if hauling occurs when large numbers of adults or juveniles are moving across roads.

***Livestock Use* —** Walking and running livestock can injure and kill spotted frogs and boreal toads. Direct injury and death can result from livestock stepping on or disrupting amphibian egg masses in shallow water, stepping on tadpoles and metamorphosing amphibians in shallow water and on banks, stepping on adult frogs and toads, and killing frogs and toads by crushing burrows near the ground surface and in banks (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Bull 2009; and see Appendix A).

Higher utilization levels by livestock generally corresponds to higher probabilities of trampling effects (Appendix A). As a general rule, a large number of livestock during a short period of time is more apt to result in detrimental trampling effects than smaller numbers spread over a longer period of time. At amphibian breeding sites, a small number of animals periodically visiting a water source has potential to trample or otherwise affect eggs, tadpoles, and metamorphosing frogs and toads, especially since this is spread over a period of time. However, only a small number of animals would be present during critical periods for frogs and toads, for example, when they are metamorphosing into juvenile frogs and toads. Conversely, a large concentration of animals, especially if this occurs at a time when amphibians are prone to trampling effects, can result in larger impacts. For example, as reported by Maxell (2000:15), "…after what may have been the first successful reproductive event at a site in southeastern Idaho in 10 years Bartelt (1998) documented the deaths of thousands of western toad metamorphs when 500-1,000 sheep were herded through the drying pond the toadlets were concentrated around. He found that hundreds of animals had been directly killed underfoot and hundreds more died soon afterwards as a result of dessication because the vegetation they had been hiding in had been trampled to the point that it no longer provided a moist microhabitat." Maxell (2000:136) reported on a personal observation whereby he had witnessed individual leopard frogs and woodhouse's toads at the bottoms of cattle hoof prints at the margins of several wetlands in eastern Montana, and reported on other authors that have reported crushing of adult spotted frogs by livestock. Bull (2009:243) found "More than 50 toadlets and one juvenile were found dead in cattle tracks" at one breeding site.

Metamorphosis of spotted frogs and boreal toads on the BTNF likely occurs between mid July and late September, depending on elevation and other factors. This is also the period of time when many breeding pools are shrinking due to evapotranspiration, declining water tables, and other factors such as drinking by livestock and native ungulates, meaning that metamorphosing tadpoles and juvenile frogs and toads become more concentrated. Therefore, on cattle allotments, the highest potential for adverse effects on tadpoles, froglets, and toadlets is typically from the onset of the grazing season through late July or mid September, depending on when metamorphosis occurs. (However, in at least one instance in 2011, many dozens of recently metamorphosed chorus frogs were observed at the edges of a drying pool at about 6,800 feet in a cattle allotment on the Greys River Ranger District; DeLong 2012, unpublished notes). In most sheep allotments, the highest potential for adverse effects is from the onset of sheep grazing through early September, typically about 1½-2 months. Although much larger numbers of sheep use any given water source compared to cattle allotments, the duration of use is considerably shorter (e.g., a much shorter period in any given day, and far fewer days) and usually sheep do not venture as far into the water as cattle.

While some studies did not detect trampling effects of livestock on eggs and tadpoles (Bull and Hayes 2000, Adams et al. 2009), several factors combine to set the stage for periodic adverse impacts. These factors include the timing of livestock grazing relative to key life-history stages of spotted frogs and boreal toads, the use of breeding pools as water sources for livestock, the tendency of cattle to hang out near water during some parts of the summer, hundreds of sheep watering in a very short period of time (e.g., <2 hours each day, possibly for several consecutive days), behavior of livestock at watering sites, the small size of some breeding pools relative to the typical large number of tadpoles and recently metamorphosed frogs and toads (i.e., high concentrations), and relatively slow reaction and speed of froglets and toadlets.

Direct mortality of frogs and toads due to being crushed by livestock is discussed further, in relation to livestock grazing intensities, in the “B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter” section, above.

Camping and Other Recreational Uses — Brown et al. (2015:53) assessed that “High overlap exists between Yosemite toad habitats and areas often used for recreation,” and this applies equally well to the BTNF for spotted frogs and boreal toads since recreational use is concentrated in riparian zones and this is where both species spend most of their time.

Additive effect of dispersed camping and hiking — above and beyond soil compaction, alteration of plant species composition, trampling of vegetation, and noise — are people and horses stepping on frogs and toads, which can increase mortality (Maxell and Hokit 1999, Loeffler 2001, Keinath and Patla 2005, Patla and Keinath 2005, USFWS 2012, Brown et al. 2015), and disturbance effects of campers (Rodríguez-Prieto and Fernández-Juricic 2005). Brown et al. (2015:53-54) reported that “Anglers, hikers, and their pets have been observed trampling and disturbing western toad egg masses, tadpoles, and metamorphosing froglets at a site in Oregon (Brown 2001).” Because horses walk and run more than cattle, the potential for causing mortality due to trampling is higher, as much as twice as high (Mandema (et al. 2013); this pertains to horses associated with outfitters and recreationists, as well as sheep herders.

There are several other related factors that can increase direct mortality rates of spotted frogs and boreal toads in the vicinity of campgrounds and dispersed camping sites. These mortality factors likely contribute to reduced populations in the vicinity of dispersed camping areas.

- The short-stature vegetation associated with dispersed camping sites, due to vehicle use, trampling, and grazing, increases the potential of predation and desiccation. Food attracts predators such as skunks, foxes, ravens, and gray jays, which compounds the exposure factor (Maxell 2000, Patla and Keinath 2005). Both sets of authors reported on an instance in which 20% of the western toads at a breeding site near a recreation facility were depredated by ravens.

- Impacts of increased exposure to predation due to dogs and native predators such as ravens, magpies, and jays (Maxell and Hokit 1999, Maxell 2000, USFWS 2012). This is due to a combination of presence of dogs and lack of hiding cover.

- Capturing and handling amphibians can increase mortality. While handling of toads and frogs by children and adults may not always result in direct mortality, it may make them more susceptible of dying from other causes (Maxell 2000, Patla and Keinath 2005).

- Little if anything has been written about the disturbance effects of human activity on amphibians, but it stands to reason that intense human activity — especially when assessed cumulatively with all other effects of camping on amphibians — contributes to reduced amphibian populations or to their absence in the immediate vicinity of dispersed camping areas, developed campgrounds, recreation residences, guard stations, and Forest Service compounds.

Very little research appears to have been done on the disturbance effects of recreation, but Rodríguez-Prieto and Fernández-Juricic (2005) found that Iberian frog abundance was significantly affected by the proximity of recreationl areas, the time to resume pre-disturbance activities increased with the number of disturbance events, and lower intervals between disturbance events corresponded with reduced resource use by Iberian frogs. They found that taller and denser herbaceous vegetation reduced disturbance effects to some degree. Human disturbance has the potential to contribute substantively to reduced population levels of spotted frogs and boreal toads adjacent to campgrounds, popular fishing sites, and other recreation centers.

***Unnaturally High Populations of Native Ungulates* —** It is possible that concentrations of elk moving away from feedgrounds could elevate mortality of adult frogs and toads. Some feedgrounds are located near riparian areas, which makes this a possibility. It would be possible for late concentrations of elk in riparian areas near feedgrounds to affect adult frogs and toads shortly after emerging from hibernation and while they are migrating to breeding wetlands. However, because elk typically leave feedgrounds betwee late March and late April, there would be a low likelihood for elk concentrations to occur when and where frogs and toads are migrating.

Building Complexes — Due to the concentration of human activity, motorized vehicles, people, heavy equipment, and horses in the vicinity of building compounds have the potential to crush amphibians. Many of the same mortality factors, in addition to crushing, apply to building complexes.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including USFS (1990), deMaynadier and Hunter (1995), Maxell (2000), Patla (2000), Forman et al. (2003), Jochimsen et al. (2004), Keinath and McGee (2005), Patla and Keinath (2005), Andrews et al. (2008), PARC (2008), and WGFD (2010a,b), as well as publications cited earlier in this section and the "Buffer Zones and Levels of Protection" section.

Ensuring minimal mortality caused by crushing is most important in the immediate vicinity of breeding wetlands and, therefore, the 100 ft. buffer zone is of most importance. To the greatest extent possible roads and motor-vehicle trails should be absent in this zone and livestock grazing needs to be very carefully controlled in this zone. The next zone of high importance is within 200 yards of breeding sites. This zone is important for populations in which a majority of individuals remain near breeding wetlands throughout the summer. Most important within the 200 yard zone is the avoidance of road and motorized-trail placement adjacent to wetlands and in riparian areas, but roads and motor-vehicle trails in other habitats in this zone should be avoided to the greatest extent possible. Also important in this zone is carefully controlling livestock grazing to minimize the potential for crushing by livestock. Also, because a relatively high proportion of adults and juveniles move beyond 200 yards, avoiding the placement of roads and motor-vehicle trails in riparian areas within 1/3 mile is also important. Minimizing roads and motor-vehicle trails in habitats outside of riparian zones within the 1/3-mile buffer zone would also help to limit mortality caused by crushing by vehicles, but of all areas within 1/3 mile of breeding sites, non-riparian habitats are of lesser importance. Livestock grazing within habitats used by spotted frogs and toads needs within 1/3 mile of breeding sites needs to be carefully controlled. Because a portion of individuals move well beyond the 1/3 mile zone, especially along riparian corridors, roads and motor-vehicle trails as far as 1½ miles from breeding sites should be minimized to the extent possible.

I. Roads, Trails, and Motorized Use

1. Several important conservation actions are:
    a. Absence of roads and motor-vehicle trails in/through breeding and other isolated wetlands and within 100 feet of these wetlands. Where roads currently exist within 100 feet of known existing breeding

wetlands or historic breeding wetlands still having capable habitat, they should be relocated or closed wherever practicable. Avoid the placement of any new roads within these wetlands and within 100 feet of these wetlands. This is consistent with the Clean Water Act and Executive Order 11990.

   b. No additional roads and motor-vehicle trails and no widening of roads and trails, to the greatest extent possible (1) in or adjacent to riparian areas within 200 yards of known existing breeding sites and historic breeding sites having capable habitat (this is consistent with the Streamside Roads Standard of the Forest Plan), and (2) adjacent to wetlands within 1/3 mile of known existing breeding sites and historic breeding sites having capable habitat.

   c. A net reduction in roads and motor-vehicle trails, to the greatest extent possible (1) in or adjacent to riparian areas within 200 yards of known existing breeding sites and historic breeding sites having capable habitat (consistent with the Streamside Roads Standard of the Forest Plan), and (2) adjacent to wetlands within 1/3 mile of known existing breeding sites and historic breeding sites having capable habitat.

   d. Effective closures of non-system roads and motor-vehicle trails that impact wetlands and riparian areas used by spotted frogs or boreal toads within 1/3 mile of known breeding sites and known historic breeding sites having capable habitat. An important step in attaining these conditions is to ascertain the distributions of spotted frogs and boreal toads.

2. Where it is physically not possible to avoid the placement of a new road in or adjacent to a riparian area, incorporate bridges or underpasses and wing fences to facilitate migrations and other movements under the road rather than over the top of the road (within 1½ miles of known breeding sites and known historic breeding sites having capable habitat). See ‘5’, below.

3. Where it is not possible to relocate a road or ATV trail (that currently results in elevated mortality due to crushing by vehicles), either close the road during the reproductive period (April – August) or incorporate bridges or underpasses and wing fences to facilitate migrations and other movements under the road rather than over the top of the road. See ‘5’, below.

4. Although less effective, large culverts can be used for the same purposes. Culverts need to have a long enough span such that streambanks on both sides of the stream or river (e.g., ≥3 ft. wide banks on each side) exist under the bridge to allow for overland travel under the bridge. Wing fences many times add to the effectiveness. See ‘5’, below.

5. Within 1/3-mile of known existing breeding sites and known historic breeding sites with capable habitat and, to the extent possible within 1½-mile of known existing breeding sites and known historic breeding sites with capable habitat, construct bridges and other stream crossings such that amphibians can move along streambanks underneath roads (e.g., intact streambank width of ≥3 ft. on each side of stream underneath the bridge or culvert), even in high water (except possibly peak flows) and so that amphibians do not have to cross over the top of roads when moving up and down riparian corridors (e.g., PARC 2008). Carry this out when replacing bridges and culverts to the greatest extent possible within 1½ miles of known existing breeding sites and known historic breeding sites with capable habitat breeding sites.

6. Minimize motorized traffic near breeding sites and close routes during peak migrations and dispersals.

7. Wherever possible, close and obliterate roads and motor-vehicle trails that may elevate mortality rates (a) in all habitats potentially used by spotted frogs and boreal toads within 1/3-mile of known existing breeding sites and known historic breeding sites with capable habitat; and (b) in and adjacent to riparian habitat within 1½ miles of known existing breeding sites and known historic breeding sites with capable habitat.

8. The extent to which roads and motor-vehicle trails exist and will be maintained within 200 yards and 1/3 mile of existing breeding sites and historic breeding sites having capable amphibian wetland habitat, the roads and motor-vehicle trails should be seasonally closed (e.g., during and after breeding seasons) to

minimize the potential for crushing of adult, juvenile, and metamorph spotted frogs and boreal toads by vehicles.

9. Document movement corridors used by spotted frogs and boreal toads and, to the extent possible, conduct inventories and studies (e.g., with radio telemetry) to delineate these corridors. Use this information to better inform road, bridge, and culvert management.

10. When assessing possible locations to place underpasses or comparable mitigation devices, recognition needs to be given to the possibility that current "road-kill hotspots" may not be a good indicator of where best to locate these devices (Eberhardt et al. 2013). Where populations declined at least in part due to a road and motorized traffic — which can be difficult to determine — assessments need to be made of capable habitat and places where amphibians crossed roads prior to the population declined.

II. Heavy Equipment

1. Avoid the use of off-road heavy equipment, including skidders, within 100 feet of breeding sites.

2. Avoid the use of off-road heavy equipment, including skidders, within 1/3-mile of breeding sites during the following periods: dispersal of adults and juveniles from breeding sites and late summer when a portion of adult boreal toads disperse into upland habitats including forests.

3. Compliance with the Logging in Riparian Areas Standard, Log Skidding Standard, and Streamside Road Standard of the Forest Plan would reduce the amount of crushing of individual frogs and toads because heavy equipment would not be used in or near riparian areas and wetlands.

4. Avoiding any use of heavy equipment within 100 feet of wetlands used by spotted frogs and boreal toads and within 100 feet of riparian areas ("A.2. Mix of Succession Stages and Moist Microsites in Created Openings") would greatly reduce the potential for crushing frogs and toads in this critical habitat.

5. The next zone of high importance is within 200 yards of breeding wetlands. This zone is important (1) for the proportion of individuals that remain near breeding wetlands and move from site to site within this zone, and (2) as a take-off point for a fairly high proportion of adults and juveniles that migrate and disperse to areas well beyond 200 yards (see the discussion on 200 yards and 1/3 mile in the "Buffer Zone and Levels of Protection" section). Use of heavy equipment like skidders and road maintenance equipment (other than road-surface work) should be avoided within this zone. An exception could be made if two independent breeding surveys several weeks apart fail to document breeding activity in a particular year.

6. Because a relatively high proportion of adults and juveniles move beyond 200 yards, use of heavy equipment within 100-200 yards of riparian zones, perennial streams, and wetlands should be avoided within 1/3 mile of known breeding wetlands while adults, juveniles, and metamorphs are moving through this habitat or are inhabiting this habitat.

7. Ensure that the footprint of oil, gas, and mineral developments are beyond 200 yards of breeding wetlands and are at least 200 yards from riparian areas within 1/3 mile of toad and frog breeding sites. This would limit the potential of heavy equipment crushing frogs and toads.

III. Livestock Grazing Use

1. Eliminate the potential of crushing breeding adults and eggs by not providing access by livestock to breeding wetlands until after eggs have hatched, which typically occurs by mid to late June at lower elevations and by mid to late July at high elevations (Patla 2001, Keinath and McGee 2005, Patla and Keinath 2005). This would avoid damage to egg masses and strings during a very sensitive stage. Mid June corresponds to the turn-out date for many cattle allotments and mid July corresponds to the turn-out date for many sheep allotments. These dates may be somewhat early for any breeding wetlands that are used for water sources soon after livestock area turned out.

2. Minimize the potential for crushing by livestock during the following critical periods identified by Keinath and McGee (2005:38), Patla and Keinath (2005), and Bull (2009): metamorphosis and dispersal from breeding wetlands (late July to late August, to late September at higher elevations), dispersal of juveniles (highly variable), and overwintering (late September to mid-May). Management to address two other important periods is important: managing livestock to minimize (1) crushing of tadpoles (during May-July, depending on elevation and other factors, through metamorphosis), and (2) when adults are moving through areas being grazed or are inhabiting areas being grazed (variable from June through September). This can be addressed through the following measures:
    a. Establish retention levels in the immediate vicinity of breeding pools that adequately limit mortality (see Appendix A and the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section. Additional measure may be needed where sheep are watered because they typically do not eat herbaceous vegetation at these sites and the concentrations of hundreds of sheep moving watering at a pool for such a short period can result in high mortality if this coincides with the tadpole or metamorphis periods.

       By limiting livestock grazing use to a maximum of 30% use of total herbaceous vegetation within a perimeter of 10 ft. of the waters edge at breeding sites (as outlined in Suitable Condition Statements for B.3), the potential for crushing adult and juvenile frogs and toads and tadpoles would be lower than would take place at higher use levels. If this maximum use level is insufficient, a maximum of 20% use should be considered.
    b. Limit livestock grazing use to a maximum of 30% of total herbaceous vegetation across a minimum of 80% of the area within 1/3 mile of known existing breeding sites and historic breeding sites with capable habitat remaining.
    c. Do not permit larger than permitted numbers of livestock on pastures that contain breeding habitat until after the majority of tadpoles have metamorphosed and dispersed in those pastures.
    d. Limit sheep watering in breeding wetlands to no more than one day each season in addition to 'e', below.
    e. Require deferred rotation in pastures (cattle) and parts of allotments (sheep) that contain breeding wetlands that are used for watering by livestock. This will help limit the potential for major trampling impacts of metamorphs, as well as juveniles and adults, to fewer years. On sheep allotments, "deferred rotation" involves altering feeding routes, including switching directions year after year; if altering feeding routes merely involves changing the direction of travel back and forth every other year, this would cut in half the number of years when negative effects could happen in any particular breeding wetland.
    f. Require rest rotation. By incorporating a full year of rest, this would reduce the potential impacts of trampling on frogs and toads.
    g. Establish troughs away from breeding wetlands to "pull" livestock from breeding wetlands. This will require no net loss of water going to breeding wetlands, unless it can be demonstrated that water diversions to troughs will not accelerate water-level declines in breeding wetlands (see recommended conservation actions for spring developments).
    h. Do not allow larger than permitted numbers of livestock on pastures that contain breeding habitat, except possibly after the metamorphosis period has been completed and after dispersal from breeding wetlands in those pastures.
3. Eliminate the potential of crushing tadpoles, metamorphs, and adults in the vicinity of known existing breeding sites and historic breeding sites with capable habitat through the use of fencing (complete exclusion of livestock from breeding sites). Fences would need to be placed at least 100 feet from the perimeter of wetlands. This is by far the most common recommendation cited in the literature for protecting amphibians during the breeding season (Bartelt 2000, Maxell 2000, Engle 2001, Patla 2001,

Keinath and McGee 2005, Patla and Keinath 2005, Shovlain 2006, Schmutzer et al. 2008). the Fish; Wildlife; Threatened, Endangered, and Sensitive Species Standard requires that “Range improvements… will be coordinated and designed to help meet fish and wildlife habitat needs, especially on key habitat areas… Special emphasis will be placed on helping to meet the needs of Threatened, Endangered, and Sensitive species.”

IV. Camping and Associated Activities

1. Enforce the existing special order that prohibits dispersed camping within 100 feet of streams, and this should be extended to include frog and toad breeding wetlands as well.
2. Minimize and, to the extent possible, prevent the establishment of dispersed camping sites and other intensively-used recreation sites in riparian areas and non-riparian meadows within 1/3 mile of boreal toad and spotted frog breeding sites, with special attention of reducing dispersed camping sites within 200 yards of breeding sites.
3. Enforce regulations and special orders that require motorized vehicles to remain on designated roads and trails, especially within 1/3-mile of breeding sites and within 100 ft. of riparian areas.
4. Provide educational signs or pamphlets, at recreational sites near known breeding sites, about spotted frogs and how they could be impacted by recreationists and their pets (Maxell 2000).
5. Do not establish new motorized and non-motor-vehicle trails within 100 feet of breeding wetlands and, where they already exist within this distance, reroute the trails so no part of the trail is within 100 feet of breeding sites.
6. Require that outfitters comply with allowable-use limits (e.g., maximum utilization, minimum stubble height) that would meet retention levels outlined in Objectives B.1 and B.2.

Measures and Indicators

Currently Monitored Elements

No aspects of crushing or, more specifically, survival rates of amphibians are being directly monitored on the BTNF.

The following elements currently being monitored on the BTNF can be used to periodically assessing the potential for crushing by motorized vehicles, heavy equipment, horses, and livestock:

- Location of Roads and Motor-Vehicle Trails, by Class **—** The BTNF currently has GIS layers for designated-open roads and motor-vehicle trails by class, as well as a layer for non-system roads and motor-vehicle trails. As user-created motor-vehicle trails increase in number and distribution, future surveys will need to be conducted to collect this data.
- Percent Retention of Herbaceous Vegetation – Increasing intensity of livestock grazing brings with it an rising potential for crushing of spotted frogs and boreal toads in habitats inhabited by these species, particularly when and where they concentrate. Percent retention of herbaceous vegetation provides an indicator of this potential (see B.3, above, for more detail). Percent use of key forage species and percent use of total herbaceous vegetation is being monitored to varying degrees on different districts.
- Footprint of Skid Trails and Landings – The percent of the land in a harvest units occupied by skid trails and landings provide an indication of the potential for crushing of amphibians by heavy equipment, along with information on the distance between the units and breeding sites. Because one of the design criteria for timber harvest and mechanical treatment projects addresses skid trails and landings on many projects, this is currently monitored on a project-by-project basis.

- Known Existing Breeding Sites and Known Historic Sites **—** While incomplete (i.e., there are many existing and historic breeding sites that remain unknown), there is an existing layer that identifies all known amphibian breeding sites.

Additional Monitoring Elements to Consider

Other elements that would help in monitoring the potential for crushing include the following:

- Location and Extent of Dispersed Camping Sites, by Intensity of Use **—** Some of the dispersed camping sites on the BTNF have been mapped, but the data set is incomplete.

Knowing the locations of all historic breeding sites, at least those still having capable habitat, would be useful, but except for data that was collected historically this likely will not be possible to attain.

C.2. REPRODUCTION AND SURVIVAL AS AFFECTED BY LIGHTS AND NOISE

Introduction and Background

This factor is important because artificial night lights and artificial loud noise have been shown to have substantial negative impacts on local populations of amphibians (Dawe and Goosem 2008, Perry et al. 2008), and it is possible for this factor to contribute to the abandonment of breeding sites or extirpation of local populations.

Development of Suitable Condition Statements

Summary of Management Direction

In addition to Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, the following provisions of the Forest Plan require the Forest Service to limit road building in riparian areas, remove roads in riparian areas as possible, and to limit oil and gas development, which would help limit the extent of artificial night lights and artificial loud noises near amphibian breeding sites. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to artificial lights and noise.

> ***Goal 4.1 (Forest Plan) —*** "Road management preserves wildlife security, soil, visual resource, and water-quality values."
>
> > ***Objective 4.1(a) —*** "Minimize new road building and downgrade or close existing roads and motorized access trails to maintain or increase wildlife security."
> >
> > ***Objective 4.1(b) —*** "Design roads and structures to retain soil, visual resource, and water-quality values."
>
> ***Streamside Roads Standard (Forest Plan)*** — "Wherever possible, roads will avoid riparian areas or drainageways. Where riparian areas or drainageways cannot be avoided, location and design of roads will apply sediment-reduction practices to prevent degradation of riparian or stream quality. Roads presently within riparian areas will be relocated outside riparian areas where possible."
>
> ***Road Maintenance in Riparian Area Standard (Forest Plan)*** — "Maintenance, improvement, and repair of roads within riparian zones would mitigate impacts of the road to water quality, but would not avoid impacts because erosion and sedimentation would continue, albeit at a lower rate, and roads would continue to be a source of contaminants."
>
> ***Goal 4.4 (Forest Plan) —*** "Other resources are protected during exploration and development of subsurface resources."

> ***Objective 4.4(b) —*** "Prevent surface occupancy where potential effects on other resources, including wildlife, Threatened and Endangered species, recreation, soils, air, visual resources, and water are unnacceptable."

Estimated Natural Conditions

Natural conditions for his element consist of the complete absence of artificial night light and artificial (e.g., mechanical) noise. With a complete absence of artificial night lighting and artificial noise, amphibians would not be negatively impacted to any degree by artificial light and noise. Therefore, natural conditions with respect to this element represent ideal conditions with respect to reproduction and survival as affected by lights and noise, although it is recognized that suitable conditions for this element extends beyond the complete absence of artificial night light and artificial noise.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the natural conditions of a complete absence of artificial night light and noise. This is because meeting Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, and higher-level direction with respect to spotted frogs and boreal toads would not be enhanced by introducing artificial night lights or noise near breeding sites or other habitats used by spotted frogs and boreal toads. Amphibian communities in this area developed in the absence of any artificial night lights and in the absence of artificial (especially mechanical) noise.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, given the impracticality of a complete absence of artificial night lights and artificial noise (e.g., headlights from cars, lights from campers, noise from vehicles and campers) in the process of providing for activities like vehicle access, recreation, and timber harvest, it will be necessary to accommodate some degree of deviations from natural conditions for this element. Restated, because these uses contribute to artificial night lighting and/or artificial noises, some level of disturbance and behavioral effects must be accommodated.

Artificial night lighting and artificial noises have been shown to negatively affect a variety of amphibian species. Artificial lighting has been shown to alter growth of tadpoles, alter the behavior and physiology of adults, and can immobilize adults on roadways which increases there susceptibility to being crushed by vehicles (Patla and Keinath 2005, Perry et al. 2008). Artificial noise has been shown to impede recognition of the calls of males, alter behavior, and reduce densities at breeding sites (Wollerman 1999, Dawe and Goosen 2008). These effects are discussed in more detail in the "Risk Factors and Restoration Factors" section, below.

It is not practical, given available information, to quantify the degree to which reproductive success and survival rates of spotted frogs and boreal toads would be reduced as a consequence of different levels of artificial night lighting and artificial noise or the degree to which they would contribute to downward trends in the distribution and abundance of these species, particularly in light of all of the other non-quantified factors negatively affecting spotted frogs and boreal toads on the BTNF (e.g., loss of habitat, habitat fragmentation, low herbaceous retention levels, chitrid fungus). Determining levels of artificial lighting and noise that are within a range of acceptable impacts for each of a wide range of possible situations on the BTNF would require intensive research and follow-up monitoring, requiring a large amount of funding just for this element. Furthermore, control measures would likely be applied at a coarse scale anyhow.

With little information to identify maximum lumens of light and decibels of noise that would still allow consistent successful reproduction at breeding sites and in the absence of major research projects addressing the effects of artificial night lighting and artificial noise on spotted frogs and boreal toads in the BTNF area, a starting point would be to define desired conditions for this element based on minimum distances between artificial lights/noise and breeding sites. For any given activity producing artificial night light and/or artificial noise, negative impacts decline with progressively greater distances from breeding sites.

Lights from oil and gas developments would substantially illuminate breeding sites where located ≤200 yards from breeding sites and noise from these developments would substantively increase noise levels at breeding sites, and therefore, night lighting and noise from oil and gas developments within 200 yards of breeding sites would clearly fall outside the range of suitable conditions for this element. It is likely that lights at oil and gas developments would measurably reduce darkness at breeding sites if located within 1/3 mile (about 587 yards) from breeding sites, and noise would also be substantively increased at breeding sites (see "Risk Factors and Restoration Factors"). Negative effects of lights and noise from oil and gas developments likely decline substantively somewhere between 1/3 mile and 1½ miles, but a definitive threshold has not been identified for spotted frogs and boreal toads. It is possible that darkness, brightness of lights, and noise at breeding ponds would remain within suitable levels when oil and gas developments are located >1/3 mile from breeding sites, especially where there are physical barriers (e.g., forestland, hills) between the two, and they likely would remain within suitable levels when oil and gas developments are located >1½ miles from breeding sites.

It is likely that darkness, brightness of lights, and noise at breeding ponds would remain within suitable levels when motorized vehicles, dispersed and developed camping sites, and cabins are located ≥200 yards from breeding sites, especially where there are physical barriers (e.g., forestland, hills) between the activity and breeding sites and where headlights do not shine toward breeding ponds as vehicles pass. Exceptions are roads that have more than about 50 vehicles/hour and where barriers do not substantively reduce the lights and noise at breeding ponds.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages, and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section (they were used to help focus attention on factors that pose the greatest risk). They define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following description of suitable conditions is written qualitatively and are founded primarily on the concept of minimizing departures from natural conditions to the greatest extent possible.

1. Breeding densities, reproductive success, survival rates, and movements of metapopulations of spotted frogs and boreal toads at existing breeding sites and historic breeding sites having capable amphibian wetland habitat are no more than minimally reduced (e.g., due to reduced tadpole growth rates, altered behavior at breeding sites, and impairments that hinder movements) by artificial lighting at night and mechanical noise.

In the near future, these desired condition statement need to be expanded or replaced with a statement that defines maximum limits of lumens (a measure of visible light) and decibels at breeding sites, or comparable units of measure. The above description of suitable conditions relies upon minimum distances identified in the "Conservation Actions to Consider" section; i.e., it is assumed that if oil, gas, and mineral developments are >1/3 mile from breeding sites, negative impacts would be minimal.

"Existing breeding sites and known historic breeding sites having capable amphibian wetland habitat" is identified as the geographic scope because restrictions on activities that have potential of impacting reproduction, survival, and movements due to artificial night lights and artificial noises are only an issue where breeding sites exist, but restrictions can only be imposed around breeding sites that are known. This highlights the importance of conducting thorough pre-development surveys to ascertain whether any existing or capable breeding sites would be affected. Objective 3.3(a) and the requirement to avoid or minimize impacts to sensitive species (FSM 2670.32) must be met regardless of whether locations of breeding sites are known. Pre-development surveys and appropriate changes to any development proposal would account for this.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

The following suitable conditions were taken from other sections of the report.

> A.6. Habitat Connectivity and C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts) — To the extent these suitable conditions are attained with respect to

roads and camping sites near breeding sites, and the extent to which they contribute to in roads and dispersed camp sites near breeding sites being seasonally or permanently closed or rerouted, this would help minimize artificial noises and lights associated with vehicles and camping.

Risk Factors and Restoration Factors

The following risk factors have the potential to increase the amount and magnitude of artificial night lights and artificial noise, which limit the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

There does not appear to be any published information on the effects of artificial night lights and artificial noises specifically on spotted frogs and boreal toads, as no research has been conducted on this topic. However, artificial lights at night and loud artificial noise have been shown to affect a variety of amphibians in a range of different geographic areas (Buchanan 2006, Wise and Buchanan 2006, Dawe and Goosem 2008, Perry et al. 2008). Of all light- and noise-producing activities and developments that can potentially occur on the BTNF, oil and gas developments have the greatest potential to adversely affect spotted frogs and boreal toads, given the many bright lights and the loud artificial noise, as well as greatly increased vehicle traffic along roads that access the developments.

To the effect that artificial light and/or noise adversely affect reproduction or growth, they have the potential to contribute to lower population levels, especially given the likelihood that any reductions in numbers or distribution of spotted frogs and boreal toads on the BTNF are driven by a variety of possibly interacting or synergistic factors. While artificial light and noise may currently not have very large effects on the BTNF populations of frogs and toads, they have the potential to cumulatively add to the impacts to local populations. Activities that add or increase artificial lights at night and that add or increase loud artificial noise have the potential to impact local populations of spotted frogs and boreal toads.

The following summarize the range of potential effects of artificial night lighting and loud artificial noise.

Effects of Artificial Light at Night

Artificial illumination at night has been shown to have several effects on a range of amphibian species, and it is possible for spotted frogs or boreal toads to be affected by one or more:

- Altered Growth of Tadpoles and Production of Smaller Metamorphs — Perry et al. (2008) cited several studies showing that growth of tadpoles was slowed in painted frogs and African clawed frogs, and that the latter metamorphosed at a smaller size. Conversely, Perry et al. (2008) cited one study showing that constant light accelerated tadpole development in leopard frogs.

- Altered Behavior and Physiology of Adults — Patla and Keinath (2005:54) noted that "Artificial night lighting around facilities may disrupt breeding and foraging (Buchanan 1993)." Perry et al. (2008) cited studies showing that (1) American toads use photoperiodic cues to thermoregulate behaviorally; (2) exposure to night for as little as 1 minute can disrupt production of precursors required for tadpole melatonin production, which may in turn affect physiological performance; (3) foraging, fat storage, and growth in adult toads can be affected; (4) calling by males of studied species of frogs is disrupted by night light; (5) sperm production is lowered in common Asian toads when in constant lighting; (6) mate choice and egg-laying behavior in females can be affected by night light; (7) leopard frogs suffered from retinal irregularities when in constant lighting; and (8) constant lighting can alter the expression of genes in some species, which in turn affects other physiological processes.

  Buchanan (2006) also identified a wide range of behavioral and physiological effects of artificial night lighting on frogs and toads, including altered feeding behavior, reduced ability to forage effectively, changes in reproductive behavior (e.g., altered mate choice by females, choice of egg-laying sites by females, calling by males), altered rhythms of color changes in tadpoles, possible reduction in ability of tadpoles to thermoregulate properly and avoid predators due to miscues of illumination "informing" them to move to shallow waters when they should do the opposite, among other effects. These were supported by scientific studies.

Buchanan (2006) and Wise and Buchanan (2006) assessed that rapid shifts in illumination resulting from intermittent light sources may influence foraging success by making it difficult for amphibians to identify and catch prey. As an example, rapid shifts in illumination can occur along a curved roadway where adjoining habitats are intermittently brightly lit by headlights of traveling vehicles. This can particularly be an issue where traffic is regular for extended periods at night.

The International Dark-Sky Association (undated) referenced several of these effects on frogs and toads, adding that, because many frogs and toads need to remain close to water, they are less able to compensate for changes in their environment by relocating.

- Immobilization on Roadways — Perry et al. (2008) cited a study that found American toads, spring peepers, green frogs, and wood frogs to be "more likely to become immobile on the road when approached by automobile-related stimuli than when left undisturbed." This effect can increase mortality rates along roadways.

Effects of Loud Artificial Noise

Loud artificial noises, such as from oil and gas developments, heavy-traffic roads, off-road vehicles, loud music, and urban areas has been shown to affect a range of amphibian species, and it is possible for spotted frogs or boreal toads to be affected by one or more:

- Inability of Females to Distinguish or Hear Males Calling — Dawe and Goosen (2008) cited studies showing that noise from vehicle traffic significantly impeded recognition of males calling for five of six species tested in laboratory settings. Wollerman (1999) found that female *Hyla ebraccata* tree frogs were unable to distinguish locate male calls after a certain noise level.

- Altered Behavior — Dawe and Goosen (2008) cited one study showing that the spacing between calling males was significantly altered.

- Mistaken Cues to Emerge from Burrows — Off-road vehicles produce low-frequency sounds that travel long distances, and spadefoot toads exposed to motorcycle sounds have been shown to leave their burrows due to the behavioral response that such sounds illicit (Bondello and Brattstrom 1979, as cited by Berry 1980). They are adapted to emerge from burrows at the sound of oncoming thunderstorms that ultimately produce temporary ponds in which the spadefoot toads breed. Emerging from burrows in response to off-road vehicle sounds puts individuals at risk in such a dry environment. There is no indication this affects spotted frogs or boreal toads, but it contributes to the assessment that there is a large range of potential effects of noise on amphibians.

- Reduced Densities at Breeding Sites — Dawe and Goosen (2008) cited several studies possibly indicating that vehicle noise contributed to lower densities, but results of the studies were not able to account for the effects of crushing by vehicles and the fragmenting effects of roads.

Developments and Activities that Contribute to Artificial Night Light and Loud Artificial Noise

- Oil, Gas, and Mineral Developments — Of all developments and activities on the BTNF, oil, gas, and mineral developments have the brightest lights and produce the most noise. Therefore, of all developments and activities on the BTNF, they pose the most risk for spotted frogs and boreal toads especially when located near breeding sites. At 100 feet through 200 yards, the brightness of lights and noise at wetlands would be significant. Even at 1/3 mile (587 yards), lights from these developments could have substantial biological effects at breeding wetlands, given the brightness of the many lights and the level of noise produced. In their comments on proposed oil and gas deveopments, the WGFD typically recommends a 500-meter (550-yard) buffer (Z. Walker, WGFD; comments on the January 9, 2013 draft report). This is more conservative than was identified in WGFD (2010c). WGFD (2010c:104) recommended “No drilling activity or disturbance should be permitted within 500 feet of a riparian area, wetland or stream channel. Apply a standard NSO [no surface occupancy] stipulation to all riparian zones and a 500-ft. corridor extending from the outermost limit of the riparian habitat.” This only applies to riparian areas and wetlands in general and does not address potential effects of artificial lights and noise on amphibians at breeding sites. Their recommended 500-ft. buffer is “…conservative given the sensitivity of many wildlife species…” and “…A 500-ft. NSO buffer provides minimal protection to wetland and riparian habitat functions” (WGFD 2010c:41-42). They identified effects distances ranging from about 270 yards (820 ft.) to 0.3 miles for variety of wildlife species, and more than 1 mile for some species. They cited several scientific sources.

- Individual Buildings and Building Complexes — Lights associated with dispersed camping, campgrounds, recreation residences, and Forest Service compounds (Maxell 2000, Patla and Keinath 2005, Perry et al. 2008). Patla and Keinath (2005:54) noted that “Artificial night lighting around facilities may disrupt breeding and foraging (Buchanan 1993).” Maxell (2000:28) noted that “If breeding ponds are subject to constant illumination by a fixed light or repeated exposure to car lights near a recreation facility it is possible that breeding success may be negatively impacted.” He added that foraging by species needing complete darkness may be disrupted, based on two studies he cited. However, it does not appear that boreal toads and spotted frogs need complete darkness for foraging (Keinath and McGee 2005, Patla and Keinath 2005).

  Restricting the placement of buildings at least 200 yards from breeding wetlands would help reduce the effects of artificial lights and noise associated with the buildings and vehicles at the buildings. Effects of artificial lights and noise at buildings could extent beyond 200 yards and, therefore, buildings placed beyond 1/3 mile of breeding sites would better assure satisfactory mitigation.

  This includes buildings on private inholdings and along the National Forest System boundary, recognizing the Forest Service does not have any authority to manage these uses.

- Campgrounds and Dispersed Camping Sites — The effects of artificial light and noise at campgrounds and dispersed camping sites accessed by roads (i.e., camping associated with motorized vehicles) is similar to those of “Individual Buildings and Building Complexes,” above. Lights include external lights on recreational vehicles and camping trailers, lanterns, and fires. Noises include generators and other mechanized noise and music. It is possible for artificial lighting and noises to be of greater magnitude at camp sites because people are at camp sites to recreate and to spend time with others, meaning there tend to be more people spending time outside at night than at building complexes and because recreational vehicles many times have generators that run periodically at night, compared to building complexes which do not have this noise at night.

- Motorized Traffic on Roads Near Breeding Sites — Where roads are located near breeding sites, it is possible for lights and noise associated with the roads to affect breeding, especially when relatively high traffic levels make the noise and lights of vehicles more than infrequent. Examples include highway traffic and heavy traffic associated with oil and gas developments.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the “Suitable Condition Statements,” above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including Keinath and McGee (2005), Patla and Keinath (2005), PARC (2008), and WGFD (2010a,b), as well as publications cited earlier in this section and the “Buffer Zones and Levels of Protection” section.

Measures to mitigate effects of lights and mechanical noise need to be identified for night-time traffic on roads near breeding wetlands and facilities (e.g., oil, gas, and mineral development and building complexes) located near breeding sites. Mitigation measures need to address buffer-zone widths and restrictions applicable to these widths. As a general rule, restrictions need to get progressively higher with declining distance to breeding sites. A fundamental principle is the greater the distance and the dimmer the lights and the lower the noise levels, the better.

1. Ensure that the footprint of oil, gas, and mineral developments are beyond 1/3 mile of breeding wetlands, unless geographic features would (1) completely block direct views of lights from the wetlands and (2) greatly reduce noise (e.g., by ≥75-80%) as measured at the wetland. Darkness, brightness of lights, and noise at breeding ponds resulting from oil and gas developments would need to be assessed on a case-by-case basis (e.g., presence, location, and effectiveness of forestland, terrain, and other physical barriers). It is possible that developments will need to be substantially more than 1/3 mile from breeding sites.
2. Prevent the establishment of dispersed camping sites and other intensively-used recreation sites (1) within 200 yards of breeding sites (regardless of type of habitat) and (2) in riparian areas and non-riparian meadows within 1½ miles of boreal toad and spotted frog breeding sites. Where possible, eliminate dispersed camping sites within 200 yards of breeding sites.
3. No building complexes within 1/3-mile of breeding sites.
4. Reevaluate the suitable condition statements and adjust them to identify thresholds of acceptable night-time illumination and noise at breeding sites as additional scientific information warrants.

Measures and Indicators

Currently Monitored Elements

Light and noise currently are not being monitored on the BTNF, either at the BTNF level or at the project level, nor are reproductive output, behavior, or survival rates of amphibians.

Additional Monitoring Elements to Consider

Reproductive output, behavior, and survival rates of spotted frogs and boreal toads would continue to not be monitored directly, except possibly in limited situations depending on availability of funding.

At the project level, the distance between breeding wetlands and light and noise sources would be monitored, especially for oil and gas development projects. Ideally, maximum allowable lumens and decibels at breeding sites can be determined in the near future, at which time these two attributes could be monitored where appropriate. More information is needed on the degree of change in night-time illumination and thresholds of noise at breeding sites that are within acceptable ranges.

C.3. HABITAT EFFECTIVENESS AND SURVIVAL WITH RESPECT TO FISH

Introduction and Background

This element is important because such a large number of formerly fishless lakes and ponds on the BTNF — many of which had high potential of being inhabited by spotted frogs and/or boreal toads prior to being stocked by trout — were stocked with trout and because trout populations in most of these stocked lakes persist today, either through successful reproduction or periodic stocking. Stocked fish in high-elevation, formerly fishless lakes and ponds have had major adverse impacts on amphibians throughout the high elevations of the west (USFS 1997, Maxell 2000, Pilliod and Peterson 2001, Keinath and McGee 2005, Patla and Keinath 2005, Reaser et al. 2005, Murphy et al. 2010b). In many cases, introducing trout into formerly fishless lakes and ponds that had been used by amphibians results in amphibians no longer using the lakes and ponds, either through shifts in habitat use or through extirpation, or a major decline in numbers. This is discussed further in the “Risk Factors and Restoration Factors” section, below.

Development of Suitable Condition Statements

Summary of Management Direction

Besides Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, there does not appear to be any management direction that limits the distribution of fish stocking. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to impacts of stocked fish.

Estimated Natural Conditions

Natural conditions for his element consist of (1) the absence of nonnative and native trout in formerly fishless lakes and ponds, especially those lakes and ponds that had been used by spotted frogs and/or boreal toads; and (2) the endemic distribution and abundance of trout in streams (including beaver ponds), lakes, and ponds on the BTNF. With a complete absence of nonnative and native trout in formerly fishless lakes and ponds, amphibians would not be negatively impacted to any degree by fish. Natural conditions are within the range of suitable conditions for spotted frogs and boreal toads since these are the conditions under which amphibian communities formed or developed in this area.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to the natural conditions (complete absence of trout in formerly fishless lakes/ponds and the endemic distribution and abundance of trout in streams, lakes, and ponds), except that the elimination of trout from endemic lakes, ponds, and stream systems that provides suitable habitat for spotted frogs and boreal toads would benefit these species. The removal of trout from their endemic habitat obviously is unrealistic and is not discussed further. Stocking fish into formerly fishless lakes and ponds in no way contributes to the achievement of Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, the Diversity of Wildlife Habitat Guideline, or higher-level direction with respect to spotted frogs and boreal toads. Therefore, there is no reason — from the standpoint of spotted frogs and boreal toads — to delineate as “suitable” a larger-than-natural proportion of lakes and ponds inhabited by native and nonnative trout.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, including the provision of fishing opportunities, and the popularity of trout fishing on the BTNF, it will be necessary to accommodate some degree of deviations from natural conditions for this element (i.e., to accommodate some level of impacts from trout in formerly fishless lakes and ponds), so long as trout in formerly fishless lakes have not contributed to downward trends in spotted frog or boreal toad populations on the BTNF. The stocking of trout into formerly fishless high-elevation lakes and ponds on the BTNF likely has had major adverse impacts on amphibians (USFS 1997:23, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005) and in many cases have likely rendered the stocked lakes less-than-suitable for spotted frogs and possibly boreal toads. There likely are features of lake and pond habitat that reduce the susceptibility of tadpoles to predation by trout, but these are unclear. Introduction of trout into formerly fishless lakes and ponds that had been used by spotted frogs and boreal toads for breeding has the potential to have contributed to major declines or elimination of some local populations. See “Risk Factors and Restoration Factors” for more detail.

The Forest Plan does not require 100% of spotted frog and boreal toad habitat to be provided in suitable condition. Objective 3.3(a) and the Sensitive Species Management Standard require that an “adequate amount” of suitable habitat to be provided. Therefore, it is acceptable for some lakes and ponds formerly used by spotted frogs and/or boreal toads to have become unsuitable due to fish stocking, so long as, in combination with other factors, healthy populations can be maintained over the long term on the BTNF. The endemic distribution and abundance of trout in the BTNF area likely restricted the distribution and abundance of spotted frogs and possibly boreal toads to some degree. The introduction of trout into formerly fishless lakes and ponds appears to have further reduced the distribution and abundance of spotted frogs and possibly boreal toads on the BTNF, based on the impacts associated with predatory fish (Maxell and Hokit 1999, Maxell 2000, Corn 2003, Keinath and McGee 2005, Patla and Keinath 2005, Boone et al. 2007).The distribution of trout on the BTNF was unnaturally expanded on the BTNF to the point that no adjustments can likely be justified to stock currently fishless lakes and ponds, especially those currently inhabited by spotted frogs and/or boreal toads or those that potentially could be inhabited by the spotted frogs and/or boreal toads.

It is impractical at this time to consider the elimination of native and nonnative trout from formerly fishless lakes and ponds that now have trout, except possibly in limited situations. It is possible that, to strike a balance between meeting Objective 3.3(a) for sensitive species and Objective 2.1(a) for game species — including taking into account all of the factors negatively affecting spotted frogs and boreal toads — may entail halting the stocking of trout in some lakes and possibly even the removal of fish in some lakes that would otherwise have a high potential of supporting breeding by spotted frogs or boreal toads. Introduced trout in formerly fishless lakes that did not support breeding by spotted frogs and boreal toads is immaterial to breeding-habitat suitability for amphibians. Thus, there would be little need to consider removal of trout from formerly fishless lakes that have a low potential of supporting breeding by these amphibians. An important part of any examination of how trout in formerly fishless lakes and ponds affect habitat suitability will be an assessment of the effects of stocked fish in relation to the large number of other factors that impact spotted frogs and boreal toads.

In summary, fish stocking only affects the suitability of breeding habitat for spotted frogs and boreal toads in formerly fishless lakes where these amphibians bred. It is unclear how many stocked lakes fit into this category. Where trout now exist in formerly fishless lakes that once supported breeding by spotted frogs or boreal toads, the lakes may now not provide suitable habitat conditions for breeding.

Suitable Condition Statements

The following suitable condition statements were based on the information provided in the previous pages, and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section (i.e., they were used to help focus attention on factors that pose the greatest risk). Suitable condition statements define conditions that need to be met in order to meet the “suitable habitat” portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions of suitable conditions are written qualitatively and are founded primarily on the concept of minimizing departures from natural conditions to the extent possible while still providing opportunities for fishing in lakes and ponds that formerly did not have trout in them.

1. In lakes, ponds, wetlands, and streams that currently do not contain trout or other game fish, spotted frogs and boreal toads would continue to not be impacted by predatory fish.

2. To the extent possible, and as opportunities arise, formerly fishless lakes, ponds, wetlands, and streams currently inhabited by trout or other game fish that provide otherwise suitable habitat for spotted frogs and boreal toads would once again become fishless, especially sites that are within dispersal distances of existing breeding sites (e.g., within 1/3 to 1½ miles).

3. Conduct an evaluation of the degree to which each formerly fishless lakes and ponds now supporting trout would otherwise provide suitable habitat for breeding by spotted frogs and boreal toads, with an emphasis on lakes and ponds known to have supported breeding (i.e., known historic breeding sites) and lakes and ponds within 1½ miles of known existing breeding sites.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

None of the other suitable condition statements would contribute to meeting suitable condition statements under C.3, above.

Risk Factors and Restoration Factors

The following risk factors have likely altered the distribution and abundance of spotted frogs and boreal toads on the BTNF and pose further risks to additional losses, which limits the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

In general, stocking fish in high-elevation lakes has had major adverse impacts on amphibians throughout the high elevations of the west. According to Maxell (2000), more than 95% of high-elevation lakes in the western U.S. were fishless prior to stocking, and this likely applies to lakes on the BTNF to a large degree. Reaser and Pilliod (2005:561) stated that brook trout, cutthroat trout, and rainbow trout have "…negatively affected the distribution and abundance of Columbia spotted frogs (Munger et al., 1997a,b; Pilliod and Peterson, 2000, 2001)." Pilliod and Peterson (2001) found that, not only were spotted frogs significantly lower in abundance in trout-stocked sites, abundance was significantly lower in non-stocked sites in basins with stocked sites. Murphy et al. (2010b) provided genetic evidence that habitat connectivity was negatively affected by the presence of predatory fish in northeastern Idaho, among other factors. Bull and Hayes (2000) found that the number of recently metamorphosed spotted frogs was inversely correlated with the presence of fish below approximately 6,000 ft. elevation.

Trout feed upon eggs, larva, and some adults of amphibians (Maxell 2000, Patla and Keinath 2005, Reaser and Pilliod 2005), and stocking of nonnative fish has the potential to have had different effects on spotted frogs and boreal toads. Spotted frogs are palatable to trout, and tadpoles and adults have been found in the stomachs of trout (Patla and Keinath 2005). Patla and Keinath (2005) cited a study demonstrating significant reductions in spotted frog abundance in areas where trout had been stocked. The authors of this study apparently also documented that deep-water fishless lakes allowed the highest over-winter survival of spotted frogs. The presence of fish also can result in adults avoiding the use of waters inhabited by fish, reduced growth rates of larva as a result of staying in refugia to avoid fish predation, reduced growth rates in adults as a result of avoiding wetlands inhabited by fish (Patla and Keinath 2005). In this way, stocking of trout affects survival as well as habitat effectiveness.

On the other hand, it is not clear whether trout eat boreal toad eggs, tadpoles, and young toads and, if so, to what extent. According to Patla (2001) and Keinath and McGee (2005), some fish have been shown to avoid eating toad tadpoles and adults, and Gasso et al. (2010; as cited by Brown et al. 2015) demonstrated that Yosemite toad eggs and tadpoles are unpalatable to brook trout and generally not eaten by them. To the extent boreal toad eggs and tadpoles are not eaten by trout, boreal toads would have been less affected by fish stocking than for spotted frogs. On the other hand, Wind and Dupuis (2002:12) noted that "The practice of stocking fishless lakes may be one of the biggest threats to Western Toads, where population declines can occur unnoticed in relatively pristine, uninhabited areas." Keinath and McGee (2005) assessed that presence of fish can result in reduced growth rates of boreal toad tadpoles as a result of them staying in refugia to avoid fish predation.

Some types of diseases with potential to affect both frogs and toads, including their tadpoles, may be spread by the stocking of fish. For example, Saprolegnia ferax — a fungal disease associated with hatchery fish — has been found to cause very high mortality to boreal toad embryos (Blaustein et al. 1994, *as cited by Maxell 2000*). Brown et al. (2015:46) wrote that "Introduced fish may be vectors of introduced parasites and pathogens (Kennedy et al. 1991, Kennedy 1993). Laboratory experiments showed that the water mold, *Saprolegnia ferax*, can be transmitted from hatchery fish to western toad embryos (Kiesecker et al. 2001)." It is also possible that fish to compete with spotted frogs for aquatic insects (see Brown et al. 2015:46 for discussion relative to yellow-legged frog).

The assessment by USFS (1997:23) for the BTNF recognized that fish stocking has adversely impacted amphibian populations on parts of the national forest, including the Wind River Range. Only a small number of breeding sites have been documented in the Wind River Range. While it is possible that the elevation of a portion of lakes and ponds in the Wind River Ranger are too high to provide viable breeding sites for spotted frogs and boreal toads and while it is possible that habitat conditions of a portion of the lakes and ponds are otherwise less-than-suitable for breeding, at least some of the lakes, ponds, and other wetlands that supported breeding no longer do as a consequence of fish stocking.

The near absence of spotted frogs and boreal toads in the Wind River Range may in part be due to the high elevations of the lakes, ponds, and other wetlands; most of these water bodies in the Wind River Range are >9,000 feet in elevation and 99% of spotted frog and 97% of known breeding sites on the BTNF are <9,000 feet in elevation. There are four possibilities: (1) spotted frogs and boreal toads naturally do not breed above about 9,000 feet in elevation in this area; (2) spotted frogs and boreal toads naturally and currently breed above 9,000 feet, but few breeding sites have been documented in part given the lower amount of time and effort spent above this elevation; (3) spotted frogs and boreal toads naturally bred at higher elevations but human-related factors (e.g., stocked fish) or interaction of several factors have reduced the number of breeding sites above 9,000 feet in elevation; and (4) a combination of '2' and '3.' Aside from the possibility of factors solely affected by elevation (e.g., water temperature), it is unlikely that habitat conditions above 9,000 feet are unsuitable for spotted frogs and boreal toads.

It is possible that water temperatures in wetlands much over 9,000 feet do not reach high enough temperature for long enough each day for enough days each summer to facilitate successful breeding. Carey et al. (2005) wrote at length about the importance of relatively high water temperatures to ensure that boreal toad tadpoles successfully complete metamorphosis prior to winter. In an experiment they conducted, Carey et al. (2005:227) found that ― at four temperatures evaluated ― tadpole development stopped at a constant temperature of about 50 ºF, development was slowest at about 55 ºF, development was most rapid at about 87 ºF, and development was intermediate at an alternating regime of about 50 ºF for 12 hours and about 87 ºF for 12 hours. They did not evaluate temperatures between 55 ºF and 87 ºF, but presumably temperatures at the upper end of this range (e.g., >70 ºF) are most beneficial. Information does not exist on shallow-water temperatures at different elevations on the BTNF.

Dumas (1964:179) reported that tadpoles of leopard frogs (a close relative of spotted frogs) develop normally in the laboratory at 50 °F, and that "Under field conditions at high altitudes where waters are cooler, the time necessary for metamorphosis at 10 °F [50 °F] is so long that freezing weather often kills all young frogs before they are ready for hibernation." The difference between leopard frogs and spotted frogs was not reported, but Dumas (1964) inferred that spotted frog tadpoles could tolerate somewhat colder temperatures than leopard frogs.

If water temperatures are low enough for long enough periods of time, this can result in tadpoles not completing metamorphosis before water temperatures drop in the fall, at which time tadpole development ceases (Carey et al. 2005). Although some authors have assumed tadpoles would complete metamorphosis the following year, Carey at al. (2005) assessed that over-winter survival of tadpoles was likely low in their study area in Colorado.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads. The following management actions were based on a range of publications, including Maxell (2000) and Patla and Keinath (2005:59), as well as publications cited earlier in this section.

1. Avoid stocking of trout or any other game fish in any additional ponds or lakes that currently provide otherwise suitable habitat for spotted frogs or boreal toads, and that is within 1½ mile of breeding sites and in any additional ponds or lakes that has the potential to be used by spotted frogs or boreal toads. This would need to be coordinated with the WGFD.

2. Consider terminating the stocking of fish in lakes with suitable spotted frog or boreal toad habitat within 1½ miles of existing breeding sites, especially those in which fish are not successfully reproducing. This would need to be coordinated with WGFD.

Measures and Indicators

Currently Monitored Elements

The following attribute is currently being monitored by Forest Service and WGFD fisheries biologists:

- <u>Presence/Absence of Trout by Water Body</u>

Additional Monitoring Elements to Consider

Reproductive output, behavior, and survival rates of spotted frogs and boreal toads would continue to not be monitored directly, except possibly in limited situations depending on the need for such monitoring in relation to stocked fish and availability of funding.

C.4. SURVIVAL AS AFFECTED BY DISEASE

Introduction and Background

This is an important factor because literature reviews and conservation assessments identify disease as a major conservation concern, likely the factor that is affecting boreal toads and possibly spotted frogs to the largest degree (e.g., Maxell 2000, Wind and Dupuis 2002, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, Reaser and Pilliod 2005, USFWS 2011) and because disease appears to be a major contributor to the current status of boreal toads and spotted frogs on the BTNF (Patla 2001, Pilliod et al. 2010). Of particular concern at present are non-endemic diseases like chytrid fungus and ranavirus that are highly infectious and can have severe adverse impacts on amphibian populations (Corn 2003, Voyles et al. 2009, Padgett-Flohr and Hopkins 2010, Pilliod et al. 2010). Chitrid fungus (or, chytridiomycosis), is caused by the pathogen Batrachochytrium dendrobatidis, and is affecting boreal toads and spotted frogs in this part of the Rocky Mountains more than any other disease. Pilliod et al. (2010) found relatively high annual survival of uninfected adult toads (0.73-0.77) at all three locations they studied in Montana, Wyoming, and Colorado, and lower annual survival of adult toads at the Wyoming and Colorado sites infected with chytrid fungus (0.42 and 0.53, respectively, for Black Rock–BTNF and the Colorado site). Chitrid fungus infected amphibians in most wetlands sampled across the BTNF. When chitrid fungus or ranavirus or one of the other highly infectious diseases are introduced into a population, it commonly has severe impacts on the population regardless of actions that are taken to reduce the prevalence of the disease.

Reduced habitat conditions (e.g., as discussed in elements A.1 through B.4) and other stressors (e.g., as discussed in elements C.1 through C.3) have the potential to exacerbate the negative effects of disease on amphibians (Cleaveland et al. 2002, Corn 2003, Forson and Storfer 2006, Gray et al. 2007, Bancroft et al. 2008, Gray et al. 2009, Gahl and Calhoun 2010, Groner 2012, Adams et al. 2013, Gallana et al. 2013, Reeve et al. 2013), as discussed in more detail in the “Multiple Stressors and Viability” section in Part I of this report. Therefore, given the prevalence of chitrid fungus in this part of the Rocky Mountains, it is imperative that habitat conditions and survival elements (elements A.1 through C.3) be maintained, as a whole, in suitable conditions. Furthermore, having a large number of habitat and survival elements at the low end of suitable conditions (i.e., managing for minimum thresholds) makes boreal toads and spotted frogs more vulnerable to greater impacts to diseases than if conditions of different habitat and survival elements were spread across the range of suitability.

Development of Suitable Condition Statements

Summary of Management Direction

Aside from Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, there does not appear to be any management direction that specifically calls for actions to be taken to limit the introduction and spread of diseases in wildlife. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to disease.

While Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, and the higher-level direction on sensitive species — with respect to spotted frogs and boreal toads — may not apply directly to combating chytrid fungus, ranavirus and other diseases (since there are no known methods to directly reduce their prevalence), the achievement of this management direction in light of chytrid fungus being present relies on greater emphasis being place on providing an adequate amount of suitable habitat and ensuring that activities do not contribute to long-term or further declines in populations or habitats (Objective 3.3(a)). Therefore, because habitat conditions, habitat effectiveness, and factors that affect survival and reproduction can all influence the degree to which a given disease impacts a particular population, management direction outlined in the “Summary of Management Direction” for all previous habitat and survival elements (i.e., for A.1-A.6, B.1-B.4, and C.1-C.3) apply here as well.

Estimated Natural Conditions

Natural conditions for his element consist of the absence of nonnative diseases in spotted frog and boreal toad populations and the prevalence of native diseases remaining within a natural range of variability. With a complete absence of nonnative diseases, amphibians would not be negatively impacted to any degree by nonnative diseases and, while native diseases within a natural range of variability negatively affect spotted frogs and boreal toads (to the extent it contributes to additive mortality), populations were able to persist with the associated mortality and any reduced productivity. Natural conditions are within the range of suitable conditions for these species since these are the conditions under which amphibian communities formed or developed in this area and because it represents the absence of a mortality factor that can have severe negative effects on populations. For non-endemic diseases like chytrid fungus that can have severe adverse impacts on amphibian populations, the best option is for the disease to remain absent in populations. However, while attempts should be made to keep these diseases out of populations, the elimination of chitrid fungus likely is not realistic over the long term.

Note: because diseases like chitrid fungus are now part of the ecology of spotted frogs and boreal toads — i.e., natural distribution and abundance of disease organisms is not returning — and because reduced conditions of habitat and survival elements have the potential to exacerbate the impacts of these diseases, as discussed above, the closer that habitat and survival elements are to natural conditions, the lower the chances they will compound disease impacts.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to natural conditions (i.e., complete absence of nonnative diseases and the prevalence of native diseases remaining within the natural range of variability) in the direction of higher disease prevalence, with one possible exception. Given the multitude of factors that negatively currently affect these species (including the introduction and spread of chitrid fungus), along with strong indications of reduced population levels at the BTNF scale and likely disappearance of local populations, maintaining native diseases at lower-than-natural prevalence may offset some of these other impacts. However, this likely would not be feasible.

The prevalence of disease above the range of variability would in no way better contribute to the achievement of Objective 3.3(a), the Sensitive Species Management Standard, and higher-level direction, compared to a situation in which diseases remain within the range of natural variability.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

Given the multiple-use mandates of the Forest Service, it is not possible to eliminate the possibility of introducing and spreading nonnative diseases (e.g., to the extent disease vectors are transported by vehicles, livestock, horses, people and clothing, equipment, dogs); to restore and maintain habitat in fully natural or healthy conditions; or to eliminate all artificial stressors such as crushing by vehicles and livestock, predation by stocked fish, and artificial lights and noise. This means that some level of habitat loss from past activities and facilities, reduction of habitat conditions due to past activities, and elevation of other stressors (e.g., mortality due to crushing, and reduced habitat use and reduced reproductive success due to introduced fish) must be accommodated. However, accommodation of reduced habitat conditions and survival elements can only be accommodated to the extent that adequate amount of suitable habitat for spotted frogs and boreal toads is restored and maintained and to the extent that activities do not otherwise contribute to reductions in populations of these species (Forest Plan Objective 3.3(a) and Sensitive Species Management Standard, and higher-level management direction). Accommodating multiple uses is addressed in each of the habitat and survival elements outlined in elements A.1 through C.3, above. It is critical that suitable conditions be maintained for habitat and survival elements, as this appears to be the only way to reduce the negative effects of diseases like chitrid fungus, except for minor contributions such as disinfecting sampling equipment between breeding sites in different drainages.

The “Risk Factors and Restoration Factors” section identifies uses for which opportunities would continue to be provided on the BTNF, uses that have the potential to introduce and spread disease vectors. It is recognized that specifying the range of associated suitable conditions and identifying any thresholds for disease prevalence is not possible at this time. In fact, the only biologically meaningful threshold may be the absence of nonnative diseases, but this is not realistic from the management standpoint. The best that can be done with our current knowledge and information base — and recognizing the impracticality of making major changes in the way vehicles, livestock, horses, people and clothing, equipment, and dogs are managed to reduce their potential of transporting disease vectors — is to strive for minimizing the extent to which activities and associated vehicles, stock, and equipment introduce or spread disease vectors. This recognition makes it all the more important to attain and maintain suitable conditions for habitat (A.1 – A.6, B.1 – B.4) and survival elements (C.1 – C.3).

<u>Note</u>: because reduced conditions of other habitat and survival elements have the potential to exacerbate the effects of climate change and increases in UV radiation, fewer deviations from natural conditions of other habitat and survival elements likely can be accommodated, compared to what could be accommodated in the absence of nonnative infectious diseases, climate change, and increases in UV radiation.

Suitable Condition Statements

Quantifying suitable conditions for disease distribution and prevalence would be difficult at best and monitoring the distribution and prevalence of disease would be very costly; i.e., even if a quantified suitable condition statement could be identified, the practicality of monitoring against it would be low. None of the literature reviews and conservation assessments identifying disease as a major conservation concern identified recommendations that could be formulated into numeric suitable condition statements. Furthermore, even if a suitable condition statement identified some maximum disease prevalence, there would be little that could be done to directly achieve this condition.

The following suitable condition statements were based on the information provided in the previous pages, and were guided to some degree by the risk factors outlined in the “Risk Factors and Restoration Factors” section. Suitable condition statements define conditions that need to be met in order to meet the “suitable habitat” portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions of suitable conditions are written qualitatively and are founded primarily on the concept of minimizing departures from natural conditions to the extent possible while still providing some level of vehicle access and some level of opportunities for a range of recreational activities, livestock grazing, timber harvest, among other activities and uses.

Suitable condition statements are as follows.

I. Habitat and Survival Elements (A.1 through C.3)

Habitat quality, habitat effectiveness, survival, and reproductive success are addressed first because attaining the following suitable conditions likely is the most practical, most effective, and most important approach to preventing and minimizing the negative impacts of chitrid fungus and other diseases from fully materializing. If this suitable condition cannot be achieved, it very well may not be possible to achieve Objective 3.3(a), the Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads on the BTNF, given the presence of chitrid fungus, ranavirus, and other diseases.

1. Restore and maintain the highest quality habitat possible — in a multiple-use setting — and minimize factors that detract from habitat effectiveness, survival, and reproductive success (i.e., restore and maintain conditions at the mid-range to high end of suitability for most or all of these elements, including habitat quality) for spotted frogs and boreal toads at all known existing breeding sites and historic breeding sites meeting capable-habitat criteria. The elements listed in the previous sentence encompass elements A.1-A.6, B.1-B.4, and C.1-C.3.

II. Potential for Disease Introduction and Spread

1. The prevalence of native diseases remain within the natural range of variability.

2. Nonnative amphibian diseases that currently do not exist on the BTNF remain absent from the BTNF.
3. Nonnative amphibian diseases that currently exist on the BTNF remain below prevalence levels that do not allow available suitable habitat to be fully occupied to the extent other factors allow.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

In short, the larger the number of suitable conditions that are met, and that are met well (i.e., in the mid range to upper end of suitability, rather than at the lower threshold of suitability), for spotted frogs and boreal toads, the lower the potential for large or major cumulative and synergistic effects impacting populations in the event of diseases outbreaks. All of the following suitable condition categories apply, recognizing that many have multiple facets to them:

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat

A.2. Mix of Succession Stages

A.3. Occurrence and Extent of Beaver Pond Complexes

A.4. Herbaceous Species Composition in riparian areas and uplands.

A.5. Canopy Cover and Health of Willow Communities

A.6. Habitat Connectivity

B.1. Water Quality

B.2. Surface-Water Duration in Small Pools

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter

B.4. Soil Looseness and Maintenance of Overhanging Banks

C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)

C.2. Reproduction and Survival as Affected by Lights and Noise

C.3. Habitat Effectiveness and Survival with Respect to Fish

Additionally, the extent to which suitable conditions related to roads, motorized use, camping, livestock grazing use, and stocked fish are attained, the lower the potential for vehicles, people, equipment, horses, livestock, and stocked fish (A.1, A.6, B.3, B.4, C.1, C.3) to the introduction and spread of disease in amphibian habitat, although these lowered effects likely would be negligible or minor.

Risk Factors and Restoration Factors

The following risk factors have likely played a major role in the decline in the distribution and abundance of spotted frogs and boreal toads on the BTNF, which limits the attainment of suitable conditions and, ultimately, the achievement of Objective 3.3(a), Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads.

Recognition is increasingly being given to the effects disease introduction and spread can have on wildlife populations and to ecosystem health. Disease is often overlooked as a conservation problem until a major problem occurs and, even where it is recognized as a possible problem, the threats posed by disease may appear to represent a minor problem for conservation when compared to habitat loss, over-harvesting, and pollution (Cleaveland et al. 2002). Even if a disease is having an effect on a wildlife population or biotic community, either by itself or cumulative with other factors, this may not be detected. Cleaveland et al. (2002:139) also asserted that the effects of disease in wildlife populations already adversely affected by other factors (e.g., habitat loss and fragmentation) may be more pronounced, and that disease risks for wildlife are likely to increase "as contact with human and domestic animal populations become more frequent.” More specifically, reduced habitat conditions and other stressors have the potential to exacerbate or compound the negative effects of disease on amphibians (Corn 2003, Gahl and Calhoun 2010, Adams et al. 2013). This is discussed in more detail in the “Multiple Stressors and Viability” section in Part I.

Effects of Chytrid Fungus

General Effects

“The pathogen *Batrachochytrium dendrobatidis* (*Bd*), which causes the skin disease chytridiomycosis, is one of the few highly virulent fungi in vertebrates and has been implicated in worldwide amphibian declines…” (Voyles et al. 2009). This microscopic, parasitic fungus attacks the keratin in the skin of metamorphosed amphibians, with death rates as high as 90-100% in some situations (Patla 2001).

Patla (2001:12) continued by explaining that “Little is known about the causes of the disease or the apparent inability of amphibian immune systems to respond successfully. Biologists hypothesize either that this is a new disease recently emerged (and possibly spread into new areas by human activities), or that environmental stressors are rendering amphibians vulnerable (Carey et al. 1999). Hypothesized stressors include exposure to man-made chemicals and endocrine disruptors, increases in ultraviolet-B radiation, and changes in temperature and moisture patterns (Carey 2000). Interactions among the fungus, amphibian immune systems, other diseases, and environmental factors are under investigation. The Colorado Division of Wildlife and USGS are funding development of a genetic test that will hopefully allow for testing of amphibian tissue, soil, and water for presence of the fungus (Livo 2000). The presumed infective stage is a minute flagellated spore that can be transported in water or mud, although transmission of the disease is still poorly understood.”

According to Patla (2001:12), “Die-offs from this disease may occur over several months, manifested as steady mortality that is not easily detected unless weekly or bi-weekly surveys are conducted for dead amphibians. Affected populations in other areas have declined >90% in one year, and there are no known cases of recovery of populations following decimation by chytrid fungus.”

Muths et al. (2008) found that occurrence of chitrid fungus in boreal toad populations varied by elevation/latitude and by temperature. Although they found significantly lower occurrence of chitrid fungus in boreal toad populations at higher elevations in southern latitudes, there was no apparent relationship in northwestern Wyoming, except that the authors noted that boreal toad breeding sites are lower here than the higher elevation sites in the southern populations. It appears that temperatures at the higher elevations in the southern boreal toad populations (Colorado) were sufficiently low to reduce suitability for chitrid fungus. It appears that temperatures at breeding sites on the BTNF are above any temperature threshold.

Brown et al. (2015:39) summarized the mechanisms by *Bd* infects amphibians: “*Bd* often alters the keratin-rich mouthparts of tadpoles (Vredenburg and Summers 2001, Rachowicz 2002), but has only been recorded to produce morbidity, not mortality, in this life stage (Berger et al. 1999, Green et al. 2002, Rachowicz and Vredenburg 2004). However, as the tadpoles undergo metamorphosis, *Bd* establishes in their keratin-rich skin, where it often eventually kills them (Berger et al. 1999, Rachowicz and Vredenburg 2004). Many *Bd* epizootics may have gone undetected because observing field casualties is rare, (Green et al. 2002).”

Population Declines in the West

Voyles et al. (2009) cited many reports of severe population declines and possible local extinctions of amphibian populations due to “chytrid fungus.” Boreal toads are known to be affected by chytrid fungus (Muths et al. 2003, Keinath and McGeee 2005, Muths et al. 2008, Pilliod et al. 2010). In Colorado, the disease is now thought to be possibly responsible for boreal toad declines that first began in the 1970s, with fresh disease outbreaks in the past 2 years attacking some of the few remaining toad populations (Muths et al. 2003, Muths et al. 2008). Muths et al. (2003b) documented the sharp decline of a large local population of boreal toads in Colorado due to chytrid fungus; it was considered a large, robust population prior to 1999 and was near extinction by 2003. There are similar accounts in Utah, and boreal toad populations in New Mexico appear to have been harder hit. There seems to be some thought that major population declines of boreal toads in the Rocky Mountains is a southern Rockies phenomenon (e.g., south of the BTNF), but Maxell and Hokit (1999:2.4) assessed that “Although still widespread across the contiguous mountainous regions of Montana, recent surveys have failed to find boreal toads at most historical sites, have found them at less than 10% of sites with suitable habitat, and have found some evidence that breeding is being restricted to lower elevations (Maxell et al. 1998).” They attributed the declines primarily to chytrid fungus. It is apparently killing Wyoming Toads (an endangered species) in the Laramie Basin of Wyoming. Maxell and Hokit (1999:2.3-2.4) identified “pathogens (e.g., Carey 1993, Kiesecker and Blaustein 1997***b***, Berger et al. 1998, and Lips 1999)” as one of seven major factors, including interactions with several factors, that have been implicated as causative agents of amphibian declines.

Population Effects in the Greater Yellowstone Area

Population-level effects of chytrid fungus on spotted frogs in the Greater Yellowstone Area and on the BTNF remain largely undocumented, but this disease has been found in boreal toads, spotted frogs, and other amphibians on the BTNF and in surrounding areas (Muths et al. 2008). Of the boreal toad breeding sites sampled in northwestern Wyoming (from LaBarge Creek northward), a large majority of sites sampled by Muths et al. (2008) were infected. They sampled spotted frogs opportunistically at boreal toad breeding sites, and a larger percentage were infected than was found in boreal toads, but it is not clear where spotted frogs were actually sampled. WGFD (2010b, pg. IV-4-1) assessed that “at this time, *Batrachochytrium dendrobatidis*, a chytrid fungus, is considered to be the main cause [of severe declines in Wyoming]. Chytrid fungus was detected in 2000 in boreal toads on the National Elk Refuge (Patla 2000)…,” and continued by stating that “The disease status of Columbia spotted frogs in Wyoming needs to be determined. These animals share habitat with the boreal toad, which is susceptible to chytrid fungus infections. Populations of the Columbia spotted frogs in Wyoming should be monitored to determine if they are declining” due to chytrid fungus (WGFD (2010a, pg. IV-4-3). Patla (2000) stated that disease might be the most insidious threat to amphibians in the BTNF. An assessment of the existing distribution and abundance of boreal toads relative to pre-EuroAmerican settlement has not been completed for the BTNF, but there is no indication that such an assessment, when completed, will be much different than other parts of the Rocky Mountains.

Patla and Keinath (2005:47) concluded that occurrences of chytrid fungus and ranavirus (another lethal amphibian disease) “…in northwestern Wyoming suggest that spotted frog populations of the Shoshone and Bighorn national forests are at risk, particularly where populations are small and recolonization via immigration after a die-off is unlikely due to isolation.” Their report did not cover the BTNF, but their assessment equally applies to the BTNF. A mass die-off of salamander larvae near Bondurant in northwest Wyoming in 1999 may have been caused by a ranavirus (Patla 2001).

In a study of one uninfected site (northwestern Montana) and two sites infected with chytrid fungus (one near Blackrock Ranger Station on the BTNF and one in west-central Colorado), Pilliod et al. (2010) found relatively high annual survival of uninfected adult toads (0.73-0.77) at all three locations and lower annual survival of adult toads infected with chytrid fungus (0.42 and 0.53, respectively, for Black Rock and the Colorado site). However, Pilliod et al. (2010:1265) assessed that “Our findings contribute to a growing body of evidence that some amphibian species and populations may coexist with *Bd* or that *Bd* is not an invariably lethal pathogen for all amphibians (Carey et al. 2006; Rachowicz et al. 2006).”

Furthermore, Pilliod et al. (2010) assessed that infected populations declined by about 5–7%/year during the 6-year study, whereas the uninfected population remained relatively stable. Previous work shows similar survival rates for male and female boreal toads (Scherer et al. 2008, Muths, Scherer and Lambert 2010),” as cited by Muths et al. (2011:876).

Despite declining numbers in infected populations, Pilliod et al. (2010) and Muths et al. (2011) assessed that at least some infected populations of boreal toads have the potential to persist. Pilliod et al. (2010:1265-1266) explained that, “Assuming mortality related to *Bd* is additive relative to other sources of mortality, it is possible that chytridiomycosis is removing some individuals from the population each year, but not causing mass mortality. This suggests that chytridiomycos can function as an enzootic disease in which host and pathogen coexist. Although a 5–7% annual decline could lead to extinction within a few years, models of amphibian extinction risk suggest that population persistence is possible if some infected individuals survive (Briggs et al.

2005), which appears to be the case in our infected populations. Rates of population decline, however, may also be influenced by population size; smaller populations may be affected disproportionately by demographic stochasticity or loss of alleles that afford disease resistance."

Muths et al. (2011) provided evidence that mortality caused by chitrid fungus may be at least partially compensatory in some situations. In their study of male boreal toads at Blackrock (Buffalo RD, BTNF) and Denny Creek (Colorado), they assessed that "High recruitment rates (0.41) are probably compensating for low survival probability (range 0.51–0.54) in the population challenged by an emerging pathogen, resulting in a relatively slow rate of decline. In contrast, the population with no evidence of disease had high survival probability (range 0.75–0.78) but lower recruitment rates (0.25)" (Muths et al. 2011:873). Nonetheless, they found that the infected population (Blackrock) declined each year through the 5-year study, compared to the non-infected population that appeared to remain fairly stable. As such, if one or more stressors contributed to lower recruitment levels in infected populations (e.g., periodic large losses from crushing by vehicles or livestock), this could contribute to overall lower survival rates than found at the Blackrock site. It is unclear why recruitment was lower at the Denney Creek site.

Although populations that are declining due to chitrid fungus infection may be able to persist (Pilliod et al. 2010, Muths 2011) in relatively healthy habitat with relatively few other artificial stressors, the addition of one or more artificial stressors has a very real potential to compound population declines and cause greater concern about population persistence (Cleaveland et al. 2002, Corn 2003, Forson and Storfer 2006, Gray et al. 2007, Bancroft et al. 2008, Gray et al. 2009, Gahl and Calhoun 2010, Groner 2012, Adams et al. 2013, Gallana et al. 2013, Reeve et al. 2013).

Patla (2001:13) also reported that "Bacterial diseases are also of concern for boreal toads, particularly *Aeromonas hydrophila*, which causes the disease known as redleg in amphibians. Recent research at Idaho State University found that high conductivity water protects tadpoles from infection in laboratory tests, potentially explaining the high correlation of high conductivity waters and active toad breeding sites in portions of the Greater Yellowstone ecosystem (Hawk 2000; Hawk and Peterson, in prep)."

Resistance to *Bd* Infection

Keinath and McGee (2005) and other authors have recognized that some metapopulations appear to be resistant to infection by *Bd*. This may explain why some metapopulations on the BTNF have persisted at higher population levels than other metapopulations. Pilliod et al. (2010) identified this as one explanation for the persistence of at least one population of boreal toads on the BTNF (Blackrock). In discussing resistance in amphibians, they explained that "Innate defenses involved in resistance to chytridiomycosis occur in some amphibians (Woodhams et al. 2007), and sick animals may alter their behavior to raise their body temperature to combat the disease (Richards-Zawacki 2009). Consequently, some populations persist with Bd (Retallick et al. 2004; Briggs et al. 2005; Kriger & Hero 2006), whereas others are extirpated (Lips et al. 2006; Skerratt et al. 2007; Ryan et al. 2008)."

Brown et al. (2015:40) discussed resistance in this way: "An important area under investigation is resistance to *Bd* infection. Species in the western United States like the Yosemite toad, in which *Bd* epizootics have been identified, have been characterized as lacking innate resistance (Green et al. 2002). However, demographic trends among selected Australian frogs, in which declines associated with *Bd* infection appear slightly older, imply that resistance may exist (Berger et al. 1999, Retallick et al. 2004). Studies have investigated the role of antimicrobial peptides that occur in frog skin as a potential source of protection against diseases like chytridiomycosis (Rollins-Smith et al. 2002a, 2002b, 2003). For reasons that are unclear, chytridiomycosis activates little or no cellular immune response (neutrophils or macrophages) to infection (Carey 2000). Ten peptides in eight peptide families derived from five species of ranid frogs (northern leopard frog [*Lithobates [Rana] pipiens*], American bullfrog, crawfish frog [*Lithobates [Rana] areolata*], Columbia spotted frog [*Rana luteiventris*], and montane brown frog [*Rana ornativentris*]), four of which occur in North America, have been shown to inhibit *Bd* growth. In laboratory studies, these peptides appeared effective at low concentrations (2-25 μM) and more effective at lower temperatures (10 C vs. 22 C; Rollins-Smith et al. 2002a). Further, a four-year mark-recapture study of the Australian frog *Taudactylus eungellensis* conducted from 1994-1998 revealed a stable level of *Bd* infection (18 percent of individuals) in a post-decline population, and no difference was found in survivorship between infected and non-infected individuals (Retallick et al. 2004). This suggests that frogs should have some ability to resist *Bd* infection. While peptide defense seems to combat fungal infections, it appears ineffective against *Aeromonas* bacteria and perhaps other non-fungal diseases (Rollins-Smith et al. 2002a). Uncertainty exists about the concentrations of these peptides in free-ranging anurans, and precisely what influences their production warrants further study. Because infections continue to spread in some species despite this potential defense, either other environmental factors may be contributing to the decline or exactly what comprises this defense may not yet be understood (Rollins-Smith et al. 2002a). If interacting stressors somehow limit peptide production, some infectious diseases may continue to proliferate." (emphasis added)

Spreading of Diseases

Patla (2000) surmised that the threat of disease to amphibians on the BTNF is elevated because equipment (e.g., vehicles, waders), livestock, and pets that carry disease organisms can be transported throughout large areas given the extensive road and trail system. The transport of disease vectors on vehicles and livestock has not been addressed to any large extent in literature reviews and species assessments, but the reports discussing chytrid fungus and other published papers have addressed the transport of disease organisms on waders and equipment and the importance of disinfecting them before moving from one wetland to another (Keinath and McGee 2005, Patla and Keinath 2005). If a vehicle or livestock that waded through an infected wetland soon moved to an uninfected wetland, this possibility would appear to be possible.

While livestock as disease-transport agents has not been studied, the ecology of *Bd* and ranavirus make livestock a potential mechanism for transport. Gray et al. (2007, as cited by Schmutzer et al. 2008) "…reported that green frog tadpoles [in wetlands used by cattle] were 3.9x more likely to be infected with *Ranavirus* than those inhabiting [wetlands where cattle did not have access]." On the other hand, Padgett-Flohr and Hopkins (2010) felt that livestock and recreationists did not contribute to the transport of *Bd* from wetland to wetland, but they did not have data to support this and they also cited Johnson and Speare (2005) as finding that *Bd* survived for 1-3 hours on moist bird feathers. If they can be transported via waterfowl (as assessed by Johnson and Speare 2005 based on their study), they could be transported by cattle where wetlands are close enough for them to go from wetland to wetland within this period of time, or longer distances when vegetation is wet. Given this time-frame, cattle likely are not an important vector, except possibly short distance movements such as when they are moved from pasture to pasture.

Waterbirds (e.g., waterfowl, soras, sandhill cranes) and possibly some mammal species have the potential to spread *Bd* on parts of the BTNF, as discussed in the previous paragraph, but these are mechanisms of spread that cannot be managed.

In their study in a Mediterranean environment in California, Padgett-Flohr and Hopkins (2010) found that landscape patterns and possibly climatic patterns have some influence on the presence of *Bd* in wetlands studied. Presence in particular wetlands also varied among years.

One of the highest risk factors may involve wildlife crews that monitor amphibian breeding sites on the BTNF (Phillott et al. 2010) as a result of crews visiting multiple wetlands in different basins within short periods of time.

Habitat and Survival Elements

Deviation from suitable conditions of each of the following habitat and survival elements increases the potential they will exacerbate the negative effects of disease on amphibians (Cleaveland et al. 2002, Corn 2003, Gahl and Calhoun 2010, Adams et al. 2013), as discussed in more detail in the "Multiple Stressors and Viability" section in Part I of this report. Providing habitat conditions that are well within the range of suitable conditions and by maintaining factors affecting survival and reproduction well within the range of suitability (i.e., not attaining or maintaining minimally suitable conditions) would reduce, to some extent, the degree to which populations are impacted by chytrid fungus, ranavirus, or other infectious diseases that are introduced.

A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat

A.2. Mix of Succession Stages

A.3. Occurrence and Extent of Beaver Pond Complexes

A.4. Herbaceous Species Composition in riparian areas and uplands.

A.5. Canopy Cover and Health of Willow Communities

A.6. Habitat Connectivity

B.1. Water Quality

B.2. Surface-Water Duration in Small Pools

B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter

B.4. Soil Looseness and Maintenance of Overhanging Banks

C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)

C.2. Reproduction and Survival as Affected by Lights and Noise

C.3. Habitat Effectiveness and Survival with Respect to Fish

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads.

I. Habitat and Survival Elements

1. Implement all necessary conservation measures identified for elements A.1-A.6, B.1-B.4, and C.1-C.3 in order to achieve and maintain conditions well within the range of suitable conditions described for each of these elements. <u>This is the most important action that can be taken to minimize the potential adverse effects of chitrid fungus and other infectious diseases</u>. In their section on management actions, Keinath and McGee (2005:42) stated that "Regardless of the nature of BD, it is evident that other threats will only serve to compound the impact of the disease, particularly habitat alteration and destruction that isolates population segments. Therefore, it is crucial that habitat preservation efforts not be overlooked in favor of disease research."
2. "If newly evolved environmental stressors (e.g., increased UV radiation, chemical contamination, decreased water quality, human disturbance) facilitate infection, then management should focus on eliminating those stressors from boreal toad habitats, thus enabling the remaining boreal toads to recover and repopulate their former range" (Keinath and McGee 2005:42).
3. "If certain habitat characteristics (e.g., elevation, water temperature, vegetative cover) mitigate the rate of infection or the mortality rate of those infected, then sites with those characteristics should be given conservation priority. Further, habitat manipulation that promotes those characteristics could be implemented in other sites, especially those that have not already been infected" (Keinath and McGee 2005:42).

II. Breeding Program for Resistant Boreal Toads

1. Keinath and McGee (2005:42) also identified a captive breeding and reintroduction program for toads that are found to have natural resistance to infection. This is a viable conservation action, but this would have

to be initiated and undertaken by a range of partners; it is not an action the Forest Service could initiate independently.

III. Potential for Disease Introduction and Spread

1. Clean and disinfect all equipment and clothing used during amphibian and fish surveys prior to any potential for coming in contact with waters used by amphibians on the BTNF, following contact or potential contact with any waters in another drainage or different portion of the same drainage. This includes cleaning with a 10% bleach solution, Virkon, or comparable solution that has been shown to be effective in killing disease organisms. Equipment includes waders, other footwear, boats, floatation devices, dip nets, and thermometers used by amphibian-survey and fish-survey crews.

   Pillott et al. (2010) and other technical documents should be consulted.

2. Clean and disinfect all vehicles and heavy equipment driven through waters used by amphibians prior to driving them through amphibian-inhabited waters in another drainage or portion of the same drainage. This includes cleaning with a 10% bleach solution, Virkon, or comparable solution.

   Incorporate this into recreation and non-recreation special-use permits and livestock grazing permits, as practicable.

3. Permanently close, obliterate, and barricade roads and motor-vehicle trails where vehicles can drive through waters inhabited by spotted frogs or boreal toads, including where the designated route does not go through the water but opportunity exists for vehicles to be driven off-route and through the water body.

4. Seasonally close roads and motor-vehicle trails in which use of the designated trail or associated illegal trails can result in vehicles driving through waters inhabited by spotted frogs or boreal toads. This is especially pertinent during the breeding season (May-September), depending on elevation and other factors).

5. Do not stock fish into waters inhabited by spotted frogs or boreal toads. If fish are stocked, ensure they do not have any diseases that can be transmitted to spotted frogs and boreal toads.

Measures and Indicators

Measures and indicators for habitat, habitat effectiveness, and reproductive success elements are outlined in the “Measures and Indicators” sections under A.1-A.6, B.1-B.4, and C.1-C.3. The following focuses directly on disease.

Currently Monitored Elements

Diseases in spotted frogs and boreal toads are currently not being monitored over the long term. However, the following information that is currently being collected can be used over the long term in assessing the effects of diseases on spotted frogs and boreal toads on the BTNF:

- Presence/Absence of Breeding Activity at Known Existing and Known Historic Breeding Sites – Monitoring at a select number of sites per district has begun. Based on information collected by WNDD, WGFD, and Forest Service crews, there may be some re-shuffling of sites to be monitored over the long term.

Additional Monitoring Elements to Consider

To be able to assess the extent to which disease has had any effect on the presence/absence of breeding activity at known existing and known historic breeding sites (above bullet), the prevalence of disease at the breeding sites would need to consistently be sampled over time, along with data on other possible influencing variables.:

- Presence and Distribution of Chitrid Fungus – This information is currently being inventoried by Forest Service, WGFD, and WNDD biologists at select locations on the BTNF, but it has not yet been built into a long-term monitoring program.
- Presence and Distribution of Other Diseases – Monitoring of other diseases like ranavirus should also be undertaken, but this would increase complexity and costs associated with monitoring.
- Other Factors Affecting Populations – To be able to ascertain the degree to which monitored diseases are affecting populations would also require that other factors influencing the presence/absence of breeding activity of spotted frogs and boreal toads be monitored (i.e., those addressed in elements A.1-A.6, B.1-B.4, and C.1-C.3).

Reproductive output, behavior, and survival rates of spotted frogs and boreal toads would continue to not be monitored directly, except possibly in limited situations depending on availability of funding.

C.5. SURVIVAL AND REPRODUCTION AS AFFECTED BY CLIMATE CHANGE AND UV RADIATION

Introduction and Background

Available information indicates that climate change will result in increasingly warmer temperatures and drier conditions in this part of the Rocky Mountains (Schoennagel et al. 2004; Kaufmann et al. 2008; Rieman and Isaak 2010; Glick et al. 2011:39-40, 46; Saunders et al. 2011; Chang and Hansen 2014). Rieman and Isaak (2010:5) assessed that “Most GCMs forecast small precipitation increases for the northern interior, accompanied by a seasonal shift toward drier summers and wetter winters (Mote and others 2008; GCRP 2009). In the south, however, significant annual precipitation decreases on the order of 15 to 40 percent are projected, and this area is one of the few for which GCM projections have a high level of agreement (figure 6; Hoerling and Eischeid 2007; GCRP 2009).” Maps in Rieman and Isaak (2010:5) showed the BTNF to be immediately north of the border between the “north” and “south” in their assessment, with reduced precipitation predicted. To the degree this happens, wetlands would have lesser amounts of water, wetlands would try quicker, herbaceous production may be lower, potential for desiccation would increase, larger acreages of forestland would burn, and there may be fewer acres of moist forestland. Reaser and Blaustein (2005:61) assessed that “Amphibian populations and species most at risk due to global warming are those that (1) are already at the upper limit of their physiological tolerance to temperature and/or dryness; (2) depend on small, ephemeral wetlands; and/or (3) are bound by barriers to dispersal.” Brown et al. (2015:37) assessed that Yosemite toads are particularly vulnerable to the effects of climate change because they breed in “extremely shallow, ephemberal water,” which is true also of boreal toads and spotted frogs.

In an in-depth assessment of the Greater Yellowstone Ecosystem, Chang and Hansen (2014) assessed that spring and summer temperatures have increased; precipitation has increased slightly in the last three decades but not enough to offset temperatures, resulting in increased aridity; snowpack has declined in the past 50 years; stream discharge has declined since 1950 and stream temperatures are warming; and climate change has favored insect outbreaks resulting in higher levels of conifer forest die-offs. They predicted that temperature will rise 5-13 ºF in the coming century, which will be accompanied by increased fire frequency and severity, and a shift from forest- to shrub-dominated vegetation. This is a little different than the scenario above because Chang and Hansen (2014) estimated a slight increase in precipitation, but they qualified this by stating that aridity has nonetheless increased in the Greater Yellowstone Ecosystem.

As discussed for diseases in the previous section, reduced habitat conditions (e.g., as discussed in elements A.1 through B.4) and other stressors (e.g., as discussed in elements C.1 through C.3) have the potential to exacerbate the negative effects of climate change and increases in UV radiation (see the “Multiple Stressors and Viability” section in Part I of this report). A range of studies indicate that increases in ultraviolet (UV) radiation and synergistic effects of UV radiation with other factors such as acidification, shallower waters, certain pathogens, lowered pH, fire retardant, and a polycyclic aromatic hydrocarbon have contributed to amphibian population declines (Worrest and Kimeldorf 1975, Hatch and Blaustein 2000, Little and Chaffee 2000; Kiesecker et al. 2001, as cited by Bull 2009; Wind and Dupuis 2002; Blaustein and Beldon 2005; Reaser and Blaustein 2005, Bancroft et al. 2008), including population declines of boreal toads (Muths 2005, Carey et al. 2005). Amphibians at higher elevations are more prone to impacts due to higher levels of UV radiation.

Although there is little if any research on compounding and synergistic effects associated with climate change, there is a high potential for other stressors to compound or synergistically affect the effects of climate change. Of particular concern is the acceleration of natural water level declines in ephemeral pools and the interaction with other factors affecting this (this is discussed further in the "B.2. Surface-Water Duration in Small Pools" section).

Because climate change and changes in UV radiation cannot be controlled at the BTNF level, management of activities under the control of the Forest Service need to be adjusted accordingly, as conditions on the ground change, in order to meet suitable conditions for spotted frogs and boreal toads.

Development of Suitable Condition Statements

Summary of Management Direction

Aside from Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species, there does not appear to be any management direction that specifically calls for actions to be taken to address climate change and UV radiation. Forest Plan Objective 3.3(a), Sensitive Species Management Standard, and higher-level direction on sensitive species call for suitable conditions to be provided, which includes suitable conditions with respect to factors affected by climate change and UV radiation.

While Forest Plan Objective 3.3(a), the Sensitive Species Management Standard, and the higher-level direction on sensitive species — with respect to spotted frogs and boreal toads — may not apply directly to combating climate change and UV radiation (since any changes on the BTNF would have no more than very negligible effects on both), the achievement of this management direction in light of climate change and UV radiation relies on greater emphasis being place on providing an adequate amount of suitable habitat and ensuring that activities do not contribute to long-term or further declines in populations or habitats (Objective 3.3(a)). Therefore, because habitat conditions, habitat effectiveness, and factors that affect survival and reproduction can all influence the degree to which a climate change and UV radiation may impact a particular population, management direction outlined in the "Summary of Management Direction" for all previous habitat and survival elements (i.e., for A.1-A.6, B.1-B.4, and C.1-C.3) apply here as well.

Estimated Natural Conditions

Natural conditions for his element consist of the absence of any effects of artificial aspects of climate change and UV radiation on spotted frog and boreal toad populations. With a complete absence of climate change and increases in UV radiation caused by human activities, amphibians would not be negatively impacted to any degree by these elements.

<u>Note</u>: because artificially-induced climate change and increases in UV radiation are now part of the ecology of spotted frogs and boreal toads, because these effects are not affected by actions on the BTNF, and because reduced conditions of other habitat and survival elements have the potential to exacerbate the effects of climate change and increases in UV radiation, as discussed above, the closer that habitat and survival elements are to natural conditions, the lower the chances they will compound the effect of climate change and increased UV radiation.

Deviations from Estimated Natural Conditions to Meet Needs of the Species

There is no need, from the standpoint of spotted frogs and boreal toads, to make any fine-filter adjustments to natural conditions (i.e., complete absence of artificial climate change and increases in UV radiation) in the direction of conditions that will be produced by climate change and of increased UV radiation.

Climate change and increases in UV radiation would in no way better contribute to the achievement of Objective 3.3(a), the Sensitive Species Management Standard, and higher-level direction, compared to a situation in which artificially-induced climate change and increases in UV radiation did not occur.

Deviations from Estimated Natural Conditions to Accommodate Other Uses

This heading has little applicability with respect to climate change and increases in UV radiation because management of human-related uses on the BTNF has very negligible effects on climate change and UV radiation. Efforts are already underway on the BTNF to reduce contributions to climate change, and there is no apparent need to change or adjust these efforts due to implications of climate change and UV radiation on the BTNF's spotted frogs and boreal toads.

Note: because reduced conditions of other habitat and survival elements have the potential to exacerbate the effects of climate change and increases in UV radiation, fewer deviations from natural conditions of other habitat and survival elements likely can be accommodated, compared to what could be accommodated in the absence of climate change, increases in UV radiation, and nonnative infectious diseases.

Suitable Condition Statements

Identifying suitable conditions that directly address climate change and UV radiation is not pertinent since there are no actions that can be taken on the BTNF that will affect the (1) degree to which climate change affects precipitation levels and patterns and other weather patterns, and (2) amount of UV radiation hitting surfaces on the BTNF.

The following suitable condition statements were based on the information provided in the previous pages and the "Multiple Stressors" section, and were guided to some degree by the risk factors outlined in the "Risk Factors and Restoration Factors" section. Suitable condition statements define conditions that need to be met in order to meet the "suitable habitat" portions of Objective 3.3(a) and the higher-level authorities this objective supports. The following descriptions of suitable conditions are written qualitatively and are founded primarily on the concept of minimizing departures from natural conditions to the extent possible while still providing some level of vehicle access and some level of opportunities for a range of recreational activities, livestock grazing, timber harvest, among other activities and uses.

Suitable condition statements are as follows.

I. Habitat and Survival Elements (A.1 through C.3)

Habitat quality, habitat effectiveness, survival, and reproductive success are addressed first because attaining the following suitable conditions likely is the most practical, most effective, and most important approach to preventing and minimizing the negative impacts of chitrid fungus and other diseases from fully materializing. If this suitable condition cannot be achieved, it very well may not be possible to achieve Objective 3.3(a), the Sensitive Species Management Standard, and higher-level management direction with respect to spotted frogs and boreal toads on the BTNF, given the presence of chitrid fungus, ranavirus, and other diseases.

1. Restore and maintain the highest quality habitat possible — in a multiple-use setting — and minimize factors that detract from habitat effectiveness, survival, and reproductive success (i.e., restore and maintain conditions at the mid-range to high end of suitability for most or all of these elements, including habitat quality) for spotted frogs and boreal toads at all known existing breeding sites and historic breeding sites meeting capable-habitat criteria. The elements listed in the previous sentence encompass elements A.1-A.6, B.1-B.4, and C.1-C.3.

II. Potential for Disease Introduction and Spread

1. The prevalence of native diseases remain within the natural range of variability.

2. Nonnative amphibian diseases that currently do not exist on the BTNF remain absent from the BTNF.

3. Nonnative amphibian diseases that currently exist on the BTNF remain below prevalence levels that do not allow available suitable habitat to be fully occupied to the extent other factors allow.

Elements of Other Suitable Conditions Supporting the Above Suitable Condition Statements

In short, the larger the number of suitable conditions that are met, and that are met well (i.e., in the mid range to upper end of suitability, rather than at the lower threshold of suitability), for spotted frogs and boreal toads, the lower the potential for large or major cumulative and synergistic effects impacting populations in the event of diseases outbreaks. All of the following suitable condition categories apply, recognizing that many have multiple facets to them:

<u>A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat</u>

<u>A.2. Mix of Succession Stages</u>

<u>A.3. Occurrence and Extent of Beaver Pond Complexes</u>

<u>A.4. Herbaceous Species Composition</u> in riparian areas and uplands.

<u>A.5. Canopy Cover and Health of Willow Communities</u>

<u>A.6. Habitat Connectivity</u>

<u>B.1. Water Quality</u>

<u>B.2. Surface-Water Duration in Small Pools</u>

<u>B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter</u>

<u>B.4. Soil Looseness and Maintenance of Overhanging Banks</u>

<u>C.1. Survival as Affected by Vehicles, Heavy Equipment, Livestock, and Recreationists (Direct Impacts)</u>

<u>C.2. Reproduction and Survival as Affected by Lights and Noise</u>

<u>C.3. Habitat Effectiveness and Survival with Respect to Fish</u>

Additionally, the extent to which suitable conditions related to roads, motorized use, camping, livestock grazing use, and stocked fish are attained, the lower the potential for vehicles, people, equipment, horses, livestock, and stocked fish (A.1, A.6, B.3, B.4, C.1, C.3) to the introduction and spread of disease in amphibian habitat, although these lowered effects likely would be negligible or minor.

Risk Factors and Restoration Factors

Estimated changes in climatic factors were summarized in the “Introduction and Background” section, above.

As pointed out by Patla and Keinath (2005:44), “Because climate change so strongly influences the survival and reproductive success of amphibians, climate change is consistently cited as one of the main potential causes of amphibian population declines (Alford and Richards 1999, Matoon 2001),” including in areas where habitat remains intact. They went on to explain “Normal variations in weather patterns [e.g., years of below-average precipitation] and minor shifts in climate do not represent a threat to amphibians, but climate change could be occurring at a rate faster than to which amphibians can adjust phenotypically.” Indirect and subtle effects of climate change may have substantial but difficult-to-measure effects on amphibians.

Maxell and Hokit (1999:2.3-2.4) identified “climate change (e.g., Pounds and Crump 1994, Stewart 1995, and Pounds et al. 1999)” and “increased ambient UV-B radiation (e.g., Blaustein et al. 1994a, Blaustein et al. 1995, Kiesecker and Blaustein 1995, and Nagl and Hofer 1997)” as two of seven major factors, including interactions with several factors, that have been implicated as causative agents of amphibian declines.

McMenamin et al. (2008:16988) documented that "…recent climate warming and resultant wetland desiccation are causing severe declines in 4 once-common amphibian species native to Yellowstone. Climate monitoring over 6 decades, remote sensing, and repeated surveys of 49 ponds indicate that decreasing annual precipitation and increasing temperatures during the warmest months of the year have significantly altered the landscape and local biological communities."

Climate change and UV radiation is of greater concern when viewed in the context of multiple stressors. For example, PARC (2008:39) concluded that "…subtle changes in climatic conditions in combination with habitat alteration may be enough to push some at-risk species over the edge. To reduce the potential effects of climate change on amphibians, PARC (2008) emphasized taking action to reduce the extent to which human-related activities and facilities reduce moisture, cover, and water in amphibian habitat.

To the extent that climate change results in increasingly warmer temperatures and drier conditions, the following impacts would take place:

- Earlier Breeding — Reaser and Blausteing (2005) listed a range of amphibian species across the globe that are initiating breeding earlier than they did decades ago. They reported that western toad breeding time at three study sites (of four) in Oregon was associated with warmer temperatures, but earlier breeding at only one site was statistically significant. Reaser and Blausteing (2005) did not identify implications of earlier breeding times. One implication is a longer non-hibernating season, which exposes amphibians to the elements that, coincidently, are becoming warmer and drier.

  Results of Rieman and Isaak (2010) and Chang and Hansen (2014) support the assessment of earlier breeding, as the reviews of climate change models by both sets of authors show that the timing of snowmelt will incrementally become earlier and earlier in the Rocky Mountains (Rieman and Isaak 2010) and, in particular, the Greater Yellowstone Ecosystem (Chang and Hansen 2014), which includes the BTNF. Chang and Hansen (2014) projected that the Greater Yellowstone Ecosystem will be largely snow free by April 1 each year by 2075, which is substantially different than the situation at present.

- Drying of Wetlands — Because precipitation levels would be lower and temperatures would be higher in this part of the Rocky Mountains (Schoennagel et al. 2004, Kaufmann et al. 2008, Rieman and Isaak 2010, Glick et al. 2011) or at least that aridity would be higher in the Greater Yellowstone Ecosystem (Chang and Hansen 2014), some wetlands would start the summer season with lesser amounts of water, some wetlands may no longer provide wetland habitat in many years, and water levels in wetlands would recede quicker (Reaser and Blaustein 2005, Reiman and Isaak 2010). McMenamin et al. (2008) specifically assessed changes in desiccation rates of wetlands in Yellowstone National Park and found a cumulative increase in percentage of permanently dry wetlands and decrease in the number of hydrated wetlands. They also found indication that wetlands are desiccating earlier than what they did years ago.

  Desiccation of wetlands earlier in the summer could result in a larger number of tadpoles dying before completing metamorphosis and an increased prevalence of dry wetlands in spring and early summer could possibly result in some local populations foregoing breeding in some years (due to lack of breeding habitat). Effects of accelerated rates of the decline of water levels is discussed in the "B.2. Surface-Water Duration in Small Pools" section and in Appendix A.

  Therefore, climate change will exacerbate impacts to water levels in wetlands already being caused by altered hydrology (e.g., road placement, water diversions, spring developments, historic livestock grazing effects on water tables), removal of water in small pools by livestock, and wetlands that have been or are being prematurely being filled in by sediments, in addition to the range of other stressors impacting populations from the local level (metapopulations) to those of the BTNF and larger scales (e.g., Chytrid fungus, road impacts). Rohr et al. (2004), for example, found that reduced water levels, in combination with other stressors, had larger impacts on streamside salamander larvae than reduced water levels alone.

- Increase in UV-B Radiation — Hogrefe et al. (2005:18) assessed that "Amphibians may be particularly sensitive to changes in atmospheric conditions, including changes in levels of UV radiation (Blaustein et al. 1994b, Corn 1998). Their skin is not protected by hair or feathers and their eggs lack protective outer shells. By depositing strings of eggs in shallow water, boreal toad may be especially susceptible to effects of increased UV-B radiation (Corn 1998).” Reaser and Blaustein (2005) noted that egg-laying in shallow, open waters (which are exposed to solar radiation) is a common characteristic of species whose eggs have been shown to be negatively affected by UV radiation in laboratory and field experiments.

Results of studies on the effects of UV-B radiation on amphibians have been mixed. Most studies have examined the effects of UV-B radiation on developing embryos, and Blaustein and Belden (2005:87) concluded that “The results of field experiments strong indicate that embryos of some amphibian species are adversely affected by ambient UV-B radiation.” Hatch and Blaustein (2000) and Hatch and Blaustein (2003) demonstrated that UV-B radiation can influence the level of effects from other factors such as nitrate concentrations in breeding wetlands.

Several studies have shown negative effects. In Worrest and Kimeldorf (1975), boreal toad tadpoles exposed to simulated sunlight with enhanced UV-B radiation developed spinal, corneal, and epidermal deformities, and experienced significantly reduced survival[X]. Wind and Dupuis (2002) cited two studies (Blaustein et al. 1994b, Hays et al. 1996) that found increased mortality of boreal toad tadpoles exposed to natural levels of UV-B radiation compared to shielded tadpoles, but this may have been due to relatively low levels of photolyase within the population in Oregon. Bancroft et al. (2008:988) explained that “western toad (*Bufo boreas*) embryos are susceptible to a complex interaction between UVB radiation, a pathogenic water mold (*Saprolegnia* sp.), and changes in precipitation (Kiesecker et al. 2001). Thus, mortality in western toad embryos increases when they are infected with *Saprolegnia* in the presence of increasing UVB radiation that occurs during years of lower precipitation when water levels are low and the UVB shielding property of the water is diminished.”

Several studies failed to detect effects of elevated levels of UV-B radiation. Wind and Dupuis (2002) cited a study in Colorado (Corn 1998) that failed to find any effect of UV radiation on boreal toad tadpoles, which indicates that possibility that boreal toads are not negatively affected by elevated UV-B radiation in all situations. Hogrefe et al. (2005) cited two others (Grant and Licht 1995, Blaustein et al. 1996). Additionally, Reaser and Pilliod (2005) reported that “Studies by Blaustein et al. (1999) suggest that, at least at the embroyonic stage, Columbia spotted frog populations are not presently being limited by UV-B radiation.” While these studies indicate that spotted frog populations are not being affected in some situations, this may not apply in all situations across the range of this species. However, spotted frogs posses 2-5 times as much of a UV-B damage repair enzyme as western/boreal toads and a few other amphibian species (Blaustein et al. 1998).

Licht and Grant (1997, as cited by Wind and Dupuis 2002:20) “…suggest that current levels of UVB are not high enough to support the hypothesis of UV alone as a causative factor of amphibian declines, but acknowledge that radiation levels will likely increase in the next decade [e.g., 2012] and that some species may be more vulnerable to these changes.”

Increases in UV radiation and UV radiation in conjunction with other factors (e.g., nitrate, acidification, lowered water levels, fire retardant) has the potential to reduce survival of tadpoles. Impacts to frogs and toads include reduced hatching success, reduced growth rates, deformities, damage to eyes, and altered behavior (Hatch and Blaustein 2000, Hatch and Blaustein 2003, Blaustein and Beldon 2005, Reaser and Blaustein 2005). Hatch and Blaustein (2003) found that tadpole growth and survival in some wetlands were not affected by increased nitrate concentrations (up to 10-20 mg/L) when UV-B radiation was blocked, but were substantively negatively impacted when UV-B radiation was not blocked. Blaustein and Belden (2005:88) also noted that “Even if levels of UV-B remain constant or only slightly increase, synergistic interactions with UV and other agents could harm amphibians.” For example, Kiesecker et al.

[X] Corn (1998, as cited by Hogrefe et al. 2005:18) “…cautions that the ecological relevance of the experiment is uncertain, because tadpoles were continuously exposed to UV-B radiation levels that were much higher than those observed in natural systems.”

(2001, as cited by Bull 2009:244) reported "…reductions in water depth caused high mortality of embryos by increasing their exposure to UV-B radiation and vulnerability to *Saprolegnia ferax* infections" (Bull 2009:244). Bull (2009) indicated that increases in UV radiation in combination with reduced water depth may have contributed to reduced survival of embryos and tadpoles in their study. Another example is that UV radiation has been shown to increase negative effects of certain contaminants, including those in fire retardant. Little and Chaffee (2000:4) concluded that "Mortality of rainbow trout [] and southern leopard [] frog tadpoles exposed to Fire-Trol GTS-R, Fire-Trol 300-F, Fire-Trol LCA-R, and Fire-Trol LCA-F was significantly increased in the presence of UV radiation," and that "…both species were equally affected by relatively low concentrations of YPS [sodium ferrocyanide] alone in the presence of UV." These results were obtained with UV levels being well below those typically found in a variety of natural habitats, meaning that mortality rates could be higher in natural habitats. When sodium ferrocyanide was not in retardant forumulations, Little and Chaffee (2000) found survival of trout and tadpoles to be consistent with that of other studies under laboratory lighting conditions. They concluded that "Un-ionized ammonia likely contributed to the decreased survival…"

- Increased Potential for Desiccation of Metamorphs, Juveniles, and Adults — Increased aridity in this part of the Rocky Mountains due to climate change will increase the potential of desiccation of amphibians because all three of the main environmental factors affecting the potential of desiccation (availability of water, humidity level, and temperature) will be affected. These changes in climate will likely reduce the distribution and abundance of wet and moist habitat and moist microsites, and will reduce the time that amphibians can spend in open, unprotected country without desiccating. Reaser and Blaustein (2005:61) noted that "Because amphibians are reproductively and physiologically dependent on moisture, moisture uptake is temperature sensitive, and amphibian dispersal capacities are low compared with other groups (Blaustein et al., 1994a; Stebbins and Cohen, 1995), it would not be surprising if they are among the first vertebrates to exhibit broad-scale changes in response to global warming."

  Results of Dumas (1964) depict what would appear to be a rather extreme situation: death in 2 hours under a given set of environmental conditions. However, the environmental conditions are by no means extreme: relative humidity of 65% at 78°F (25° C). Daytime humidity during late June through early September in open country below about 8,500 feet on the BTNF can range widely, depending on weather conditions, but is substantially less than 50% on most days (humidity as low 20% or lower are not uncommon). Maximum daytime late-June through early September temperatures at NRCS weather stations on the BTNF between about 7,000 and 8,500 feet typically range from the low 70s to the mid 80s (NRCS temperature data for Hams Fork, Snider Basin, Base Camp, and Loomis Park SNOTEL sites; expressed in ºF). About 72% of known spotted frog breeding sites on the BTNF occur between 7,000 and 8,500 feet in elevation or lower.

  An important point is that relative humidity of 65% at 78°F resulted in *death* within 2 hours in the study by Dumas (1964). Even if raising the relative humidity level by a small degree (e.g., up to 70% or 75%) or lowering the temperature by asmall degree (e.g., down to 75°F or 70°F) reduced the potential for mortality, these humidity levels and temperatures would in all likelihood cause substantial negative impacts (if not mortality) within 2-3 hours. In other words, humidity somewhat above 65% with temperatures somewhat below 78°F still have the potential to adversely affect spotted frogs in 2 hours. Because humidity in lower elevations of the BTNF are commonly well below 65% (e.g., 20% and 30% humidity is common), adverse impacts to spotted frogs could likely occur at temperatures in the low 70s in relatively short periods of time where an inadequate amount of suitable microsites are available.

  Therefore, climate change will exacerbate the elevated potential for desiccation already being caused by altered hydrology (e.g., road placement, water diversions, spring developments, historic livestock grazing effects on water tables), surfaces of roads and other artificial bare-ground areas, altered plant species composition (e.g., shift to short-stature species, increases in bare ground) and reduced plant vigor due to livestock grazing and recreation, and reductions in amounts of herbaceous plant material due to removals by livestock and elevated elk herds, in addition to the range of other stressors impacting populations from the local level (metapopulations) to those of the BTNF and larger scales (e.g., Chytrid fungus, crushing by vehicles, trampling by livestock).

- Lower Herbaceous Production — Lowered precipitation levels and higher temperatures in this part of the Rocky Mountains due to climate change will contribute to reductions in herbaceous production levels due to direct effects of reduced precipitation and higher temperatures and indirect effects stemming from any further reductions in stream flow and water table levels and wetland water supplies and duration. Any reductions in herbaceous production will contribute to reductions in moist habitat conditions and availability of moist microsites, reductions in hiding and escape cover, reductions in invertebrate habitat, and other effects outlined in the "A.4. Herbaceous Species Composition" section, "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section, and Appendix A. Reduced herbaceous production will compound the effects of warmer, drier air and reductions in the distribution and abundance of wet and moist habitat and moist microsites.

  Therefore, climate change will exacerbate the elevated potential for desiccation and reductions in hiding and escape cover already being caused by factors discussed above.

- Higher Potential for Fire — Warmer temperatures and drier conditions will contribute to more acres being burned (Schoennagel et al. 2004; Kaufmann et al. 2008; Rieman and Isaak 2010; Glick et al. 2011:39-40,46; Chang and Hansen 2014). This has an important implication to future fire regimes and subsequent effects on the mix of succession stages, and elements of amphibian ecology affected by the mix of succession stages (see the "A.2. Mix of Succession Stages in Forests" section). On the one hand, it would contribute to restoring a more natural fire regime compared to existing conditions, given the lengthened fire return-intervals due to fire exclusion. On the other hand, the plant communities that form after fires may be different than what had formed prior to climate change (Breshears and others 2009; van Mantgem and others 2009, as cited in Rieman and Issak 2010).

  Under drier and warmer conditions, continuing to suppress fires for whatever reasons, including "hanging on" to substantially more late-seral forestland than an area naturally supported could result in less late-seral forestland than naturally occurred (Lehmkuhl et al. 2007). Lehmkuhl et al. (2007) explored the practicality of successfully protecting large reserves for spotted owls in dry forests of the inland northwest. While there are differences between these forests and lower-elevation forests on the BTNF (i.e., below the spruce-fir zone), a central common feature is that forest composition and structure in both are driven by fire as the dominant natural disturbance process. After an in-depth review of existing forest conditions and ecological principles and research, they concluded that fire suppression and other management activities during the last 100 years or more have created unstable and unpredictable forest conditions, and that it is not practical to maintain large forest landscapes in late-seral condition (i.e., no prescribed burning and logging). A mix of succession stages and differences in fuel loading, particularly a higher prevalence of aspen communities with low amounts of conifer, has the potential to reduce the size of future fires.

- Changes in Forestland Conditions — Some of the potential changes to forests that has potential to affect spotted frogs and boreal toads include shifts toward drier forests, reduced footprint of forestlands, and further long-term declines in the distribution and abundance of aspen (Huang and Anderegg 2011, Morelli and Carr 2011). Drier forests would be less suitable for use by boreal toads (spotted frogs do not use forestland, except possibly during migrations). Reductions in the footprint of forestland would likely take place where they would be replaced by rangeland habitat (e.g., mountain big sagebrush, subalpine big sagebrush, mountain shrubland) and not in areas that could benefit amphibians (e.g., where forestland would be replaced by willow or meadow communities); the shift toward rangeland habitat may have slight negative effects on boreal toads. On the one hand, to the extent that fires increase, aspen would benefit since they are fire-dependent species and a history of fire exclusion has contributed to downward trends in the condition and amount of aspen habitat (Gruell 1980a,b, Jones and DeByle 1985, Bartos 2000), which could facilitate further increases in the distribution and abundance of beaver pond complexes which in turn would benefit spotted frogs and boreal toads (see "A.3. Occurrence and Extent of Beaver Pond Complexes"). On the other hand, however, as conditions become drier and warmer, the long-term acreage of aspen may decline (Huang and Anderegg 2011, Morelli and Carr 2011), which would affect the distribution and abundance of beaver pond complexes and amphibians in turn.

Conservation Actions to Consider

The following conservation actions would contribute to achieving suitable conditions outlined in the "Suitable Condition Statements," above and, ultimately, to achieving Forest Plan Objective 3.3(a) with respect to spotted frogs and boreal toads.

I. Habitat and Survival Elements

1. Implement all necessary conservation measures identified for elements A.1-A.6, B.1-B.4, and C.1-C.3 in order to achieve and maintain conditions well within (i.e., not at the lower edge of) the range of suitable conditions described for each of these elements. This is the most important approach to take to minimize the potential adverse effects of climate change and increases in UV radiation.

Measures and Indicators

Measures and indicators for habitat, habitat effectiveness, and reproductive success elements are outlined in the "Measures and Indicators" sections under A.1-A.6, B.1-B.4, and C.1-C.3. The following focuses directly on disease.

Currently Monitored Elements

Climate change and UV radiation currently are not being measured on the BTNF. However, the following information that is currently being collected can be used over the long term in assessing the effects of climate change and UV radiation — cumulative with all other factors — on spotted frogs and boreal toads on the BTNF:

- Presence/Absence of Breeding Activity at Known Existing and Known Historic Breeding Sites – Monitoring at a select number of sites per district has begun. Based on information collected by WNDD, WGFD, and Forest Service crews, there may be some re-shuffling of sites to be monitored over the long term.

Additional Monitoring Elements to Consider

No additional monitoring elements have been identified at this time.

Part III – Inventory, Monitoring, and Research

A. INVENTORY

The first amphibian inventory on the BTNF was conducted by Patla (_______)….. [summary of this effort]

In addition to beginning to monitor some of the breeding sites identified by Patla (______) in about 2005, efforts by the Forest Service to inventory amphibians on the BTNF increased at this time. The Wyoming Game and Fish Department began inventorying amphibians on the BTNF soon thereafter. Then during 2012-2014, the Wyoming Natural Diversity Database, WGFD, and Forest Service coordinated efforts to inventory parts of the BTNF that had not been inventoried to any large degree in the past.

Because the inventory of spotted frogs and boreal toads on the BTNF remains incomplete and because of the importance of having an as-complete-of-an-inventory-as-possible, inventory work on the BTNF will continue as time and resources are available. Use of environmental DNA (eDNA) in inventory efforts will begin in 2015 and this likely will help to avoid false negative survey results (e.g., where no frogs or toads are observed in a wetland, but where they actually exist).

An inventory and monitoring protocol will be developed for spotted frogs and boreal toads on the BTNF, which will provide details of this program. The following are over-arching goals for inventoring spotted frogs and boreal toads on the BTNF:

I.1 Working with WNDD, WGFD, and other partners, determine the locations of all boreal toad breeding sites and key summer habitat on the BTNF by September 2017, and determine the locations of a large majority of spotted frog breeding sites on the BTNF by September 2017. Full achievement of this goal will require extensive involvement by partners and acquisition of additional funding.

I.2 Working with WNDD, WGFD, and other partners, continue to build the database of locations of spotted frog summer habitat, over-wintering sites, and movement corridors, and locations of boreal toad over-winter sites and movement corridors.

I.3 Working with WNDD, WGFD, and other partners, continue to build the database of chitrid fungus occurrences on the BTNF in order to attain a better understanding of its distribution.

I.4 Working with WNDD, WGFD, and other partners, continue to build the database of genetic samples of boreal toads on the BTNF in order to contribute to a better understanding of the ranges of distinct clades.

B. MONITORING

A relatively large number of monitoring attributes were identified for habitat/survival elements A.1-A.6, B.1-B.4, and C.1-C.4, but many of the same or similar attributes were identified across these elements, many were identified for consideration, and no succinct, coherent monitoring plan was identified. This section identifies overarching goals for monitoring and a monitoring program to meet these goals.

Goals of Monitoring

The Sensitive Species Management Standard requires the Forest Service to "…participate in species and habitat surveys and monitoring programs needed to gain necessary data to determine population status." The standard also requires that objectives be developed to identify the status of sensitive species. An inventory and monitoring protocol will be developed for spotted frogs and boreal toads on the BTNF, which will provide details of this program. The following are over-arching goals for monitoring, with many of them being adopted from Patla et al. (2008):

M.1 At any time after 2020, be able to determine whether breeding activity of spotted frogs and boreal toads is remaining stable, increasing, or declining — as an indicator of trends in population levels — at the BTNF and district scales.

This is based on the first listed goal of Patla (2008:7). They identified a similar goal in their document, except it focused on being able to determine population trends. Goal M.1, above, was stated more in terms of what actually would be monitored as an indicator of population trends. In this report, their Objective 1 (somewhat adjusted to meet the needs on BTNF) is treated as a means to accomplish Goal M.1 (see the next section, "Population Level Monitoring").

M.2 Working with WGFD and other partners, determine whether the rate at which known breeding pond complexes of boreal toads and spotted frogs has changed at forest, district, and local scales and, for any scale at which the rate of use is changing, estimate the rate of change. Accomplishing this goal will depend on extensive partnership involvement. It would be most useful if the assessment were completed by the end of 2013. To the extent possible, reassessments should be completed periodically to be able to track changes in the use of breeding pond complexes over time.

This was adopted from Patla (2008:9)….. "Objective 3: For boreal toads (*Bufo boreas*), estimate the proportion of previously identified breeding areas that are used annually, and estimate the rate at which their use is changing over time." The authors stated that this objective was needed because boreal toads are too rare to be adequately sampled using the sampling scheme designed to meet their other objectives, which formed the basis of the sampling program outlined below in the next section. They also mentioned that "…at this time we are constrained by not having sufficient fiscal resources, and therefore full implementation of this objective is postponed…"

As a step in this process, work with WGFD and other partners to determine, by the winter of 2015, the proportion of previously identified breeding areas of boreal toads and spotted frogs that are currently being used for breeding, and (1) estimate the rate at which their use changed between the year(s) of the previous records and current, and (2) estimate the rate at which their use is currently changing.

M.3 To the extent possible, collect data on vegetative habitat (including herbaceous species composition, annual retention levels in the vicinity of breeding sites), changes in habitat (e.g., conversion of conifer habitat to aspen habitat near the bottoms of drainages, clearcuts near breeding sites), changes in facilities and motorized use (e.g., road locations) in ways that will allow assessments of cause-and-effect relationships between management decisions and use rates of breeding pond complexes.

This is supported in part by the second goal of the monitoring program outlined by Patla et al. (2008), which is to answer the question "What are the possible underlying causes of any observed decline?" Goal M.5 does not require that cause-and-effect relationships be definitively worked out, as this typically requires intensive research. It only calls for information to be collected in ways that allow for a better understanding of cause-and-effect relationships to be obtained over time.

M.4 Ascertain the degree to which chitrid fungus occurs in boreal toads and spotted frogs on the BTNF, changes over time, and assess relative effects on populations BTNF-wide. As funding allows, determine combined effects of chitrid fungus and other stressors on the BTNF, for example, through research.

Population Level Monitoring

W. Estes-Zumpf of the Wyoming Natural Diversity Database, University of Wyoming, coordinated with the U.S. Forest Service and WGFD to design a long-term monitoring program for the BTNF. It is modeled after a monitoring program developed by U.S.G.S., which is outlined below.

As pointed out by Patla et al. (2008:7), "Determining the abundance and trends of wildlife species can be notoriously difficult, expensive, and prone to bias due to short-term fluctuations in population sizes or methodological problems. Fortunately, the problem of how to monitor amphibians on Department of Interior lands has been the subject of an integrated effort by senior USGS scientists with expertise in biology, cartography, hydrology, and statistics (Corn et al. 2005a). The conceptual, ―mid-level‖ approach embraced for monitoring amphibians in selected administrative units (e.g., national parks) focuses on changes in the number of populations, as opposed to changes in the size of populations. This is based on Green‘s (1997) framework for discerning declines: *A decline is the condition whereby the local loss of populations across the normal range of a species so exceeds the rate at which populations maybe established, or reestablished, that there is a definite downward trend in population number* (Green 1997)."

Patla et al. (2008:7) continued by explaining that, "To assess amphibian status and trends in these terms, USGS scientists proposed monitoring changes in the proportion of area occupied based on presence-absence data, using estimation techniques that incorporate measures of detection probability and allow for testing how environmental variables affect occupancy dynamics (Corn et al. 2005a). The approach assumes: *As populations increase in* *abundance they should expand into available habitat with a concomitant increase in occupancy. As populations decrease in size, distributions should shrink, with fewer species in the sampling units and a concomitant decline in occupancy. Thus the occupancy estimator can provide indirect information on temporal and spatial variations in species abundance. With simultaneous monitoring at sampling sites of environmental variables and stressors that can affect amphibians, correlation with possible causes of change can be established and studied* (Corn et al. 2005a)."

The sampling design described below will allow for spotted frog and boreal toad populations at the BTNF level to be tracked over time, as indicated by presence/absence of breeding activity at individual cachments. However, while the main focus will be at the BTNF level (i.e., does monitoring generally indicate stable, upward, or downward trends at the BTNF scale?), effects on amphibian populations take place at the subpopulation level of cachments, or at the metapopulation level (Marsh and Trenham 2001). Where local 'extinctions[Y]' and colonization take place over time, stable populations at large geographic scales requires that extinction rates not outpace colonization rates. And, where a population level is below a desired population level, colonization rates must outpace extinction rates. The situation on the BTNF may be that substantive, cumulative negative impacts to subpopulations may have major implications to the BTNF-wide populations of spotted frogs and boreal toads (e.g., see Marsh and Trenham 2001). This requires great caution to be taken in making conclusions that, because a given action would only affect one subpopulation, it would have little effect at the BTNF level (e.g. due to increasingly diluted effects at increasingly large geographic scales). While re-colonization of individual breeding ponds in a complex may happen fairly quickly, amphibians are known for their relatively low dispersal capabilities and the sometimes long distances between breeding-wetland complexes. Furthermore, it is likely that some subpopulations of spotted frogs and boreal toads have already been eliminated. This means that substantive impacts at the subpopulation level, especially when viewed in terms of cumulative effects on a given subpopulation, has the potential to substantively impact the population at the BTNF level.

Goals M.1 and M.4, above, provide the main target of the population-level monitoring program and, therefore, provided the main direction for developing the population-level monitoring program. Goal M.4 is more detailed than M.1 and would require more effort to accomplish. Goals M.2 and M.3 are somewhat sub-goals of Goals M.1 and M.4, but they are important enough that they were identified as goals in their own right.

Sample Design

The sampling design of the modified long-term amphibian monitoring program that began in 2014 — by Wendy Estes-Zumpf of WNDD — is similar to the sampling design outlined in Patla et al. (2008) for Grand Teton National Park and Yellowstone National Park (GTNP and YNP). It is based on the approach developed by USGS for large administrative units such as national parks and national forests, as part of the Amphibian Research and Monitoring Initiative (ARMI); the status of amphibians is tracked through changes in the number of populations (Corn et al. 2005a, as cited by Patla et al. 2008:10). The sampling design "…is a stratified random sample of small portions of watersheds (referred to as catchments), within which all potential amphibian breeding sites (e.g., ponds, wet meadows, etc.) are surveyed for amphibians" (Patla et al. 2008:10). Under this approach, estimates of amphibian breeding occupancy at the catchment level is the major vehicle for meeting the goal of determining if amphibian populations are declining, stable, or increasing. Occupancy at the site level (cluster samples within the catchments) is a lowerscale measure that augments the catchment-level results to provide greater understanding of system dynamics.

Dr. Estes-Zumpf (WNDD) selected — based on a stratified random design — five catchments per Ranger District. Additionally, based on information in Patla (2000) and additional breeding sites located since 2000, several other known boreal toad and spotted frog breeding sites per ranger district have been selected for annual monitoring on the BTNF, on districts in which such sites exist, which is consistent with the approach taken by Patla et al. (2008) to emphasize the monitoring of boreal toads. Monitoring results are recorded in permanent databases and hard copies are stored in files at each district office.

[Y] In this context, extinction refers to the temporary or permanent cessation of breeding activity at a given breeding pond or small sub-complex of ponds, but not at the metapopulation scale (Marsh and Trenham 2001).

As noted by Patla et al. (2008), breeding populations are more feasible to monitor than total populations for practical, logistical, and biological reasons as well as for meeting the basic assumptions of currently available occupancy modeling approaches. They said that, as with other wildlife species (e.g., bald eagles, song birds), assessing the breeding portion of an amphibian population is an effective way to monitor the status of the entire population.

Patla et al. (2008:10) explained that catchments were used as the sampling unit because "…using individual ponds or wetlands (sites) as primary sampling units is not practical due to the dynamic nature of these water features. For example, a distinct pool in one year may be three distinct pools in another year due to less surface water. Similarly, several distinct pools can merge into a single large water body in a year with abundant water. These kinds of changes make it difficult to consistently define and recognize sample units from year to year. One important reason to use catchments as a primary unit is that the boundaries can be identified and used consistently among years as sites within the catchments fluctuate. Grouping sites at the catchment level also makes biological sense because amphibians can shift breeding areas among local sites depending on local conditions. For example, if a pond is dry, egg deposition may occur at a neighboring site. Monitoring for presence/absence at too fine a scale can be subject to large and meaningless fluctuations in results due to these minor spatial shifts. Clustering sites within catchments helps to smooth out this type of 'noise' to some degree. Note, however, that some spatial shifting may occur over catchment boundaries, particularly in areas of little topographic relief." Catchments used in Patla et al. (2008:11) were roughly 500 acres.

In their review of metapopulation dynamics of amphibians, Marsh and Trenham (2001:47) concluded that "Aggregations of amphibians at individual breeding ponds may not represent distinct populations and in many cases should not be managed as distinct populations… groups of ponds may often be a more meaningful unit of management than individual ponds."

Sampling Frequency

Each wetland in each catchment will be sampled using a double sampling approach once each year. According to Patla et al. (2008:19), "To obtain information about detection probability, temporal replication is used (repeated surveys for occupancy in the same areas). From the available options to accomplish this described in MacKenzie et al. (2006), the dual-observer, single visit method was chosen, in which two trained observers independently survey the same site. This is the same approach used by ARMI in Glacier National Park (Corn et al. 2005b). At small sites, one surveyor completes the 'primary' survey before the other begins the 'secondary' survey. At large sites, both observers work simultaneously but try to maintain separation by beginning the survey at different places. To preserve independence and avoid bias, observers do not communicate their individual findings during surveys."

Patla et al. (2008) continued by explaining that, "At the catchment level, detection probability is the sum of detection rates per species at all sites within the catchments. For example, Table 2-3 simulates a case in which breeding evidence for Columbia spotted frogs (RALU - Young of the Year) was detected during both primary and secondary surveys, so detection probability for Catchment XX is 100%."

Within the double sample approach, an attempt will being made to monitor each of several catchments on two separate days to to increase the potential for observing breeding activity and to increase information on timing of different reproductive stages.

Timing of Sampling

Surveys are scheduled to be conducted after amphibian egg-laying and prior to metamorphosis. Dates provided in Patla et al. (2008) — for Grand Teton National Park and Yellowstone National Park — appear to be generally applicable to the BTNF. On Grand Teton National Park and Yellowstone National Park, this period normally begins in mid June and lasts until about August 1. Therefore, until shown otherwise with BTNF-specific data, sampling will occur between June 15 and August 1 depending on elevation as well as timing of snow melt and wetland type. This should be adjusted, if needed, to better reflect timing of egg-laying and the tadpole phase on the BTNF. Timing will be addressed in more detail in the forthcoming inventory and monitoring plan for amphibians on the BTNF.

Table 5. Time envelopes for amphibian monitoring in Grand Teton National Park and Yellowstone National Park. (Obtained from Patla et al. 2008).

Type[1]	Elevation	Start	End	Notes
Non-riverine	Below 6,800 ft.	June 15	July 7	Northern Range in Yell and lowest elevation catchments in GRTE. End date is constrained by pool drying.
Non-riverine	6,800-8,000 ft.	June 15	July 24	Majority of catchments are in this category.
Non-riverine	Above 8,000 ft.	June 21	Aug. 1	Target high-elevation catchments with permanent ponds during last 10 days of survey period if possible.
Riverine	Below 7,200 ft.	June 21	July 21	E.g., Lamar River, Snake River GRTE. Postpone start date as needed to allow for waters to recede after peak flow.
Riverine	Above 7,200 ft.	July 7	July 24	E.g., upper Yellowstone River, Lewis R.

[1] Riverine refers to catchments with potential amphibian breeding habitat adjacent to 3rd order or higher streams. Time frames were based on USGS peak flow data for rivers in YELL and GRTE 1994-2005 as well as our evaluation of conditions encountered during the pilot study.

Field Methodology

On the first visit to a selected catchment, a thorough effort is made to identify all potential amphibian breeding sites within catchment boundaries (Patla et al. 2008). The procedures for first-time visits outlined by Patla et al. (2008) in “Procedures for Monitoring Catchments not Previously Surveyed (SOP 3)” of their report.

As described by Patla et al. (2008:31), “Two-person field crews conduct surveys following standard amphibian visual encounter methodology (Thomas et al. 1997). This entails walking the perimeters of water bodies and walking transects through shallow ponds and wetlands. Long-handled dip-nets are used to sweep the water for amphibian larvae. Each crew member surveys the site independently without communicating observations to the other person. This dual observer method is critical to enable accurate estimates of species detectability…” Additional information is contained in Patla et al. (2008).

Field methodology will be outlined in more detail in the forthcoming inventory and monitoring protocol for amphibians on the BTNF.

Monitoring the Attainment of Suitable Conditions

The following table summarizes material from the “Measures and Indicators” sections for each element discussed in this report. The “Future” column in Table 6 primarily identifies monitoring parameters that are already being monitored by various disciplines for a wide range of purposes (and that should be continued), and it also identifies several parameters that should begin to be monitored.

Table 6. Summary of potential monitoring parameters applicable to each set of suitable condition statements (A.1 through C.4), and identification of whether each monitoring parameter provides a direct or indirect measure of each suitable condition statement. THIS IS NOT A LISTING OF ALL MONITORING THAT WILL BE DONE.

Monitoring Parameter	**A.1**	**A.2**	**A.3**	**A.4**	**A.5**	**A.6**	**B.1**	**B.2**	**B.3**	**B.4**	**C.1**	**C.2**	**C.3**	**C.4**	Future
Known Existing Breeding Sites	x	x		x	x	x	x	x	x		x	x		x	✓
Known Historic Breeding Sites w/ Cap. Hbtt.	x	x		x	x	x	x	x	x		x	x		x	✓
Acres of Each Veg. Type (riparian, wetland)	D														✓
Acres of Dir. Habitat Loss, by Project*	D														✓*
Streambank Stability*	I						I	I							✓*
Stream Channel Integrity	I						I	I							✓
Stubble Heights on Green-line	I				I		I		I	I					✓
Percent Streambank Shearing	I						I		I	I					✓
"Streambank Stability" strictly for MIM★	I									D					✓
Herb Species Comp. (wetlands, riparian)	I			D			I								✓
Herb Species Comp. (uplands)	I			D			I								✓
Ground Cover (uplands)	I			I			I								✓
Ground Cover (riparian areas)	I			I			I								✓
Mix of Succession Stages*		D	I												✓*
Distribution of Aspen Communities*			I												✓*
Distrib. & Acreage of Willow Communities*					D										
Locations of Roads & Motor-vehicle Trails*						I					I	I			✓*
Locations/Extent of Dispersed Camp Sites						I					I				
Footprint of Skid Trails/Landings, by Project										I	I				✓
Crushing by vehicles and heavy equipment											D				
Flow Volume at Springs	D							I							
Water Quality (Streams & Isolat. Wetlands)*							D								
Movement Rate of Headcuts*	I														
Sedimentation From Roads and Trails*	I						I								
Water Infiltration Rates										I					
Herb Veg. Retention – Breeding Sites				I				I	D	I	I				✓
Herb Veg. Retention – Riparian/Uplands				I						I					✓
Change in Horiz. Cover (e.g., Robel Pole)									I						
Soil looseness/compaction										D					
Numbers trampled by livestock											D				
Density of burrows collapsed/not collapsed										D					
Density of Aspen Suckers >10 ft. at 10 years			I												✓
Canopy Cover of Willows/Dec. Shrubs					D										
Canopy Cover of Conifers in Aspen/Willow			I		D										
Retention of Willow Leaders, Site-Sp. Needs*					I										✓*
Proportion of Willow Stems that are Alive					D										
Loc's and Numbers of Beavers Harvested*			I												
Loc's and Numbers of Beavers Relocated*			I												
Tons/acre of Down Woody Mat., by Project*		D													✓*
No. of Live/Dead Trees/Acre, by Project*		D													✓*
Presence/Absence of Trout in Water Bodies													D		✓
Water Depth, Water-Surface Acreage, etc.*								D							
Distance between Br. Site and Facilities*												I			✓*
Decibels of Noise at Breeding Sites*												D			
Lumens of Night Light at Breeding Sites*												D			
Presence and Prevalence of Diseases*														D	✓*
Survival Rates, Reproductive Output, etc.*	t	t	t	t	t	t	t	t	t	t	t	t	t	t	
Ext. to which Conserv. Actions Implemented*	I	I	I	I	I	I	I	I	I	I	I	I	I	I	

Legend for Table 6:
x = Needed for geographic scope with respect to monitoring against suitable condition statements.
D = Direct measure.
I = Indirect measure, or Indicator.
* = New monitoring parameter.
⋆ = Stable streambanks in Burton et al. (2011) is generally applicable to any bank that is not characterized as not having breakdowns, slumping, shearing, fractures, or active vertical erosion, regardless of the extent to which the bank is stabilized by deep-rooted vegetation (e.g., a bluegrass covered bank not having any of these characteristics would be considered stable).
t = Desirable and useful, but very expensive and dependent on site-specific needs and adequate funding.

D. INFORMATION NEEDS AND DESIRES ON THE BTNF

In previous versions of this report, information needs were identified in different parts of the report, but were not compiled in one location. This prompted at least one set of reviewers to make the comment that information needs had not been identified in the report and they should be.

The detailed examination of suitable conditions, risk factors, and potential conservation measures for boreal toads and spotted frogs on the BTNF has made apparent several pieces of information that, if made available, would better assure that Forest Plan and higher-level direction on sensitive species would be met with respect to Columbia spotted frogs and boreal toads. Some of the information needs outlined below involve gaining a better understanding of suitable conditions and potential effects related to commercial and recreational activities and facilities in part to ensure that constraints on these activities and facilities are sufficient to meet Forest Plan and higher-level direction for sensitive species with respect to spotted frogs and boreal toads. It should be noted that the impetus for reevaluating herbaceous retention (see the "Livestock Grazing Management" subsection, below) is to ascertain whether potential impacts to livestock grazing use could be reduced and not to better assure that Forest Plan and higher-level direction on sensitive species would be met, but rather to.

Basic Ecology

While the following information would be helpful in conserving Columbia spotted frogs and boreal toads on the BTNF, especially the first two, none of it is needed to design and implement projects to restore the health and natural functioning of riparian and other habitats, and to place sufficient constraints on commercial and recreational activities to provide suitable conditions for these species. Most of the information needs identified below after the first two items are supplementary in nature (all information is useful!).

x. Estimates of historic distribution and abundance on the BTNF, and distribution and abundance that would allow the species to perpetuate and meet the target of keeping common species common (USDA 2012).

1. Movement distances from breeding wetlands, by age group. This was identified in several published papers as being of utmost importance for conserving any population of boreal toads and Columbia spotted frogs.

2. Metapopulation dynamics — How interconnected, genetically and through physical movements, are boreal toads within and among watersheds of different scales up to the scale of the BTNF?

x. Water temperatures in shallow waters — The extent to which stocked fish impacted spotted frogs and boreal toads on the BTNF is unclear, and one of variables that could help answer this question is temperatures in shallow waters of capable wetlands at elevations in a range of known breeding wetlands and incrementally higher elevations. This could be compared to known suitable temperatures (e.g., Dumas 1964:179, Carey et al. 2005).

x. Mortality rates at different life history stages for different areas on the BTNF and proportional contributions from different sources of mortality at these areas, and determination of mortality factors stemming from human activities and developments and their contributions to overall mortality rates.

3. What habitats are being used for what purposes; how far into each type of habitat — from water — do frogs and toads go; how are they geographically related, and how does this relate to daily and within-season movement distances?
4. What microsites are being used by boreal toads and spotted frogs and for what purposes; how are they geographically related, and how does this relate to daily and within-season movement distances?
5. What is the satisfactory range of humidity levels in microsites used by boreal toads, recognizing that some microsites used by boreal toads may have humidity levels that are less-than-satisfactory (i.e., it is possible they select the best of what's available even if none of the microsites are satsifactory)? Microsites include burrows, underneath large woody material, and under the canopies of shrubs and herbaceous vegetation.
6. Where and when ambient humidity levels are low, what is a satisfactory density of microsites with satisfactory humidity levels (per toad and for pertinent numbers of toads per unit area), and how is this density affected by ambient humidity levels?
6. What is the relationship between humidity at ground level and vegetation height/canopy cover characteristics? And how is this affected by the difference in vegetation structure between grasses with stalks and canopy intact and stalks without canopy?

Conservation and Management

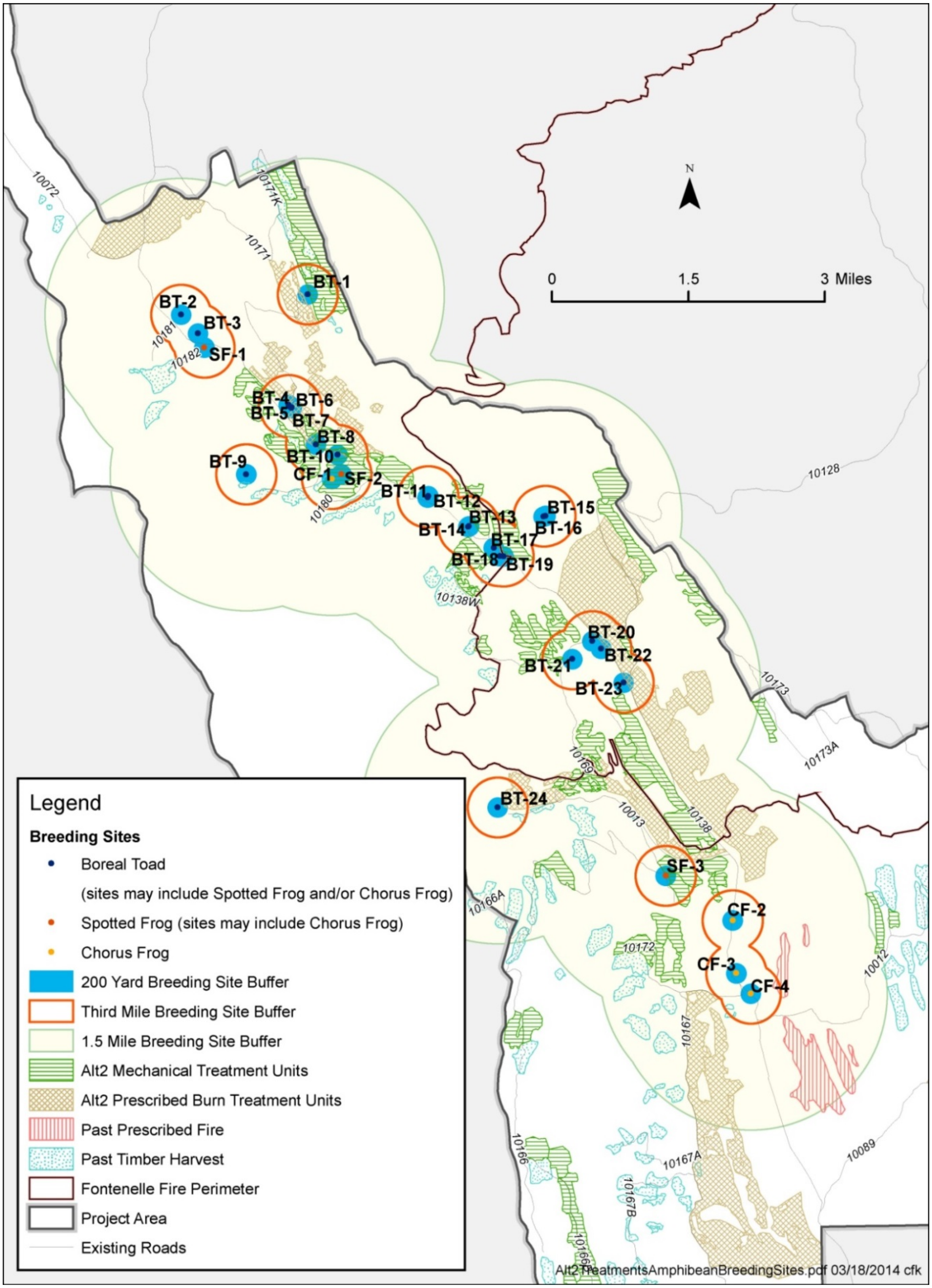
Management of Motorized Routes and Motorized Use

A large volume of scientific information exists on the effects of motorized routes and motorized use on amphibians, and this is being readily applied to the situation on the BTNF; i.e., locally-derived information on the effects of motorized routes and motorized use on spotted frogs and boreal toads is probably not needed to effectively mitigate the Site-specific estimates of mortality would be helpful, but recognition needs to be given to (1) the potential for mortality to be low frequency, but possibly high levels; and (2) the potential for population level effects to have already occurred. Regarding the first item, there is a low potential for detecting more-than-minor mortality in any given project since major mortality events may be infrequent. In some cases, where population level effects of roads have already taken place, it is possible that the same roads may currently only be having a relatively small effect (e.g., Eberhardt et al. 2013).

Assessments are needed on proximity of motorized routes (authorized and unauthorized) to known breeding sites and migration routes. A BTNF-wide assessment would be valuable given the major risks associated with roads and motorized trails, and site-specific assessments are imperative when addressinga any motorized-route issues. An example is the assessment that was done for the LaBarge Vegetation Treatment Project (Map 7). The GIS analysis identified the miles of each road type within 100 feet, 200 yards, 1/3 mile, and 1½ miles of known existing breeding sites, and this was converted to road density within each of these zones. Proposed new roads (both temporary for timber sales and for addition to the BTNF Road System as public roads) were added to the analysis to determine the effects of the new roads. Also, individual roads within each zone were examined to estimate potential impacts. The analysis, in combination with the large volume of scientific information on the effects of roads on amphibians, revealed that roads and motorized use likely have a substantive effect on boreal toad populations in the LaBarge watershed. Now that the corporate data layer has been completed for unauthorized motorized routes, this shouldbe added to any future assessments.

Recreation Management

While it is known there is a high level of overlap between the distribution of recreation and spotted frogs/boreal toads, a GIS analysis would help to begin honing in on where problems are most prevalent and where changes in management would reduce any ongoing impacts.



Map 7. Known amphibian breeding sites relative to treatment units of Alternative 2 of the LaBarge Vegetation Treatment project.

Livestock Grazing Management

The main impetus for further examining 70% herbaceous retention as a low-end threshold did not come from a desire to ensure that the needs of spotted frogs and boreal toads are being adequately met, but rather is coming from a concern about implications of reducing the maximum forage utilizatoin limits on livestock AUMs. From the standpoint of spotted frogs and boreal toads, there is some question that setting the low-end threshold of herbaceous retention at 70% is not low enough to satisfactorily meet the needs of these species and/or would not adequately protect them from the activity of livestock grazing. As yet, there has been no push to determine whether the lower threshold should be moved closer to 100% to better meet these criteria, but any further investigation of this issue should address whether a minimum herbaceous retention level of 70% is set high enough especially with respect to potential trampling effects. The impetus thus far for further examining the low-end herbaceous-retention threshold of 70%, coming from livestock grazing interests, is to reduce this low-end threshold as low as possible (e.g., 60% or 50%) in order to minimize the degree to which livestock grazing use in frog and toad habitat is reduced below existing levels.

Design of research projects needs to recognize that pre-activity or pre-treatment conditions for the season (e.g., herbaceous vegetation near annual-production levels, water quality unaffected by livestock, absence of mortality caused by trampling) are within the range of suitable conditions, and consideration should be given to assuming that movement away from pre-treatment conditions affects these species unless statistical significance of “no effect” and corresponding power are high enough. Care needs to be taken in designing studies under the traditional null hypothesis of no effect, and in interpretting results from these studies. See the “Use of Scientific Information” section near the beginning of the report.

Also, investigations of low-end herbaceous retention levels for spotted frogs and boreal toads need to consider the needs of the native wildlife-community.

The question with respect to livestock grazing use is not whether it can or does have negative effects on spotted frogs and boreal toads, since there is a large volume of scientific information demonstrating there is a point at which the intensity of livestock grazing is high enough at the “right” time (e.g., at a given life history stage) to impact one or more aspects of spotted frog and boreal toad ecology. Whether livestock grazing use negatively affects these species in a given location depends in part on the timing, frequency, duration, and intensity of livestock grazing use in particular parts of their habitat.

A much more relevant question for managing livestock grazing use is, how can livestock be managed in ways that minimize the potential for livestock grazing use to contribute to the combined and possibly synergist effects of multiple stressors such as chitrid fungus, climate change, increases in UV radiation, increases in atmospheric inputs into breeding wetlands, introduced fish into formerly fishless waters, overrepresentation of late-seral forests, declines in aspen, reduced distribution and abundance of beaver pond complexes, and effects of roads and motorized use? An important part of this is determining which life history stages have the highest potential of being impacted by livestock grazing use and to determine how to address the previous question in this context. Obviously, studying all the identified factors would require far more funding than is available, but research questions should be asked in this context, recognizing that it is only possible to answer parts of this question in any given research project.

In studies in which herbaceous retention levels are investigated relative to providing suitable habitat for spotted frogs and/or boreal toads and protecting them from livestock, the desing of studies need to build in the well-supported premise that habitat not grazed by livestock equates to suitable habitat (with minor, localized exceptions), and incremental reductions in herbaceous retention and incremental increases in livestock grazing intensity beyond this baseline are not suitable unless substantive information demonstrates that it is suitable (for the habitat attributes and survival elements investigated in the study).

<u>Habitat Attributes</u>

1. Humidity retention and temperature moderation at ground level.

2. Hiding and escape cover.

3. Tadpole forage / forage base.
4. Litter and mulch
5. Forage, cover, and substrate for invertebrate prey.
6. Openings providing sun exposure for eggs/tadpoles and for basking.
7. Sustainability of shallow burrows dug by small mammals.
8. Soil looseness and porosity.
9. Maintenance of suitable willow height and canopy cover.

Survival Elements

1. Survival as affected by water quality, especially in isolated pools — Substantial research has been done on this factor. On the BTNF, it would be helpful to assess water quality through the livestock grazing season at breeding wetlands most prone to changes in water quality due to livestock use.
2. Survival of tadpoles/metamorphs as affected by accelerated water-level declines in small, isolated pools — If this is investigated, it should be done at breeding wetlands most prone to effects of drinking by livestock. Investigation of this factor would necessarily involve examination of subsurface and surface inputs and outputs.
3. Survival as affected by trampling — Recognition needs to be given to the reality that any site-specific estimates of mortality can be affected by potential for this form of mortality to range from high frequency/low magnitude to low frequency/high magnitude. The chances are small for detecting low frequency/high magnitude events in any given study.
4. Survival as affeted by diseases. The transport of disease organisms by cattle has not been investigated.

Timber Harvest and Vegetation Treatments in Forests

Possibly the most important issue related to timber harvest and vegetation treatments in forests is the minimum amount (e.g., size, density) of large woody material that needs to be left in different types of logging and treatment practices. This should be done in the context of the native wildlife-community and conditions relative to estimated natural conditions.

Site-specific assessments of potential effects of proposed timber sales and mechanical treatments will be important for future timber sales and mechanical treatments. An example is shown in Map7 for the LaBarge Vegetation Treatment project. The GIS analysis identified the acres of each logging/treatment type within 100 feet, 200 yards, 1/3 mile, and 1½ miles of known existing breeding sites.

Oil, Gas, and Mineral Development

Additional investigation is needed on the issue of maximum artificial light and noise, as measured at breeding ponds and in other occupied habitats, that are still suitable for spotted frogs and boreal toads. If this is not possible, further investigate and determine more precisely minimum distances for different uses (from dispersed camping up to oil and gas developments) and measures to mitigate adverse effects.

LITERATURE CITED (see Appendix E)

Appendix A

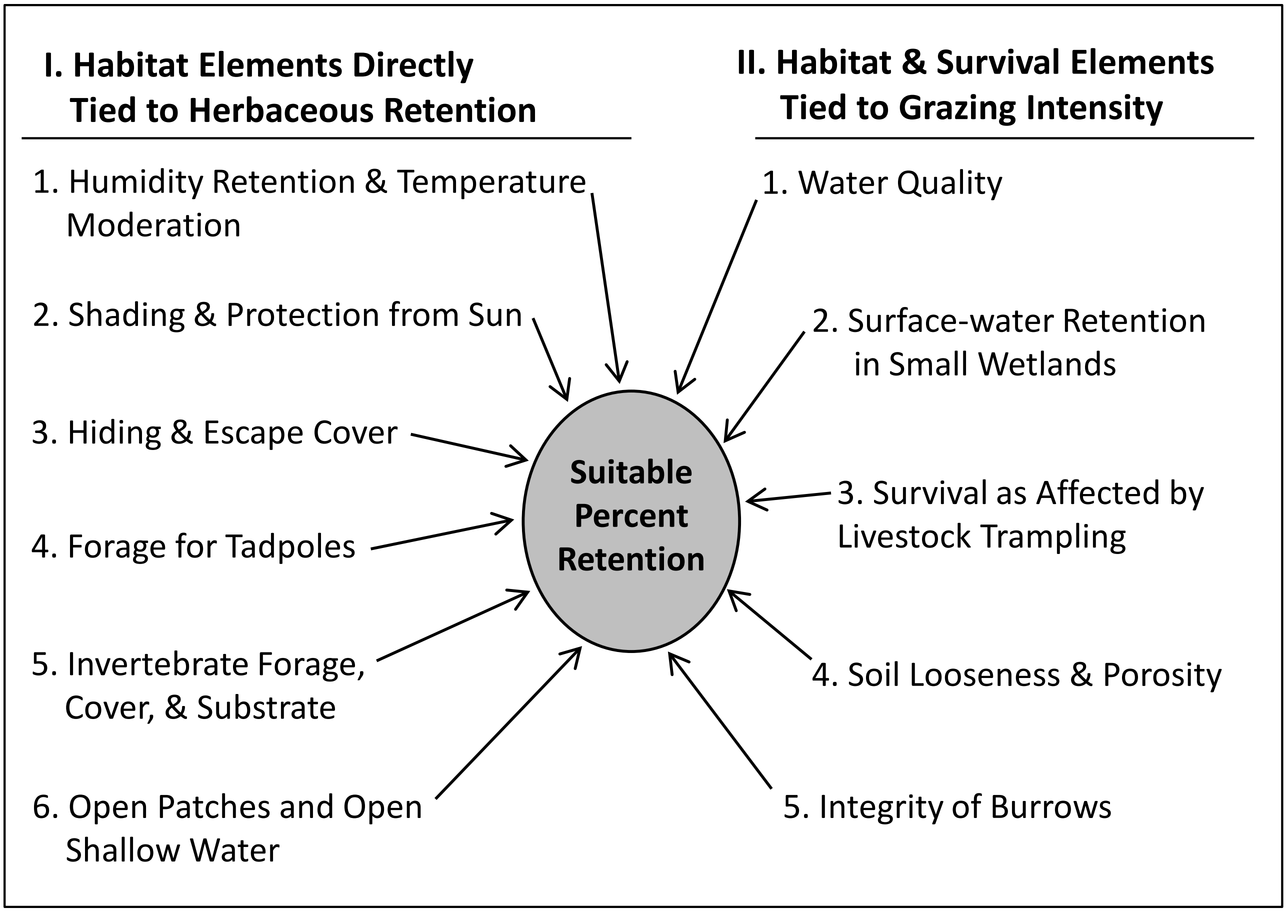
Basis of Suitable Condition Statements Addressing the Retention of Herbaceous Vegetation

for the:

Literature Review and Analysis of Scientific Information for the Conservation Assessment for Spotted Frogs and Boreal Toads on the Bridger-Teton National Forest

Don DeLong

05-20-2015



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Figures

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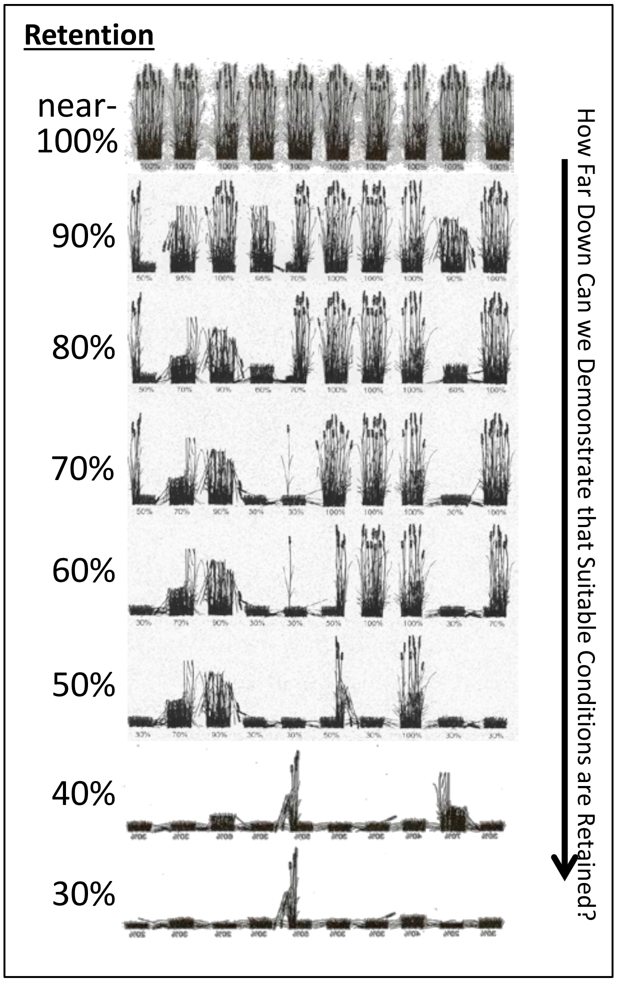
Summary

A thorough review of the scientific literature was conducted in order to ascertain an herbaceous retention threshold that would (1) maintain suitable habitat conditions and survival in order to meet Forest Plan Objective 3.3(a) and 4.7(d); Sensitive Species Management Standard; the Fish, Wildlife, and Threatened, Endangered, and Sensitive Species Standard; and policy with respect to Columbia spotted frogs and boreal toads; and (2) provide for continued livestock grazing use. If it were not for Forest Plan direction to provide opportunities for livestock grazing use, there would not be a need to pursue a lower herbaceous retention level than would naturally occur, with one possible exception in small, site-specific areas. Given the Forest Plan and policy direction for sensitive species, the basic approach was to start with near-100% retention and then to incrementally work downward as far as possible while still being able to demonstrate that the retention level is within the range of suitable conditions and will otherwise meet management direction for sensitive species.

Available scientific information shows that, of the large number of ways in which livestock grazing affects habitat and survival of spotted frogs and boreal toads, only three changes are beneficial and they are outweighed by negative effects. Two of the three identified benefits of livestock grazing (creation of basking sites in extensive stands of relatively-tall, dense vegetation; and increased productivity of algae) can result from relatively light use by livestock (e.g., 20% use or 80% retention of herbaceous vegetation), and higher levels of grazing use shifts these potential benefits to negative effects. The other identified benefit (opening up of dense emergent vegetation to facilitate egg and tadpole development) has no more than limited application on the BTNF and requires heavy livestock grazing use, which has many negative effects.

Aside from Loeffler (2001), which recommended a maximum 30% utilization of herbaceous vegetation in riparian zones used by boreal toads, none of the scientific documents or plans recommended any particular maximum percent utilization or minimum percent retention levels for spotted frogs or boreal toads. The only other recommendation that addressed herbaceous retention is fencing to exclude livestock from breeding sites, metamorph concentration ares, or larger areas, and several scientific papers and plans recommended this. Recommendations for maintaining 4-6 inch stubble heights were specifically in reference to maintaining riparian health and (1) no scientific information was cited in support of its use to retain herbaceous vegetation for boreal toads or spotted frogs, and (2) available scientific information shows that a 4-inch stubble height would not retain suitable habitat and would not protect against trampling, water quality reductions, and other factors.

Hundreds of scientific documents were reviewed from a wide range of disciplines. Starting with near-100% herbaceous retention and working downward as scientific information demonstrated that each successively-lower retention level provided suitable habitat and minimizes mortality, strong scientific support was found for 90% retention, moderately-strong scientific support was found for 80%, moderate scientific support was found for 70% retention, and low to no scientific support was found for 60% and 50% retention (illustration instert). There is moderate support for the assessment that retention of ≥70% of total herbaceous vegetation would maintain suitable habitat conditions for spotted frogs and boreal toads and would help protect against elevated mortality due to trampling by livestock and accelerated water-level declines



(Table A.1, Figure A.1). A concern at 70% retention is periodic mortality due to trampling by livestock, and possibly reductions in water quality in some wetlands. Figure A.2 shows retaining ≥70% herbaceous vegetation fits within the contemporary key forage utilization limits bounded by 30% and 50%, and it relatively far from recommendations in the literature for fencing livestock out of frog and toad habitat.

A 70% retention threshold fits well with meeting the needs of native wildlife-communities as a whole in wet meadow, moist meadow, meadow-willow, and silver sagebrush communities, recognizing that 70% retention is too low for some species and some species can accommodate lower retention levels.

In comparison, little scientific information (1) supports the assessment that ≥60% herbaceous retention would maintain suitable habitat conditions for spotted frogs and boreal toads and help protect against elevated mortality due to trampling by livestock and accelerated water-level declines, and (2) a relatively large amount of scientific information shows that spotted frogs and boreal toads would be negatively affected in many situations at an herbaceous retention level of 60%. Negative effects at 40% utilization of herbaceous vegetation would be compounded where herbaceous canopy cover is already low and where livestock make greater use of wetlands than percent retention indicates (e.g., due to comparatively low use of the vegetation and high use for drinking).

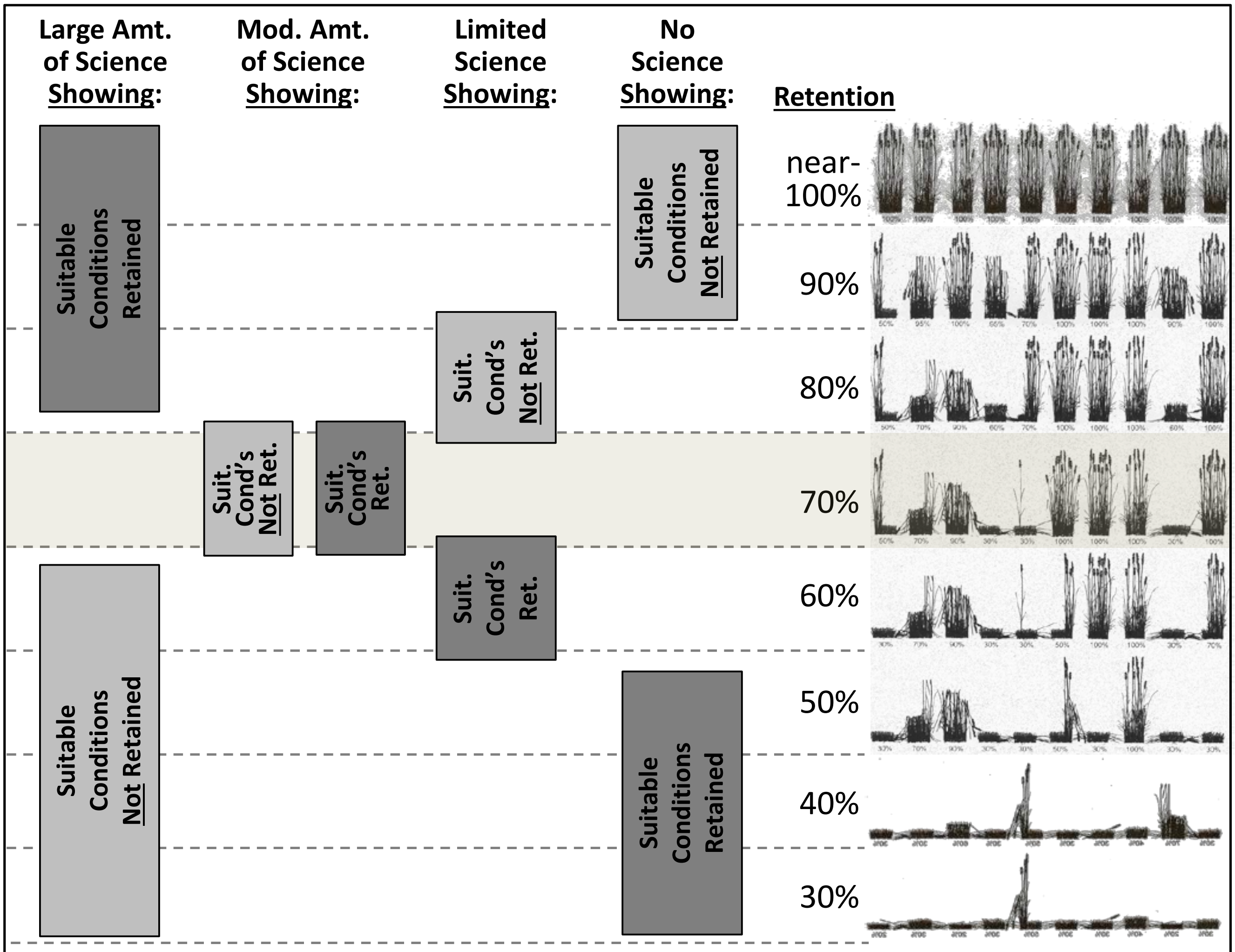


Figure A.1. Summary of the relative amount of scientific information (1) demonstrating that each herbaceous retention level would retain suitable habitat and survival conditions (dark-shaded boxes), and (2) identifying that suitable conditions would not be retained (light-shaded boxes), based on the analysis in Appendix A. Herbaceous retention levels are illustrated on the right side. The 70% herbaceous retention row is also highlighted.

Table A.1. Summary of the level of scientific support for each habitat and survival element for each retention level analyzed in Appendix A.

	Percent Retention of Herbaceous Vegetation					**4” Stubble Ht. Sedges**
Habitat and Survival Elements	**90%**	**80%**	**70%**	**60%**	**50%**	
Humidity Ret. & Temp. Mod. – frogs	S	M – MS	ML – M	L – ML	n	n
– toads		MS-S	M-MS	ML-M		
Shading & Protect. from Sun	S	S	M-MS	M	ML-L	n
Hiding & Escape Cover	S	M – MS	M	ML	L	n
Tadpole Forage	S	M – S	M	L	n	L
Invertebrate Habitat – native communities	S	M	ML – M	L	n	n
– diverse habitat	S	MS – S	M – MS	M	L	n
Shallow-water Exposed to Sun	n	n	L – M	M	M	MS
Open Patches (Basking Sites)	≤M	S	M	n	n	n
Water Quality	S	MS	M	L	n	n
Surface-Water Retention	MS	MS	M	L	L	L
Survival as Affected by Trampling – adults	S	M-MS	M	L	L	n
– metamorphs	S	M	L – M	L	n	n
Soil Looseness & Porosity	S	S	S	M	L	L
Integrity of Near-Surface Burrows	MS	M-MS	ML - M	L	n	n
Total	S	MS	M	L – ML	n – L	n

Level of Scientific Support:
S = strong, MS = moderately strong, M = moderate, ML = moderately low, L = low, and n = no (none).
* Reducing emergent canopies and impacting emergent vegetation to create and/or maintain openings in shallow waters where emergent vegetation is growing requires higher use than 50% use of herbaceous vegetation.

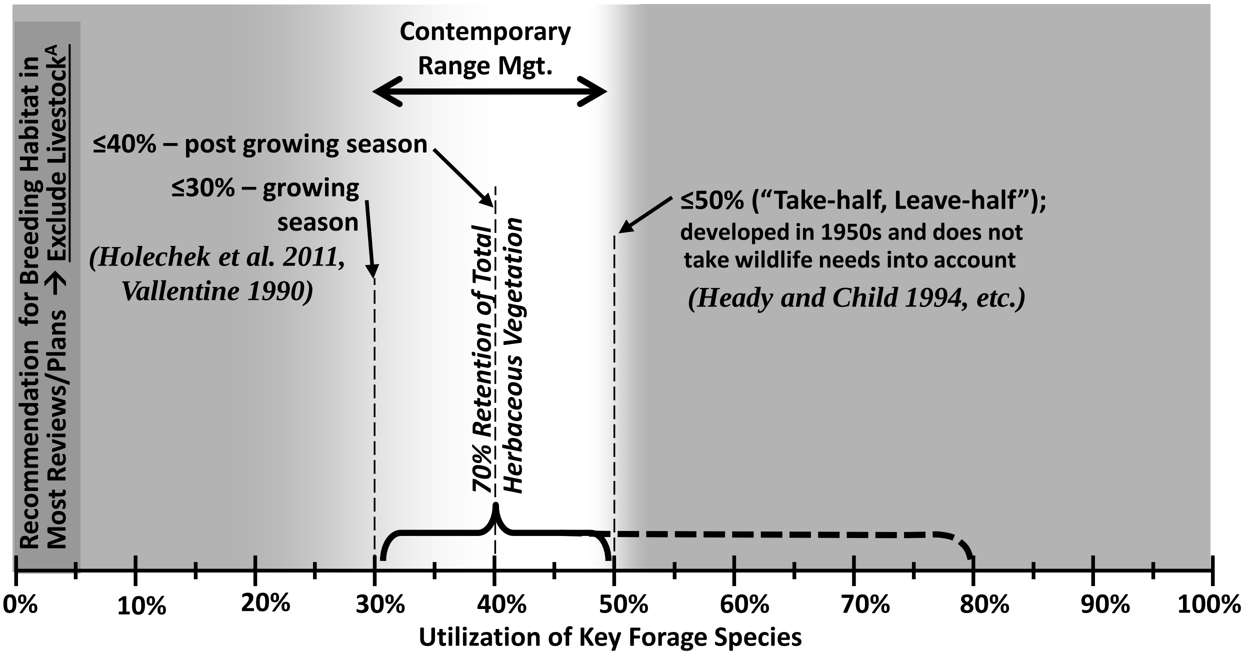


Figure A.2. Conceptual illustration showing the relationship between 70% retention of total herbaceous vegetation and (1) exclusion of livestock grazing (i.e., near 0% utilization as measured in the fall) and (2) utilization limits being applied in contemporary range management. The dashed line extending from 50% to 80% use of key forage species indicates that 70% herbaceous retention can equate to as high as 80% use of key forage species, but these high use rates of key forage species are unlikely where use of total herbaceous vegetation is limited to 70%.

[A] Use of fencing to exclude livestock from habitat of spotted frogs, boreal toads, and related species was identified as a possible management action in several documents (*Bartelt 2000, Maxell 2000, Engle 2001, Loeffler et al. 2001, Patla 2001, Hogreffe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Schmutzer et al. 2008, Pilliod and Scherer 2015*).

Introduction

This appendix was included to provide additional details on the "B.3. Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section in the main part of the report. Herbaceous retention is addressed in substantially more detail than other habitat/survival elements in the report for several reasons, including (1) minimum herbaceous retention levels have not been worked out for these species in the literature; (2) herbaceous retention levels is a proxy for several of the other habitat and survival elements addressed in the main part of the report and they are addressed in more detail in this appendix; (3) livestock grazing directly affects more acres of spotted frog and boreal toad habitat than any other human-related activity on the BTNF especially compared to activities like timber harvest which affect such small acreages; (4) wetlands and meadows are the centers of the distribution of both amphibians and cattle; (5) areas favored by foraging cattle overlap to a large degree with habitat of spotted frogs and boreal toads; (6) there is considerable internal and external resistance to the identification of herbaceous vegetation needs that have the potential to result in changes to maximum utilization levels for livestock, and discussions on this topic routinely lead to questioning of the science; and (7) information on basic ecology, ecological relationships, and grazing behavior are included to provide a foundation. With these considerations in mind, not to mention the professional need to use scientific information to define suitable conditions, this appendix outlines in detail the scientific information that supports the assessment that 70% retention of total herbaceous vegetation would maintain suitable habitat for spotted frogs and boreal toads, assuming that a substantial amount of habitat remains available with ≥80% of herbaceous vegetation retained.

The height and structure of herbaceous vegetation and the retention of herbaceous vegetation — whether expressed as absolute measures or as percentages of annual production — are the subject of both standards and objectives. It is well established that forage utilization limits and minimum stubble heights are used as management constraints implemented as a means to achieve long-term objectives for ground cover, plant species composition, and bank stability (Heitschmidt et al. 1998, BLM et al. 1999, University of Idaho 2004). As assessed by Sanders (pg. 6 in Heitschmidt et al. 1998), "Allowable use levels make poor and inconclusive allotment and riparian objectives because they provide no information by themselves on whether desired long-term conditions are being met." The same holds true for uplands. In this vein, herbaceous height and biomass is addressed as allowable-use standards in the Forest Plan and not as objectives.

On the other hand, the height, structure, and retention of herbaceous vegetation are subjects of objectives when it comes to wildlife habitat (Wyo. Partners in Flight 2003, Adamcik et al. 2004, Laubhan et al. 2012). The height and structure of herbaceous vegetation retained through the summer and into the fall does not only indicate the ability to meet long-term rangeland and riparian objectives in the future — as discussed above — it is the key component of habitat for many species of wildlife, including spotted frogs and boreal toads, in herbaceous communities. For this reason, it is a key element of wildlife habitat objectives, which is reflected in Objective 4.7(d) of the Forest Plan that treats herbaceous retention as an objective. Therefore, Sanders' words from the previous paragraph can be modified somewhat to put it in the context of wildlife habitat management: *retention levels make good and conclusive wildlife habitat objectives because they provide information by themselves on whether desired short-term (annual and seasonal) conditions for wildlife are being provided*. Healthy, functioning riparian areas, rangelands, and forestlands are critical for achieving Objective 3.3(a) with respect to spotted frogs and boreal toads, but healthy, functioning riparian areas do not provide suitable habitat if sufficient herbaceous vegetation is not retained through the entirety of periods when this vegetation is needed by frogs and toads.

In addition to herbaceous retention being a key part of habitat objectives for spotted frogs and boreal toads, it also serves as an indicator as to whether other important elements (e.g., water quality, soil looseness, survival as affected by trampling, surface-water retention in small pools) are maintained within acceptable limits. This use of retention is similar to its application in rangeland management.

Therefore, herbaceous retention directly and indirectly captures a large array of habitat elements and impacts, including being a proxy for several habitat, habitat effectiveness, and survival elements that are affects by livestock grazing pressure. This means that managing herbaceous retention levels has the potential to control livestock grazing use sufficiently to meet a large number and variety of habitat needs and to limit excessive mortality. Because of the large number of habitat, habitat effectiveness, and survival elements tied to herbaceous retention levels, it is crucial that retention levels be set sufficiently high to minimally meet suitable conditions for these elements, especially given limited information on some of these elements.

Discussions primarily address cattle grazing use, but also pertain to sheep grazing use to some extent. Because of the differences in behavior and management of these two classes of livestock, they can affect amphibian habitat and amphibian survival in different ways. Additional assessment of sheep grazing use and adjustments to suitable condition statements and objectives may be needed. While effects of livestock grazing are important in-and-of-themselves — as evidenced by extensive scientific literature — it is all the more important given the range of stressors acting on amphibians. The underrepresentation of tall, dense herbaceous vegetation on the BTNF increases the importance of retaining attributes of these communities where tall, dense communities remain.

The focus of this appendix is on suitable conditions for herbaceous retention, as opposed to herbaceous vegetation height and structure, because herbaceous species composition, water availability, and plant vigor are the main drivers of the height and structure of herbaceous vegetation on any given site; and herbaceous species composition is addressed in a separate section in the main report and water availability and vigor are also beyond the scope of the analysis in this appendix.

Many questions, issues, and concerns — as well as many positive comments — were brought up about the draft report, particularly in regard to herbaceous retention (see responses to comments). Questions, issues, and concerns ranged from questions related to livestock grazing behavior and how they relate to amphibian ecology, to issues about examining the details about particular studies, to concerns about using results from lab studies, studies from other areas, and studies from other disciplines. To address many of these questions, issues, and concerns, additional information was added to introductory sections of this appendix and to other sections in the appendix.

Forest Plan Direction on Herbaceous Retention

Management direction for protecting sensitive species and providing for an adequate amount of suitable habitat, including the herbaceous component of habitat, is outlined in the main report. This section summarizes some of the key points with respect to retaining herbaceous vegetation for spotted frogs and boreal toads and maintaining livestock grazing intensity at a low enough level to adequately protect these species and their habitat.

Herbaceous retention fills the dual role of being the subject of suitable conditions/objectives and being a constraint on an activity to ensure the activity does not cause long-term or further declines in populations or habitats (i.e., by acting as a proxy for the effects of livestock grazing on habitat and survival elements like water quality, survival as affected by trampling, retention of water in small pools, and soil compaction):

1. *Suitable Conditions/Objectives* — Objective 4.7(d) of the Forest Plan calls for an adequate amount of suitable forage and cover to be retained for wildlife in livestock allotments, meaning that herbaceous retention is the subject of wildlife objectives. Also, because the amount and structure of herbaceous vegetation are important components of spotted frog and boreal toad habitat, Objective 4.7(d) essentially provides a step-down objective to Objective 3.3(a). Also, Objective 4.7(d) is for all wildlife species and, of all wildlife species, sensitive species have a higher priority. Objective 3.3(a), as reinforced by the Sensitive Species Management Standard, provides broad direction to provide adequate amounts of suitable habitat for sensitive species. Objective 4.7(d), which applies to sensitive species and all other wildlife that occur within livestock allotments, provides more specific direction for herbaceous communities and understories; e.g., that an adequate amount of suitable forage and cover be retained for spotted frogs and boreal toads. Because sensitive species are second only to threatened and endangered species in terms of management priorities for wildlife and because herbaceous retention has little application to threatened and species on the BTNF, it is most important for an adequate amount of suitable forage and cover to be retained for sensitive species, to the extent herbaceous retention is pertinent to particular sensitive species.
2. *Constraint on Livestock Grazing Use / Proxy for Other Habitat and Survival Elements* — Objective 3.3(a) calls for suitable and adequate amounts of habitat to be provided "…*to ensure that activities do not cause*: (1) long-term or further decline in population numbers or habitats supporting these populations;

> and, (2) trends toward federal listing," emphasis added. Also, the Forage Utilization Standard requires that allotment-specific utilization limits be set at levels that ensure Forest Plan objectives (e.g., Objective 3.3(a)) be achieved and that site-specific utilization limits will be established on key wildlife ranges (e.g., amphibian breeding areas). Because percent retention of herbaceous vegetation is directly correlated with grazing intensity and because grazing intensity is directly correlated with habitat and survival elements such as water quality, survival as affected by trampling, retention of water in small pools, and soil compaction, management of herbaceous retention provides a way to ensure livestock grazing does not contribute to long-term or further declines in spotted frog or boreal toad habitat or populations due to livestock impacts on water quality, survival as affected by trampling, retention of water in small pools, and soil compaction. Livestock grazing, which has the highest potential of any activity on the BTNF to affect spotted frogs and boreal toads, affects 9 of the 15 habitat/survival elements covered in the main report, and all of these can be managed through managing herbaceous retention levels.

Additionally, the Fish; Wildlife; Threatened, Endangered, and Sensitive Species Standard requires that "Range improvements… will be coordinated and designed to help meet fish and wildlife habitat needs, especially on key habitat areas… Special emphasis will be placed on helping to meet the needs of Threatened, Endangered, and Sensitive species." This does not directly address utilization limits or herbaceous retention levels, but it does provide clear direction for installing and maintaining "range improvements" like fences to ensure that the needs of spotted frogs and boreal toads are met. Fencing breeding areas and surrounding habitat, as well as other important habitat for spotted frogs and boreal toads is the most pertinent application of this standard (1) given the large number and large variety of ways in which livestock grazing use can negative impact spotted frogs and boreal toads, (2) because facilities like fences are the most recognized means of conserving habitat for these species and protecting individuals from harm[A], and (3) because fences provide the most consistent and reliable means of providing for the habitat needs of spotted frogs and boreal toads in livestock allotments and protecting them from reduced water quality, trampling, and surface-water reductions.

In short, the Forest Plan directs that livestock grazing use be carefully managed in and around spotted frog and boreal toad breeding sites and in other important habitats and, where an appropriate level of livestock management is not undertaken, the Fish; Wildlife; Threatened, Endangered, and Sensitive Species Standard points strongly in the direction of fencing livestock out or using riparian pastures in which livestock would be grazed for very short periods.

Risk Factors and Restoration Factors

The following are among the factors that are affected by management decisions on the BTNF that can affect the height and structure of herbaceous vegetation, with particular focus on retention levels:

- ***Depleted Herbaceous Species Composition* —** Herbaceous species composition produced during the growing season is what drives the height and structure of herbaceous vegetation that is produced on any given site. The "Herbaceous Species Composition…" section in the main body of the report addresses this in detail.
- ***Reduced Plant Vigor* —** Plant vigor is affected by the history of past grazing patterns and by other activities that break or damage vegetation year-to-year on the same site (e.g., a pattern of repeated motorized use, camping). Vigor affects annual production and, therefore, the height and structure of vegetation that is produced during the growing season.
- ***Grazing by Livestock* —** Livestock grazing is the main factor on the BTNF that affects herbaceous height and structure in spotted frog and boreal toad habitat.
- ***Camping and Off-trail Motorized Use* —** Spotted frogs and boreal toads may be adversely impacted within and in the immediate vicinity of campgrounds and dispersed camping areas located within riparian

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[A] Bartelt (2000), Maxell (2000), Engle (2001), Patla (2001), Keinath and McGee (2005), Patla and Keinath (2005), Shovlain et al. (2006), Schmutzer et al. (2008), Pilliod and Scherer (2015).

zones since vegetation is smashed down, grazed (by horses), or nonexistent in heavily used areas. Thomas et al. (1979a) noted that camping areas in riparian zones reduces the amount of habitat due to loss of vegetation, trampling, and soil compaction.

- ***Grazing by Recreational, Outfitter, and Livestock-Herder Horses* —** Grazing by horses have similar affects as those of livestock grazing, except in more limited areas.
- ***Grazing by Unnaturally High Populations of Native Ungulates* —** Grazing by native ungulates have similar affects as those of livestock grazing, except in more limited areas and a much smaller degree of effect. Elk, mule deer, moose, and bison numbers are managed by the WGFD.

The remainder of this appendix addresses all factors except for the first two since this appendix deals with retention. Of the latter four factors, livestock grazing is the one that affects herbaceous height and structure in habitats used by spotted frogs and boreal toads to the largest degree across large portions of the BTNF.

Addressing retention, specifically with respect to the risk factor of grazing, is important for several reasons:

- The preponderance of information shows a reasonable potential for livestock grazing to negatively impact spotted frogs and boreal toads where livestock grazing intensity and utilization rates are not controlled in their habitat or are not kept at low enough levels to limit negative effects. For example, Patla and Keinath (2005:47) noted that “All the available summaries of threats faced by spotted frogs list livestock grazing as a major concern (Gomez 1994, Perkins and Lentsch 1998, Maxell 2000, USFWS 2002, Munger et al. 2002),” meaning that livestock use needs to be carefully controlled. Literature reviews and conservation assessments of spotted frog and boreal toads that identify livestock grazing as a threat include Maxell (2000), Patla (2001), Keinath and McGee (2005), Muths (2005), Patla and Keinath (2005), Reaser and Pilliod (2005), and PARC (2008). A majority of studies conducted on ranid frogs and livestock grazing have concluded that livestock grazing use of wetlands has detrimental effects on frogs (e.g., Engle 2001, Jansen and Healey 2003, Bradford (2005), Schmutzer et al. 2008). As a general rule, negative effects are least at the lowest levels of livestock use and highest at high livestock use levels. Other scientific literature showing these relationships are cited throughout this appendix.
- The most common recommendation on livestock grazing in the vicinity of amphibian breeding wetlands is to exclude livestock from them, and some authors recommend excluding livestock from larger areas (Bartelt 2000, Maxell 2000, Engle 2001, Patla 2001, Keinath and McGee 2005, Patla and Keinath 2005, Shovlain et al. 2006, Schmutzer et al. 2008). No recommendations were found for utilization limits or minimum retention levels below that which is accomplished through complete exclusion. Allen-Diaz et al. (2010), Roche et al. (2012a), and McIlroy et al. (2013) — all part of the same study — identified a maximum use level of 40% as the use level imposed in their study area, concluded that it was sufficient, but did not recommend this as a maximum use level. Note: utilization in the immediate vicinity of breeding wetlands was substantially lower and the majority of meadowland was grazed at less than 40% use.
- The levels of livestock grazing use and intensity that historically occurred on the BTNF, that occurred in the recent past, that are permitted to take place today (e.g., max. use levels of 60%, 65% in riparian areas), and that takes place today in parts of the BTNF have been shown to negatively impact ranid frogs and toads.
- There is no data on the BTNF countering results of scientific studies and that indicate livestock grazing has not and is not affecting the distribution and abundance of spotted frogs and boreal toads, either at the BTNF geographic scale or at particular breeding complexes (both those that are being used by frogs or toads for breeding and those no longer being used for breeding).
- In all vegetation types comprising the most important spotted frog and boreal toad habitats, except in willow thickets, herbaceous vegetation is the most important element of their habitat, with the exception of water (see the “Roles of Herbaceous Canopy/Retention and Openings” section). And the ability of herbaceous vegetation to perform these functions declines as grazing intensity increases.

- There is major overlap between the most important vegetation types used by spotted frogs and boreal toads and the vegetation types preferred by cattle (e.g., wet meadow, moist meadow, silver sagebrush/shrubby cinquefoil, and meadow-willow).
- Although domestic sheep usually do not graze in typical amphibian habitat, they water at ponds, pools, and other wetlands that are important to spotted frogs and boreal toads, and because they visit these sites in such high concentrations (up to many hundreds of sheep in a matter of ≤1-2 hours) and the wetlands are typically small, there is a high chance of negative impacts, especially when there are high concentrations of either tadpoles, metamorphs, or adults in and around the wetlands.
- Livestock grazing directly affects more acres of spotted frog and boreal toad habitat than any other human-related activity on the BTNF especially compared to activities like timber harvest which affect such small acreages. Roads and motorized use is another major threat factor for these species, but roads and motorized use affect proportionately fewer acres than livestock grazing.
- Additionally, given the inverse relationship between herbaceous retention and grazing intensity and the inverse relationship between other habitat/survival elements and grazing intensity, herbaceous retention provides a proxy for the condition of these other habitat and survival elements (e.g., water quality, survival as affected by trampling, retention of surface water in small pools, soil compaction, integrity of near-surface burrows, maintenance of willow habitat).
- The effects and potential effects of chitrid fungus on spotted frogs and boreal toads, in combination with livestock grazing and other factors affecting their populations, can be major. There is a growing body of scientific information showing that amphibian populations inhabiting high-quality habitat with few artificial stressors (i.e., not marginal or just-above marginal habitat conditions) have a better chance of persisting in the face of chitrid fungus and Ranavirus (Cleaveland et al. 2002, Corn 2003, Forson and Storfer 2006, Gray et al. 2007, Bancroft et al. 2008, Gray et al. 2009, Gahl and Calhoun 2010, Groner 2012, Adams et al. 2013, Gallana et al. 2013, Reeve et al. 2013).
- Spotted frogs and boreal toads are designated as sensitive species in Region 4, and boreal toads are being considered for Federal listing as threatened or endangered (and the eastern population of the boreal toad only exists in an estimated 4% of its historic range; USFWS 2012).

Therefore, despite there being little or no data showing that livestock grazing has contributed to any declines in the distribution or abundance of spotted frog or boreal toad on the BTNF, there is sufficient reason to address herbaceous retention in objectives and suitable condition statements. It also must be recognized that the lack of data on the BTNF showing negative effects of livestock grazing on spotted frogs and boreal toads is meaningless when there is a complete lack of data specific to the BTNF on this subject.

Given these reasons — particularly given the sensitive-species status of spotted frogs and boreal toads, the downward trend for both species across their ranges, and the consideration by the U.S. Fish and Wildlife Service to Federally list the eastern population of the boreal toad as threatened or endangered — the burden of proof is on demonstrating that a given herbaceous retention level satisfactorily meets all and or most of habitat elements and proxies associated with herbaceous vegetation before it is deemed suitable.

Roles of Herbaceous Canopy/Retention and Openings

Keinath and McGee (2005:29) assessed that “Boreal toads require three main habitat components: 1) shallow wetlands for breeding, 2) terrestrial habitats with vegetative cover for foraging, and 3) burrows for winter hibernation (Loeffler 2001).” In wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities, “vegetation cover for foraging” primarily consists of herbaceous vegetation and, in willow-herb communities, herbaceous vegetation is an important component of foraging habitat. In addition to providing an adequate supply and availability of forage (invertebrates), foraging habitat also needs to be sufficiently humid (or must have humid microsites in close proximity, including burrows or soil/duff to burrow into) and suitable hiding and escape cover for toads, and the potential for trampling/crushing mortality needs to be low enough to not pose a substantive threat.

Retained herbaceous vegetation serves two distinct roles with respect to meeting Objective 3.3(a), Objective 4.7(d), Sensitive Species Management Standard, and higher-level management direction on conserving sensitive species with respect to spotted frogs and boreal toads. Percent herbaceous retention provides a/an:

- **Direct measure of herbaceous habitat conditions** (e.g., humidity retention, temperature moderation, and shading; hiding and escape cover for adults and juveniles on shorelines, in meadows, and along migration/movement corridors; hiding and escape cover for tadpoles in wetlands; forage for tadpoles in wetlands; litter and mulch for future years; and habitat for invertebrate prey).
- **Indicator of other factors directly related to grazing use intensity** (e.g., water quality, survival as affected by trampling, surface water duration, soil looseness, integrity of near-surface burrows, maintenance of willow habitat).

Openings in herbaceous communities also appear to be important in meeting Objective 3.3(a), Objective 4.7(d), Sensitive Species Management Standard, and higher-level direction on conserving sensitive species with respect to spotted frogs and boreal toads. The amount and locations of openings in herbaceous communities provide:

- **Openings to allow for sun exposure** (e.g., for egg and tadpole development, thermoregulation of juveniles and adults).

The following discussion provides more detail on each of these roles and the individual habitat and survival elements that fall under each.

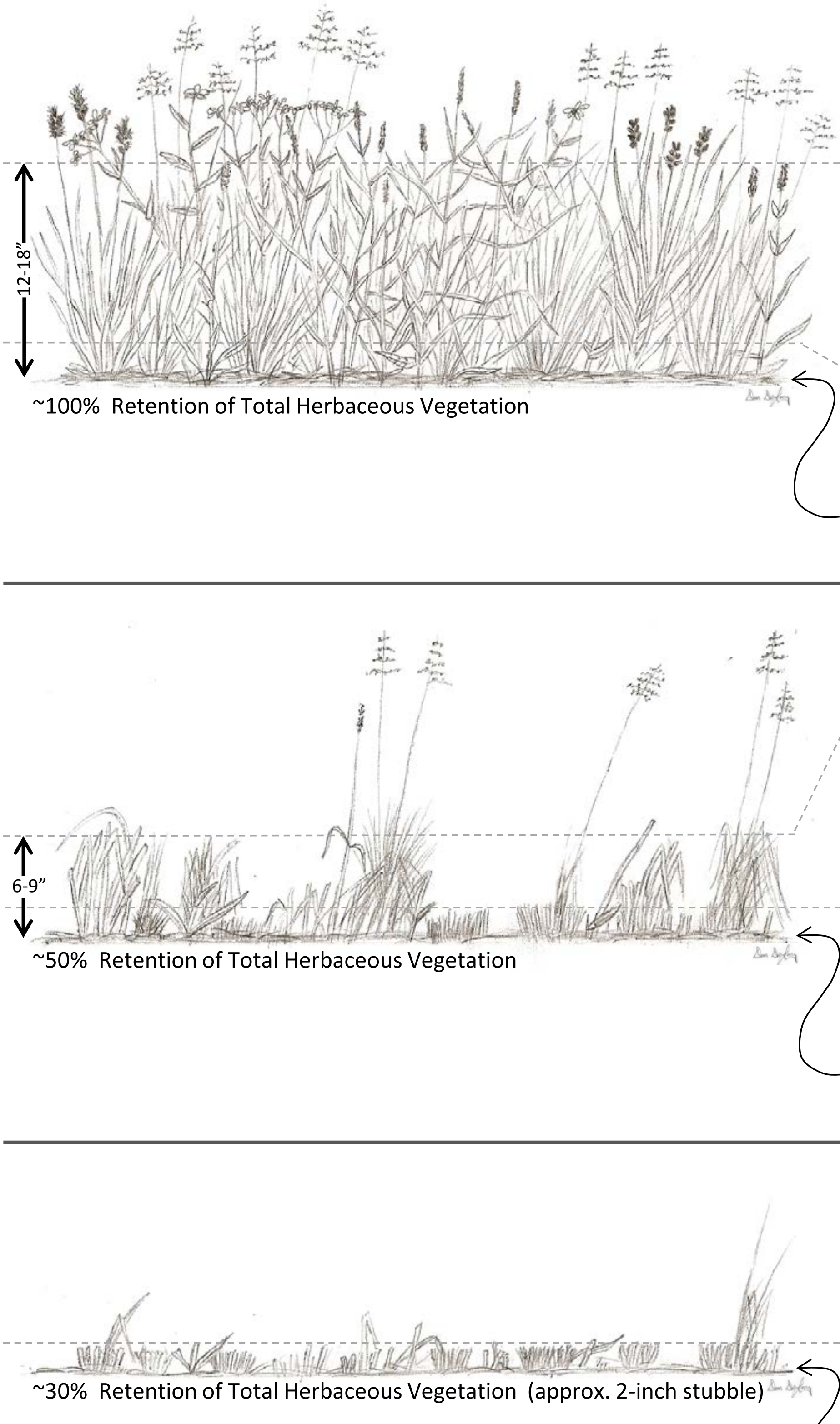
HERBACEOUS HABITAT CONDITIONS

Retaining herbaceous vegetation is central to meeting Objectives 3.3(a) and 4.7(d) and the Sensitive Species Management Standard on the BTNF from the standpoint of spotted frogs and boreal toads. In wet meadows and moist meadows — i.e., where shrubs are no more than minor components — herbaceous vegetation constitutes the entirety of frog and toad habitat, outside of water and soil components. In silver sagebrush, shrubby cinquefoil, meadow-willow, and willow-herb communities, herbaceous vegetation is a major component of their habitat. Willow-herb communities typically are either low-stature willow (e.g., Wolf willow) in which herbaceous vegetation comprises substantive part of the canopy or tall willow communities with enough space between willow canopies to allow for substantive herbaceous understories. They are distinguished from willow communities where willow canopies are tall and dense enough to limit herbaceous production.

Live, upright herbaceous vegetation, when tall enough and dense enough — in combination with residual vegetation and mulch — provides shading, moderates temperatures at ground level on hot days and cold nights, maintains higher levels of humidity and moderates temperatures at ground level, provides shading and protection from the sun, provides protection from predators for all age classes, sustains habitat for invertebrate prey, and provides substrate and material for tadpole forage in wetlands (Warkentin 1992, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Shovlain et al. 2006, Schmutzer et al. 2008, Burton et al. 2009). In shrubby cinquefoil, silver sagebrush, meadow-willow, and willow-herb communities, shrub canopies contribute to these attributes. A key assumption is that herbaceous species composition generally reflects a natural composition, including in meadow-willow and willow-herb communities. The role that herbaceous vegetation plays in providing for each of these functions is discussed in more detail in each of the subsections, below.

Herbaceous habitat quality is a function of vegetation height, structural density of vegetation, and patchiness of different height categories. Herbaceous height by itself is a poor indicator or measure of herbaceous habitat quality because it does not take into account the structural density of vegetation and because it averages heights among patches of sometimes very different heights, especially following livestock grazing . In grass-dominated and grass-sedge communities, differences between grazed and ungrazed patches can be large (e.g., 1-3 inches vs. ≥12-18 inches) (McKinney 1997), making average height fairly meaningless.

Figure A.3 illustrates the culmination of all of the functions of herbaceous vegetation that contribute to the habitat of small vertebrate wildlife, including spotted frogs and boreal toads, and invertebrate wildlife in herbaceous communities that naturally are relatively dense. Drawing of the figure began with ideas in Figure 6.6 of Körner (1994), and then expansion of characteristics of each layer based on scientific information summarized in this



<u>Upper Layer</u>
- Fully exposed to ambient climate
- High light, virtually no shade
- Low Visual Obstruction
- Abundance of Flower and Seed Forage
- Species composition fully realized
- Abundance of Substrate

<u>Middle Layer</u>
- Moderate humidity, little wind
- Somewhat moderated temperatures
- Reduced light, moderate shade
- Moderately high visual obstruction
- Meets behavioral attachment to dense overhead canopy
- Abundance of leaf forage and substrate
- Large variety of forage types

<u>Bottom Layer</u>
- High humidity, moderated temperature
- No wind
- Deep shade, little light
- High visual obstruction
- Some basal leaf forage

<u>Litter Layer</u>
- Well developed
- Good moisture retention

<u>Upper Layer</u> — *Greatly Expanded*
- Fully exposed to ambient climate
- High light, no shade
- Negligible Visual Obstruction
- Minimal flower and seed forage
- Minimal leaf forage and substrate

<u>Middle Layer</u> — *Little Remaining*
- Near ambient humidity and temp.
- Near ambient wind
- Little reduction in light, minimal shade
- Low visual obstruction
- Does not meet behavioral attachment to dense overhead canopy
- Low amount of leaf forage and substrate
- Low variety of forage types

<u>Bottom Layer</u>
- Near ambient humidity & temperature
- Near ambient temperature
- Near ambient wind
- Mod. to high light, low to mod. shade
- Low visual obstruction
- Small amount of leaf forage

<u>Litter Layer</u>
- Moderately developed
- Moderate moisture retention

<u>Upper and Middle Layers</u>
Effectively Absent
- Fully exposed to ambient climate
- High light, no shade
- No visual obstruction
- Does not meet behavioral attachment to dense overhead canopy
- Virtually no leaf forage
- No flower and seed forage

<u>Bottom Layer</u>
- Near ambient humidity and temp.
- Ambient wind
- Ambient light, no effective shade
- Virtually no visual obstruction
- Virtually no leaf forage

<u>Litter Layer</u>
- Nearly absent
- Virtually no moisture retention

Figure A.3. Contributions of meadow vegetation to wildlife habitat and changes relative to retention levels.

section, including changes in characteristics relative to different levels of canopy cover of relatively-intact vegetation. Forestland has some of the same characteristics, except at a larger scale (Appendix C).

Background on Several Basic Concepts and Measures

The following subsections outline the basis of several concepts and measures that are used throughout this appendix, including the upcoming discussions of individual habitat and survival elements (e.g., humidity retention, hiding and escape cover, water quality, survival as affected by trampling).

Herbaceous Height Versus Weight

Weight is used in this report in part because it is a unit of measure used in range. A fundamental principle in dealing with weight and height of bunchgrasses and moist-meadow sedges (e.g., small-winged sedge) is that the least amount of their weight exists in the upper part of the plant and the majority of their weight is packed into their lowest part. Figures A.4 and A.5 illustrate the relationship between percent height of bunchgrasses (from the soil surface to the top of seedstalks) and the percent weight of the weight at these height intervals, based on height-weight curves from several studies (BLM et al. 1999:118, Kinney and Clary 1994).

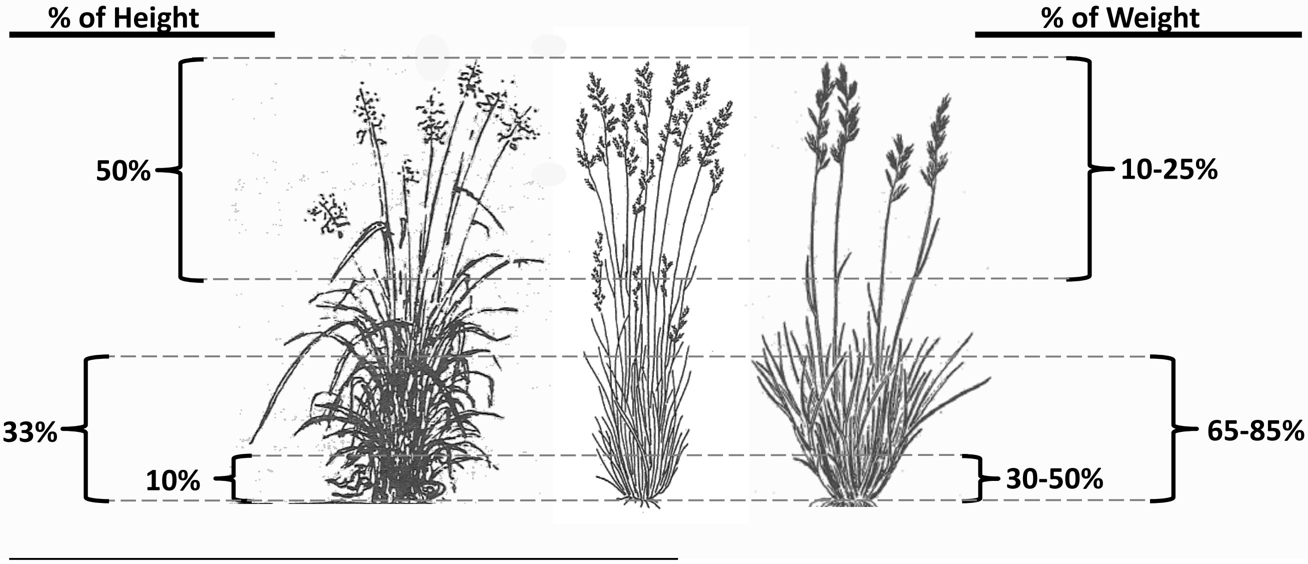


Figure A.4. Relationship between percent of bunchgrass height and percent of the weight of bunchgrasses.

An important implication is that reductions in height (working from the top of the plant, downward) result in proportionately less reductions in weight until fairly close to the ground where the reverse is true; most of the weight of bunchgrasses is near the ground. As discussed further in the “Plant Material Above a 2-Inch Height” subsection, below, the lowest 10% of the height of a bunchgrass contributes little to cover for small wildlife like frogs and toads and contributes little if anything to humidity retention, temperature moderation, and insect habitat.

A similar relationship exists for wet-meadow sedges (e.g., water sedge, beaked sedge, Nebraska sedge; Kinney and Clary 1994), but it is not as dramatic of a difference.

Herbaceous Retention Versus Utilization

Retention of herbaceous vegetation is used in this report, as opposed to utilization of herbaceous vegetation, mainly because the vegetation that remains is what is most meaningful for wildlife and because Objective 4.7(d) frames suitable conditions for wildlife in terms of retention of herbaceous vegetation. The following outline definitions of applicable terms used in this appendix.

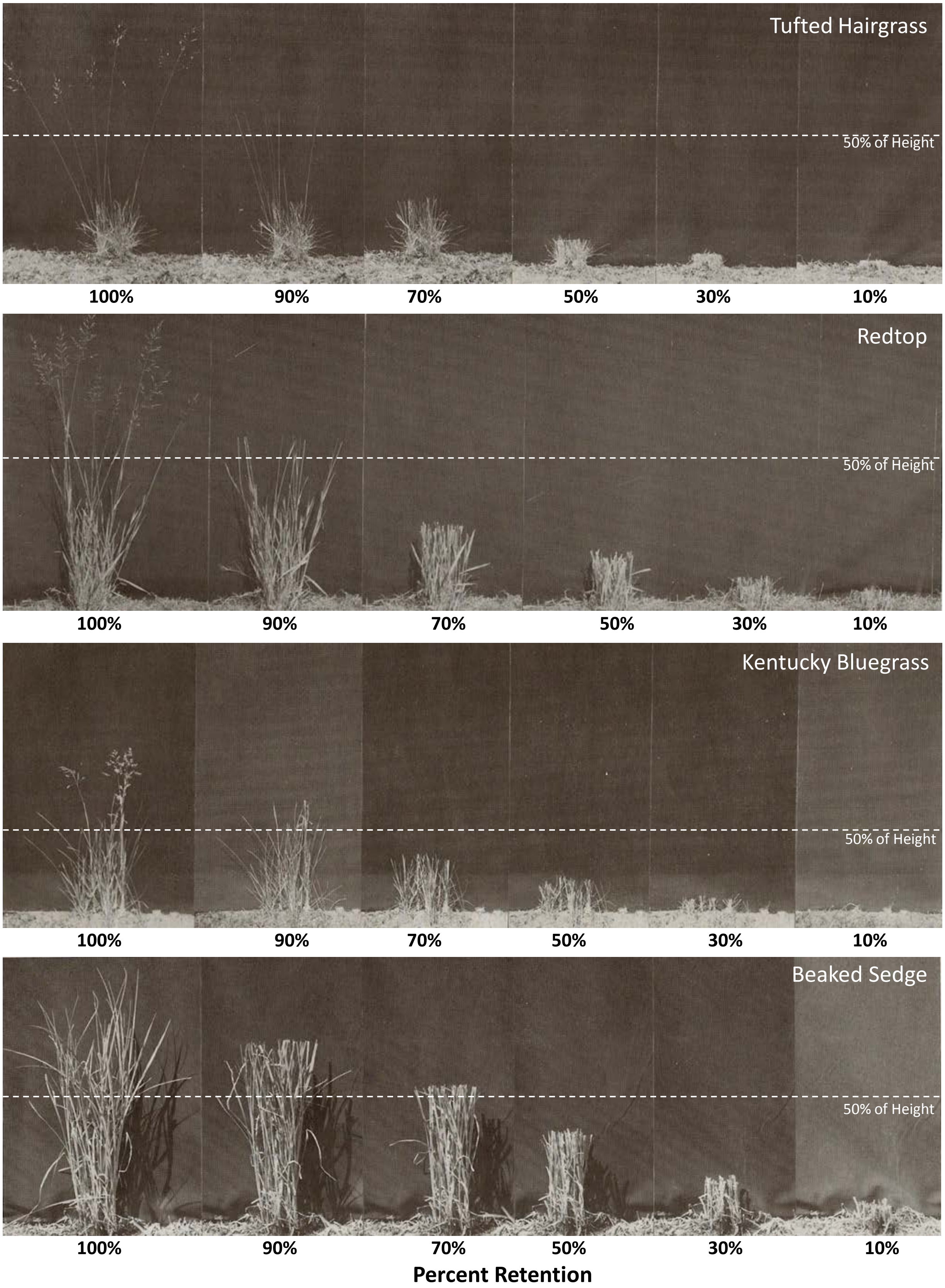


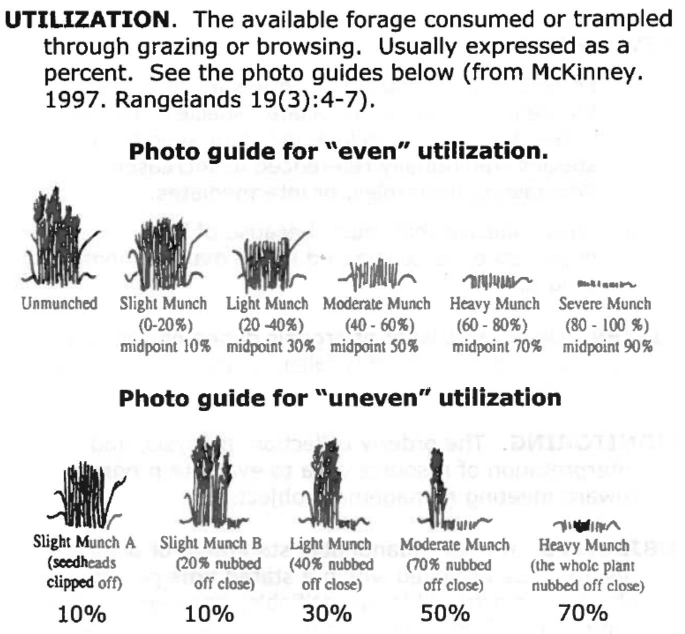
Figure A.5. Four grass and sedge species at potential height and at five retention levels (from Kinney and Clary 1994).

Retention of Total Herbaceous Vegetation (or Retention of Herbaceous Vegetation) **—** The current year's production of all herbaceous vegetation on a given site that is not consumed or trampled by grazing animals. The herbaceous vegetation that remains intact or relatively intact.

Percent Use or Utilization **—** "The percent of current year's forage production that is consumed or impacted by grazing animals. May refer to a single species or to a plant community" (BLM et al. 2008:53).

Utilization of Total Herbaceous Vegetation **—** The consumption and trampling, by grazing animals, of the current year's production of all herbaceous vegetation on a given site. In this case, percent use (see definition of "Percent Use or Utilization," above), refers to a plant community.

Utilization of Key Forage Species **—** The consumption and trampling of forage species whose use serves as an indicator of associated forage species. BLM et al. (2008:54) defined and characterized utilization as shown in Figure A.6.



UTILIZATION. The available forage consumed or trampled through grazing or browsing. Usually expressed as a percent. See the photo guides below (from McKinney. 1997. Rangelands 19(3):4-7).

Figure A.6. Illustration of even and uneven grazing, in relation to the definition of utilization identified in BLM et al. (1999:54).

BLM (2008:53) defined key species as "1. Forage species whose use serves as an indicator to the degree of use of associated species. In many cases, key species include indicator species, and species traditionally referenced as increasers, decreasers, desirables, or intermediates; 2. Those species that must, because of their importance, be considered in the management program." The first definition apparently came from the Society for Range Management (1989, as cited by Holechek et al. 2011).

The use of key forage species in this report focuses on "decreaser" portion of the above definition.

Figure A.7 provides a simplified illustration of the utilization of key forage species and retention of total herbaceous vegetation.

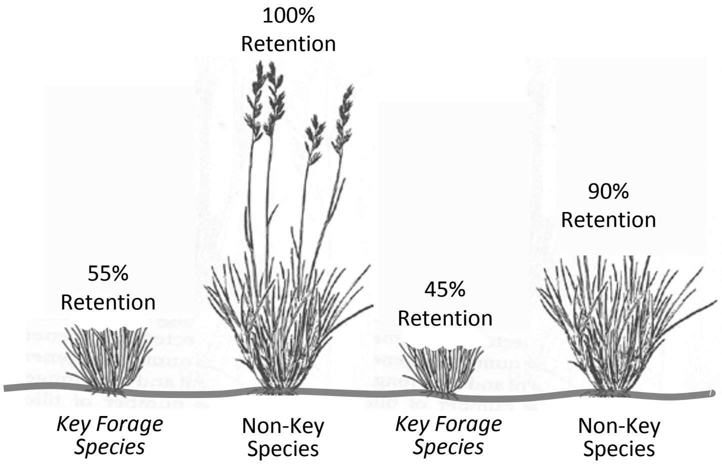


Figure A.7. Illustration of the relationship between percent use of key forage species and percent retention of total herbaceous vegetation. Average use of key forage species is 50% and average retention of total herbaceous vegetation is about 73%. (55% + 100% + 45% + 90% = 290%; and 290/400 = 72.5%)

Utilization of key forage species and of herbaceous vegetation traditionally has been measured after the grazing season, which allows regrowth **—** to the extent this actually occurs **—** to offset the some of the actual reductions in the biomass of key forage and herbaceous.

In order to provide a more accurate reflection of the minimum retention levels that actually occur each season, retention of herbaceous vegetation needs to be measured *during* the grazing season. At a minimum, retention needs to be measured or estimated just prior to or immediately after livestock move out of a given pasture.

Two Ways that Herbaceous Canopy Cover Declines with the Act of Grazing

There the three ways in which grazing-use reduces humidity trapping and temperature moderation attributes of herbaceous communities.

1. Immediate Reduction in Relatively-Intact Canopy Cover (Uneven Utilization)

This involves livestock biting-off plant material near ground level which, combined with them stepping on vegetation, creates small and then large openings in the herbaceous canopy as grazing and trampling progresses, eventually to where only patches of relatively-intact canopies remain and then none remain as grazing pressure becomes severe (McKinney 1997) (Figure A.6). Figure A.8 illustrates this form of grazing relative to progressively lower retention levels. This is typical of herbaceous communities dominated by bunchgrasses, rhizomatous species like Kentucky bluegrass, and moist-meadow sedges such as small-winged sedge.

The landscape appearance method of estimating percent utilization of herbaceous vegetation (BLM et al. 2008) was designed for communities dominated by bunchgrasses, rhizomatous bluegrasses, and other growth forms grazed as described by McKinney (1997).

2. Reduction in Height (Even Utilization)

This involves livestock biting-off plant material at the tops of plants and then progressively working downward, which lowers the height of plant communities as grazing progresses until the same result is obtained as in no. 1, above (BLM et al. 2008:53) (Figure A.6). Figure A.9 illustrate this form of grazing relative to progressively lower retention levels. This form of grazing is typical of herbaceous communities dominated by beaked, water, analogue, Nebraska, and similar sedge species. As such, the clipping study by Kinney and Clary (1994) provides directly-applicable information to this form of grazing.

In plant communities that are grazed “from the top down,” the retained height of herbaceous vegetation compared to pre-grazed height provides a better indicator of percent retention than methods like the landscape appearance method. This is because “landscape” characteristics used to estimate percent utilization in the landscape appearance method are based primarily on individual plants being bitten off near the ground level (BLM et al. 2008, and as described by McKinney 1997). The height/weight curves in Kinney and Clary (1994) would provide a better indication of percent retention.

Table A.2 and Figure A.14 (in the “Humidity Retention, Temperature Moderation, and Protection from the Sun” section,” below) present both the height of sedges above 2” if grazed evenly and the height of all graminoids above 2” if grazed evenly. Emphasis is placed on the former since sedges many times are grazed “from the top down” which is different than the way bunchgrasses are grazed (described above).

In recognition of the lowest 2 inches of plant material contributing no more than a negligible amount to humidity retention and temperature moderation near the ground surface, shading, hiding and escape cover, and invertebrate habitat provided by herbaceous vegetation — as discussed earlier — these lowest 2 inches of the height of plants can be discounted to provide a better reflection of the retention of herbaceous vegetation that actually contributes to these habitat elements. Since this measure primarily (and possibly exclusively) involves plant communities dominated by wet meadow sedges (e.g., water sedge, beaked sedge, Nebraska sedge), height-weight curves in Kinney and Clary (1994) were used to calculate the percent of pre-grazed heights (minus the lowest 2 inches) that would be retained at each category of percent retention by weight.

3. Reduction in Leaf Cover of Forbs

Sheep typically graze flowers and leaves from forb plants without, at first, grazing or trampling stalks. They focus on particular plant species, which initially creates patches of lesser canopy cover, but as grazing progresses, stalks increasingly get trampled and the openness of canopies increases. However, grazing by sheep in forb communities

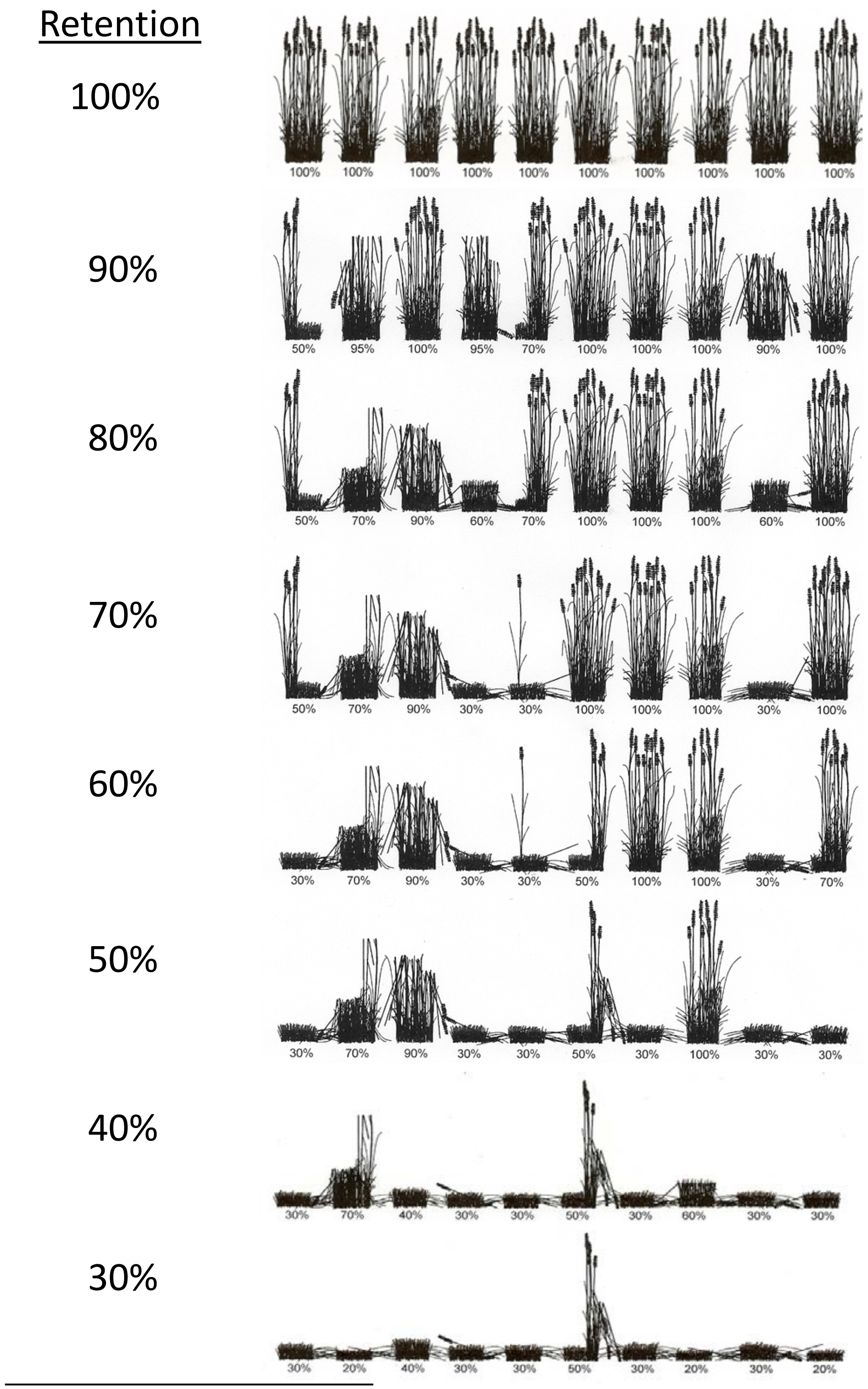


Figure A.8. Illustration of vegetation structure at a range percent retention of total herbaceous vegetation..

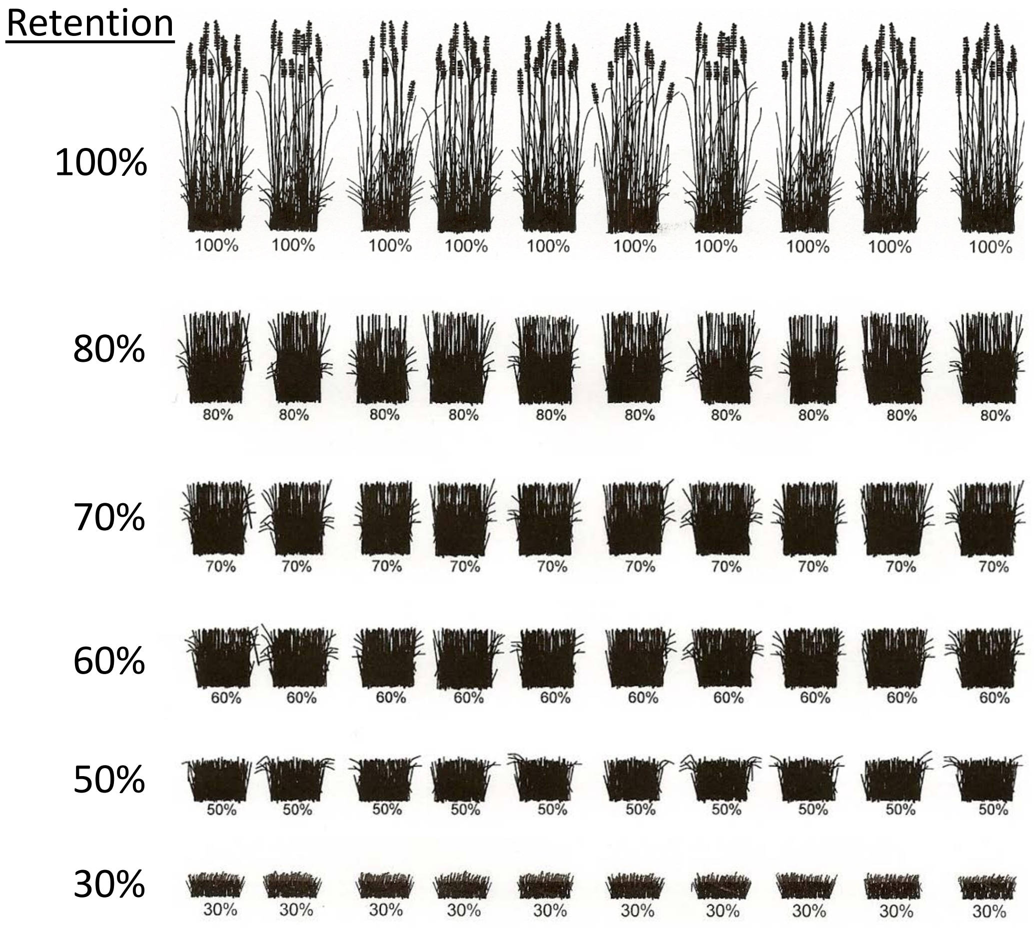


Figure A.9. Illustration of vegetation structure at a range percent retention of total herbaceous vegetation.

does not appear to be an issue for spotted frogs and boreal toads, except where frogs and toads migrate through these habitats.

Relationship between Total Herbaceous Vegetation and Key Forage Species

Of the terms outlined in the previous subsection, range managers focus on utilization of key forage species. In contrast, retention of total herbaceous vegetation is more applicable to ensuring that an adequate amount of suitable herbaceous habitat remains available for spotted frogs and boreal toads because (1) what remains is more important that what was removed (e.g., Objective 4.7(d)), and (2) key forage species of livestock have little meaning to spotted frog and boreal toad habitat.

However, utilization of key forage species likely will continue to be important in managing livestock grazing. As such, crosswalks are important to be able to go between the two terms. Crosswalks and methods are provided in Appendix B. Conversion between the two methods is straightforward. Converting percent retention of key forage species to percent retention of total herbaceous vegetation is a matter of simple mathematics with one known element (percent retention of key forage species) and two variables: (1) composition of key forage species by weight, and (2) percent retention of non-key forage species. Because both of these are variable, percent retention of total herbaceous vegetation for a given percent retention of key forage species needs to be expressed as a range; if both are known, then percent retention of total herbaceous vegetation can be expressed as one number. While Smith et al. (2007) used slightly different terms and took a slightly different approach, their report provides a published report by range professionals that describes the basic approach used in Appendix B.

Going the other direction, converting percent retention of total herbaceous vegetation to percent retention of key forage species is also a matter of simple mathematics with one known element (percent retention of total herbaceous vegetation) and two variables: (1) composition of key forage species by weight, and (2) percent retention of non-key forage species.

Plant Material Above a 2-inch Height

The intent of discounting the lowest 2 inches of herbaceous plant material from assessments in this report is to focus on the plant material that (1) most influences herbaceous habitat of spotted frogs, boreal toads, and their prey; and (2) is shared between livestock and frogs/toads. Discounting the lowest 2 inches of plant material from assessments gives a more meaningful reflection of the proportionate effects of removing plant material on the remaining herbaceous habitat qualities. For example, removing 40% of the annual production of total herbaceous vegetation gives the impression that the entirety of the remaining 60% of plant material contributing to wildlife cover. However, excluding the lowest 2 inches of plant material only leaves an estimated 0-53% of the plant material that contributes to humidity retention, temperature moderation, shading, hiding and escape cover, and herbaceous habitat of invertebrate prey remains, depending on plant species composition and growing conditions (Table A.2).

Discounting the lower 2 inches of plant material from assessments allows for a more meaningful evaluation of the effects of retained vegetation biomass on humidity retention and temperature moderation near the ground surface, shading, hiding and escape cover, and invertebrate vegetative habitat. This is because including the biomass of all plant material — including plant material that consistently does not contribute to humidity retention, temperature moderation, shading, hiding and escape cover, and herbaceous habitat of invertebrate prey — dilutes the effects of biomass reductions, due primarily to (1) the disproportionately heavy weight of plant material near the soil surface, combined with (2) the limited to negligible degree to which this plant material contributes to humidity retention and temperature moderation near the ground surface, shading, hiding and escape cover, and herbaceous habitat for invertebrates.

While frogs and toads inhabiting herbaceous plant communities mostly occur on the ground (i.e., in the lowest 2-inch zone), it is the plant material above this that provides nearly all of the functional habitat needs (Figure A.3). The role of plant material just above the soil surface (e.g., the lowest 2 inches), from the standpoint of herbaceous habitat for spotted frogs and boreal toads, is to hold up the plant material that contributes to the habitat elements listed in the previous paragraph. Obviously, from the plant perspective, it is not possible to have herbaceous plant material above 2 inches if it were not for the lowest 2 inches of each plant.

An above-ground height of 2 inches provides a practical, easily applied threshold between (1) plant material that contributes not more than negligibly to wildlife forage and cover (< 2 inches) and (2) plant material that contributes to wildlife forage and cover (>2 inches). Even if plant material at and immediately below the 2-inch mark contributes to humidity retention, temperature moderation, shading, hiding and escape cover, and invertebrate habitat, it is very marginal at best (DeLong 2009b, and see Table A.2 and the "Humidity Retention and Temperature Moderation," "Hiding and Escape Cover," and "Forage, Cover, and Substrate for Invertebrates" sections).

Each habitat element is addressed below:

- *Humidity Retention and Temperature Moderation* — Given the characteristics of herbaceous vegetation that "trap" humidity and moderate temperatures (primarily herbaceous canopies), there is no indication or evidence that live plant material below about 2 inches (primarily stalk material that is more-or-less vertical) contributes to retaining humidity and moderating temperatures near the ground level. (Dead plant material (e.g., litter, mulch) contributes to humidity retention and temperature moderation, but in a different way.)
- *Shading and Protection from the Sun* — Given the characteristics of herbaceous vegetation that provide shade (i.e., overhead plant material, especially leafy material), live plant material below about 2 inches contributes little to shade compared to the contributions of herbaceous canopies.

- *Hiding and Escape Cover* — While the lowest 2 inches of plant material comprises an estimated 20-40% of the weight of individual grass plants (to as much as 50% in some situations), depending on species and a range of situations, it contributes substantially less than 20-50% of the hiding and escape provided by the plant. With respect to areal predators, it may provide no more than negligible hiding and escape cover. On sites with stubble heights of 2 inches or less, Robel pole readings from both 4 meters (e.g., simulating the view of ground predators) and ½ meter (e.g., simulating the view of aerial predators) are predominantly at zero (unpublished data, Greys River Ranger District). Changes in modeled estimates of biomass above 2 inches and canopy cover above 2 inches relative to retention levels are very similar to the pattern of Robel pole readings from 4 meters and ½ meters at different retention levels (Table A.2, Figure A.14), which further validates the use of the 2-inch mark as a threshold. If the lowest 2 inches of plant material is not discounted, the amount of plant material contributing to wildlife cover and insect habitat is overestimated.
- *Herbaceous Habitat for Invertebrate Prey* — Several aspects of invertebrate habitat in herbaceous plant communities (humidity retention, temperature moderation, shading, and hiding and escape cover) are addressed above. Other key habitat elements include, depending on invertebrate species, forage (e.g., leafy material, stalks, flowers, seeds); substrate for eggs, pupae, and adults; and material for detritus in coming years. For invertebrate species that depend on plant parts that are at or near the top of plants (e.g., leaves higher on the plant, flowers, seeds), contributions are essentially non-existent until the height is tall enough to retain these plant parts.

  Based on general plant physiology (Briske 1991, Holechek et al. 2011), plant material below a height of about 2 inches is considerably more stalky and of lesser nutritional value for herbivores than plant material higher in the plant. The ratio of stalks to leaves increases as remaining stubble height declines, and the stalks of nearly all herbaceous species have lower nutritive value, considerably lower in many cases (Holechek et al. 2011:210). A 2-inch height does not demark a definitive threshold in regard to nutritive value of forage, but plant material below 2 inches, for most forage species, consists primarily of non-leaf material. Therefore, plant material within about 2 inches of the ground has no more than minimal nutritional value for most or nearly all herbivorous invertebrates.

Furthermore, retaining some amount of plant material through the grazing season — with the amount needed depending on plant species, season, availability of water, among other factors — is important for maintaining plant health and vigor, based on basic principles of plant physiology (Heady 1950, Crider 1955, Dietz 1989, Briske 1991, Clary and Webster 1989, Hall and Bryant 1995, Clary and Leininger 2000, Holechek et al. 2011). Maximum utilization limits of 30%, 40%, and even 50% of key forage species would retain stubble heights that are taller than 2 inches for nearly all grass and sedge species (BLM et al. 1999, Kinney and Clary 1994, Holechek et al. 2011:163) and, therefore, plant material below a 2-inch height would not be considered “available” for grazing by wildlife and livestock under these standards. With few exceptions, grazing bunchgrasses down to 2 inches equates to 45-80% or more utilization of individual plants, depending on species (Kinney and Clary 1994, BLM et al. 1999:118), and greater than 50% utilization of individual bunchgrasses impacts vigor and survival of plants (Crider 1955, Holechek et al. 2011). For some species like bluebunch wheatgrass — likely the most representative species of mountain big sagebrush and some mountain shrub communities — grazing them down to a 2-inch stubble height has severe consequences on survival; in fact, some studies have shown that grazing to a 6-inch stubble height on this species reduces survival (Heady 1950, Anderson 1991). In short, plant material within 2 inches of the ground is not “available” for consumption by livestock, native ungulates, and other herbivores from the standpoint of plant health.

Canopy Cover of Relatively-Intact Herbaceous Vegetation

A related concept is the distinction between canopy cover of relatively-intact herbaceous vegetation and vegetation that no longer provides for the functions of intact herbaceous canopies (i.e., humidity retention, temperature moderation, deep shade, hiding and escape cover, and invertebrate habitat associated with a high level of intact or relatively-intact herbaceous canopies (Figure A.10). Herbaceous vegetation not providing for these functions includes vegetation that is grazed to short heights, matted/laying down, and bent-over or broken to the point that canopy structure is no longer provided (Figure A.3, Figure A.10). The concept of canopy cover of relatively-intact vegetation is illustrated in Figure A.10; short stubble that is counted as canopy in some inventory methods is not counted.

A key reason for making this distinction is that, if canopy cover is measured after vegetation has been grazed — in the way that canopy cover is traditionally measured —, the remaining vegetation still gets counted as canopy even if no true canopy is functionally provided by the remaining vegetation. Also, the definition of "Percent Use" in BLM et al. (2008:53) and "Utilization" (BLM et al. 2008:54) specifies that trampled and otherwise impacted plant material is included as being utilized; for percent retention to be the flip-side of percent utilization, trampled / impacted plant material cannot be counted as being retained.

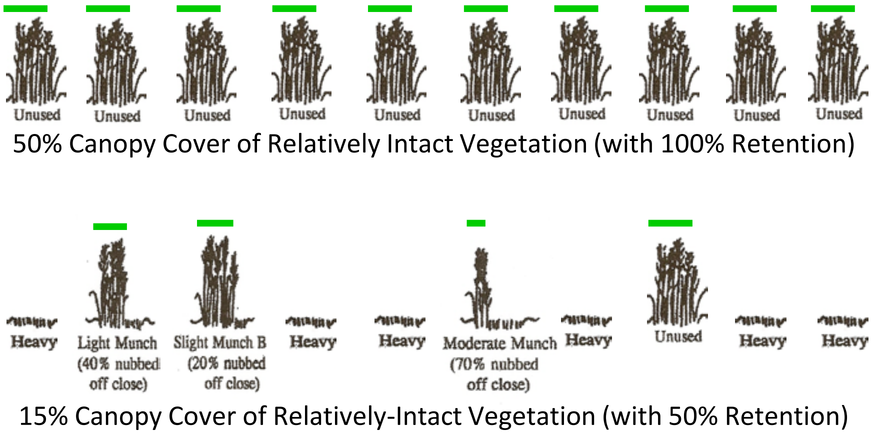


Figure A.10. Use of drawings in McKinney (1991) to illustrate percent canopy cover of relatively intact vegetation.

The use of the term, "relatively-intact canopies" (which includes intact canopies), therefore, allows for discussions to be directed at percent canopy cover of the portions of measured canopy cover that provide for the identified functions. Canopy cover of plant material above a 2-inch height is not synonymous with canopy cover of relatively-intact vegetation because some plant material above a 2-inch height does not necessarily provide for the identified functions.

This patchy grazing results from the grazing behavior of cattle as described by McKinney (1997). As he described, "when Bessy visits a tasty bunchgrass plant she puts her mouth down next to the ground, gives the head a little tilt, and ropes the whole plant in with her tongue at about *Heavy Munch* on the old chart" (McKinney 1997:4). In his paper, heavy munch is 60-80% utilization of a given plant (i.e., a mid-point of 70% utilization). The resultant uneven utilization of bunchgrass communities is illustrated in the *Wyoming Rangeland Monitoring Guide*, using illustrations from McKinney (1997). In these illustrations, the ungrazed portions of individual plants represents relatively-intact vegetation and the grazed portions represents the parts of plants that no longer are no longer "relatively intact" and, therefore, are not counted in the canopy cover of relatively-intact vegetation.

Estimates of canopy cover of relatively-intact vegetation assumed that changes in the percent canopy cover of relatively-intact vegetation are inversely proportional to the changes in the percent basal area of the vegetation (i.e., as an increasing proportion of basal area is grazed, there is a declining percent canopy cover of relatively-intact vegetation). This is generally true, but it is likely that changes in basal area change more rapidly than changes in canopy cover of relatively-intact vegetation because as plant material is removed from bunchgrasses — as described above — the remaining canopy likely "moves into" spaces that are freed up, but as grazing progress beyond light grazing, this probably no longer happens.

Percent of Visual Obstruction Retained

The Robel pole was originally developed as part of a study of greater prairie chicken nesting ecology, and in particular was designed to correlate visual obstruction measures with the amount (weight) of herbaceous vegetation on given sites (Robel et al. 1970). Robel poles have been used in many studies since 1970 to provide a quantitative index of visual obstruction of herbaceous vegetation (or, hiding cover) for gallinaceous birds and a wide range of other vertebrate and invertebrate wildlife species. Uresk and Juntti (2008) modified the Robel pole by using 0.5-inch alternating white and gray bands instead of the 1 decimeter bands of Robel et al. (1970). The Robel pole method is identified in the *Interagency Technical Reference for Utilization Studies and Residual*

Measurements (BLM et al. 1999) as one of three methods for measuring residual vegetation, and BLM et al. (1999) is the document that outlines accepted methods for use on National Forest System lands.

Cover provided by herbaceous vegetation is made up of above-ground parts of plants, especially plant material above about 2 inches, as previously discussed. Although Robel pole readings are mostly used as an index to visual obstruction (i.e., hiding cover), the readings also can provide indices of the capability of vegetation to retain humidity, moderate temperature, provide shade, and provide for the needs of invertebrate habitat. However, specific, quantitative relationships have not been ascertained as yet.

In addition to the standard reading of 13.2 feet (4 meters) from the pole and 3.3 feet (1 meter) above the ground, readings from an shorter distance are also provide valuable information. The standard reading of 4 meters out and 1 meter up provides an index of cover that visually obstructs small animals from ground-based predators (readings are at an angle of 14º from the ground), but this provides little information about the ability of vegetation to visually obstruct small animals from aerial predators. Readings 1 meter out and 1 meter up (45º angle from the ground) or ½ meter out and 1 meter up (63.4º angle from the ground) provide more information on visual obstruction relative to aerial predators. As an example, (1) Robel pole readings at a distance of 1 meter in smooth brome communities were about 14-29% of the readings at a distance of 4 meters, indicating sparse canopy and little visual obstruction from aerial predators; compared to (2) Robel pole readings at a distance of 1 meter in two wet meadow (sedge) communities were 59% and 80% of the readings at a distance of 4 meters, indicating fairly substantive visual obstruction from aerial predators (DeLong 2009b).

Tall, dense herbaceous cover not only makes it harder to see small animals and nests on the ground, it also helps to retain moisture and lower temperatures within a few inches of the ground on hot days (particularly when the wind is blowing) and to retain somewhat higher temperatures on cold days and nights. Accumulations of dead plant material can contribute substantially to these cover qualities. Some wildlife species have an innate sense about cover such that they tend not to venture out of areas where they have a “sense of security.” Therefore, some species of wildlife will not exist in favored plant community types if suitable herbaceous cover does not exist and will disappear from an favored habitat types if herbaceous cover declines below a certain threshold — this is the issue that prompted the developed the development of the Robel pole (Robel 1970). Other wildlife species may continue to attempt to reproduce, forage, and roost in cover at the threshold of suitability or below suitable conditions, but may experience higher levels of mortality, whether from predators, desiccation (drying) from the sun, or other causes. Some species may not require herbaceous cover, but may depend on species that do require this cover, thereby indirectly requiring herbaceous cover.

Humidity Retention, Temperature Moderation, and Protection from the Sun

Frogs and toads seek out and require moist to wet habitat and microsites (Dumas 1964, Schwarzkopf and Alford 1996, Sjogren and Ray 1996, Engle 2001, Patla and Keinath 2005, Rittenhouse et al. 2008, Bull 2009, Burton et al. 2009, Long and Prepas 2012); moderated temperatures are important to spotted frogs and boreal toads (Dumas 1964, Sjogren and Ray 1996, Engle 2001, Semlitsch et al. 2008, Semlitsch et al. 2009); and shade and protection from the sun is important to these species (Schwarzkopf & Alford 1996 , Engle 2001, Bartelt et al. 2004, Semlitsch et al. 2008, Semlitsch et al. 2009).

Moist and humid environments are important to frogs and toads because their bodies have only limited ability to regulate the loss of water through their skin and, therefore, their skin must remain moist (Schwarzkopf and Alford 1996, PARC 2008, Rittenhouse et al. 2008). They regulate skin moisture through the selection of places they inhabit. Dumas (1964) reported that relative humidity of 65% at about 78 °F (25 °C) is lethal to adult spotted frogs in approximately two hours. Daytime ambient humidity in open country at lower elevations of the BTNF during late June through early September can range widely, depending on specific location and weather conditions, but is substantially less than 50% on most days, with humidity as low 20% or lower not being uncommon. Maximum daytime late-June through early September temperatures at NRCS weather stations on the BTNF between about 7,000 and 8,500 feet typically range from the low 70s to the mid 80s (NRCS temperature data for Hams Fork, Snider Basin, Base Camp, and Loomis Park SNOTEL sites; expressed in ºF). About 72% of spotted frog breeding sites occur between 7,000 and 8,500 feet in elevation or lower.

Therefore, when they move across terrestrial habitats, either the terrestrial habitat must be sufficiently moist or humid, or the distance from one moist site to each of the next moist sites must be of short enough that frogs will not be caught in-between for too long (Engle 2001, Pilliod et al. 2002, Patla and Keinath 2005). Boreal toads are able to inhabit habitat that is not as wet as habitats typically used by spotted frogs (Keinath and McGee 2005; Rittenhouse et al. 2008; Bull 2009; Thorson 1955, Schmid 1965, Duellman and Trueb 1986, Conant and Collins 1998, as cited by Burton et al. 2009), but spotted frogs typically inhabit wet habitats (e.g., wetlands, streams, springs), whereas boreal toads commonly inhabit moist habitats that surrounds these wet sites. While boreal toads have more protection against losing body moisture and while they can withstand greater water loss than spotted frogs, they are still dependent on relatively moist habitats and protection from the sun when inhabiting terrestrial habitats (Schwarzkopf and Alford 1996, Wind and Dupuis 2002, Bartelt et al. 2004, Keinath and McGee 2005, Muths 2005, Bull 2006, Bull 2009, Long and Prepas 2012). As such, boreal toads require either moist habitat conditions or a relatively high density of moist microsites in somewhat drier environments. This appears to be true for shoreline habitat when boreal toad metamorphs transition from water to land (e.g., Bartelt 1998). Browne et al. (2009:218) assessed that "a greater density of understory vegetation could provide more cover to protect amphibians from… desiccation" (their study included western toads, chorus frogs, and wood frogs).

Juvenile boreal toads are found in similar habitat as adults, but they require conditions that have a higher level of moisture, for example, denser herbaceous vegetation (Muths 2005, Bull 2009) or a denser herbaceous and shrub canopies. Bull (2009:243) found that "Compared to available plots, juveniles selected sites closer to water, farther from forests, with a lower canopy closure, gentler slopes, taller ground cover, more grass ground cover, fewer logs and shrubs, and more shelters." In Bull's (2009) study, canopy cover of grass was about 3 times higher at juvenile boreal toad locations than at random sites, and she noted that "Juveniles in my study used sites with water, little tree canopy, gentle slopes, dense grass and forb cover, and south- and west-facing slopes, thereby maximizing both temperature and hydration" and that "The moisture and solar radiation [in wet meadows] resulted in dense growth of grasses, forbs, and mosses, which likely provided abundant cover and prey for toads" (Bull 2009:245). She observed that habitat used by juveniles was similar to that of adults, except that it was wetter, likely because juveniles are less able than adults to retain body moisture. Similarly, "Newly metamorphosed individuals however, have a higher surface area to volume ratio, and are more vulnerable to desiccation than adults (Livo 1998)" (Wind and Dupuis 2002:18).

Shrub canopies contribute to the retention of ground-level humidity, temperature moderation, and shading to varying degrees. Silver sagebrush and willow bushes provide shade, but silver sagebrush bushes contribute substantially less to humidity retention and temperature moderation than willow bushes having a natural structure (i.e. no more than limited influence of browsing and trailing). In willow-herb and dense willow communities, the denser the willow canopy cover, the greater the differential contribution that willow canopies and herbaceous vegetation make to humidity retention, temperature moderation, and shading. However, dense willow communities (particular tall, dense willow communities) would appear to be *too* shaded and not have sufficient basking sites for toads and likely are not heavily used. Percent willow canopy cover that is low enough to provide basking sites is also low enough to provide for herbaceous production in these gaps. With lower levels of canopy cover, herbaceous vegetation plays greater roles in retaining ground-level humidity and temperature moderation.

In forestlands, possibly the largest impact to amphibians resulting from changed habitat conditions after timber harvest is the reduction in moist microsites (Patla 2001, Bartelt et al. 2004, Keinath and McGee 2005, Patla and Keinath 2005, PARC 2008, Rittenhouse et al. 2008, Semlitsch et al. 2009). Major concern has been expressed about effects of timber harvest and fuel reduction projects on the availability of moist microsites for boreal toads. The importance of moist microsites is no less important in non-forested habitat, and in fact, may be more important because there are fewer options for moist microsites. Results of Schwarzkopf and Alford (1996) support the principle that greater amounts of soil moisture and greater amounts of herbaceous canopy cover retain higher humidity levels at ground level. They found that water loss in simulated toads was greatest in the open on sandy ground, somewhat lower in dry grassy sites, substantially lower in wet grassy sites, and lowest in burrows. In another part of their study, Schwarzkopf and Alford (1996) found that cane toads (*Bufo marinus*) made greatest use of burrows and wet grassy sites and little or no use of dry grassy sites and open sites during the dry season, and made relatively high use of dry grassy sites and less use of burrows and wet grassy sites during the wet season. In a study by Long and Prepas (2012), 19% of refugia (humid microsites) used by boreal toads consisted of vegetation including grasses and/or shrubs, and these had relative humidity measurements that were higher than random points.

Additionally, even when they use other refugia in herbaceous communities and herbaceous-shrub communities, moist and humid conditions may be important in these communities outside of the refugia. For example, Long and Prepas (2012) noted that "…Northern Cricket Frogs (*Acris crepitans* Baird, 1854) preferred moist substrates within proximity to shelter and surface water (Smith et al. 2003). These complementary microhabitats may be as important for behavioural thermo and hydro-regulation as the refugia themselves."

Shovlain et al. (2006) found that (1) under lower grazing pressure, as measured by pin-counts of vegetation that indicated the amount of vegetation removed, Oregon spotted frogs did not show a preference for cattle exclosures or areas grazed by cattle, and (2) 80% of frogs spent more than 50% of their time inside exclosures when the pin-count difference exceeded 1.5. She did not identify a crosswalk between pin-counts and percent utilization, and it is possible this transition happened at a relatively high retention level. Jansen and Healey (2003) found that vegetation height and diversity affected the composition of frog communities, and one possible mechanism for vegetation height and diversity to affect frog diversity and abundance is the effects that vegetation has on shading, maintaining relatively higher ground-level humidity, and moderating ground-level temperatures.

Although Pilliod et al. (2002) found that fall-migrating spotted frogs in central Idaho travelled furthest at night and during or shortly after a rain event, many frogs were observed migrating during the day and during dry periods. Successful migrations during the day would require the availability of shade and moist habitats. Rittenhouse et al. (2008)[B] found that desiccation can be a major source of mortality for juveniles after leaving breeding wetlands and while moving through terrestrial habitats. While adults may be able to call on previous experience in traveling through specific areas and be able to find somewhat scattered moist microsites as needed (although there is no actual data supporting this), juveniles have no previous experience in their movements away from breeding sites and may depend more greatly depend on closely spaced or homogenously-moist habitats with relatively high humidity at ground level.

Thus, survival in some places depends on terrestrial habitat that retains higher humidity/moisture at ground level and provides protection from the sun and predators (e.g., herbaceous and shrub cover) or that provides many suitable microsites with these qualities. This is particularly important for individuals that move across terrestrial habitat during July, August, and early September (when temperatures are highest, relative humidity is lowest, and rain events may be widely spaced). Engle (2001) discussed the importance of herbaceous vegetation in maintaining comparatively higher humidity levels and moderated temperatures for spotted frogs in migration habitat. She concluded that "The creation of drier and more hostile dispersal habitats with greater daily variation in both humidity and temperature slowed down dispersing frogs and likely increased mortality from desiccation and predation," citing Sjogren and Ray (1996) as supporting information.

"In dense grass and low plant cover, complete calm exists at ground level. This calm is an outstanding feature of the microclimate near the ground, since it influences both temperature and humidity and creates a favorable environment for insects and other animals" (Smith 1977:149).

In herbaceous plant communities, herbaceous vegetation is central to retaining near-ground humidity and moderating temperature (Marlatt 1961, Thom 1971, Cionco 1972, Goudriaan 1977, Smith 1977, Oke 1978, Baldocchi et al. 1983). An examination of the key attributes of herbaceous vegetation that maintain higher humidity near the ground surface and that moderate temperatures near the ground surface reinforce the importance of herbaceous vegetation to spotted frogs and boreal toads, especially where the ground surface does not remain wet during summer months. In the absence of vegetation, temperatures immediately above the ground on a warm summer day can be substantially warmer than the air temperature 6 ft. above the ground

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[B] The study area of Rittenhouse et al. (2008) received an average of about 17 inches of rain from March through May, and amphibians still had issues with desiccation (the study area received less rain during this period in one year of their study). Ambient humidity in the Missouri study area is higher than on the BTNF. Because the BTNF is less humid and receives less rain in spring, the principles found in their study would be generally applicable to the BTNF (the potential for desiccation would be greater on the BTNF).

(where air temperatures are taken). The main reason for this difference is solar radiation that warms the soil, which in turn radiates back upward as long-wave radiation within a thin layer of air above the soil (Smith 1977:148). Where vegetation exists, it intercepts solar radiation and radiates it upward and sets the stage for moderated temperatures immediately above the ground and below the vegetation canopy.

As herbaceous height and/or canopy cover of intact and relatively-intact vegetation declines (e.g., Figure A.8 and Figure A.9), humidity-retention and temperature-moderation attributes decline (Figure A.11). Similar patterns have been found in forest vegetation. Edgerton and McConnell (1976, as cited in Thomas et al. 1979d:113) found that *average* midday temperatures in late July in unlogged mixed conifer were about 11 ºF cooler than in clearcuts (74 vs. 85 ºF), and the opposite was true for low night-time temperatures (56 vs. 39 ºF). Similar relationships were portrayed in Stoeckeler (1962, as cited in Smith 1977:150).

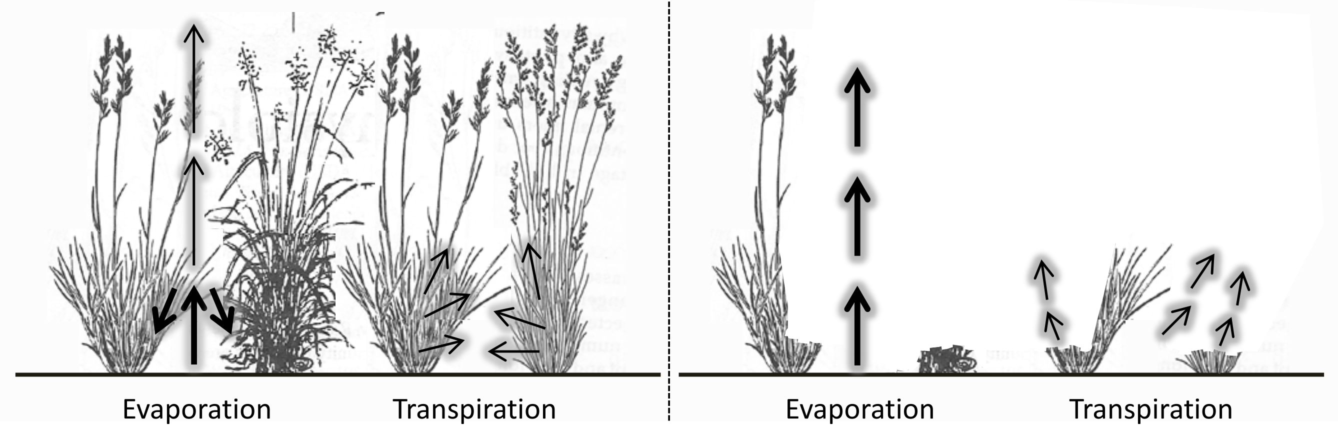

Figure A.11. Illustration of the generalized effects of herbaceous vegetation canopy on evapotranspiration, without any removal of plant material and with removal of a large portion of the canopy.

Canopies of herbaceous vegetation maintain lower temperatures and higher humidity levels near ground level during midday than would occur without the vegetation (Smith 1977:147-149, Oke 1978:104-120, Baldocchi et al. 1983, Honek and Jarosik 2000), as illustrated in Figure A.11 and Figure A.12. In the papers presenting humidity profiles for agricultural crops, the methods did not include measuring vapor pressure all the way down to the soil surface. These results were obtained in row crops (e.g., wider spacing than would occur in native meadowland), with little diversity in structure (compared to native plant communities with a large variety of plant heights and shapes), and typically with low amounts of litter and mulch. Closer plant spacing and taller plants with dense canopies retain more humidity and moderates temperatures near ground level more so than wider spacing and shorter plants with sparse canopies (Marlatt 1961, Wolfe et al. 1962, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988). Figure A.12.e shows there are similarities between the leaf-surface profile of a soybean crop and a mixed meadow community, with leaf-surface profile having a major influence on the capability of a plant community to “trap” humidity and moderate temperatures near ground level. Therefore, although most information available on the capability of herbaceous vegetation to retain humidity and moderate temperatures is from studies on row crops, general principles are applicable to native herbaceous communities, recognizing that specific measures could very well be different.

Litter and mulch contribute to retaining moisture at the ground surface, which contributes to higher humidity just above the soil surface, and litter and mulch buffer air temperatures near the ground level (Hopkins 1954, as cited by Fagerstone and Ramey 1996; Molinar et al. 2001), all of which are important to frogs and toads (Maxell 2000, Bartelt et al. 2004). There are many reasons for this. Starting at a point just above the vegetation canopy, solar radiation declines down through the vegetation canopy toward the ground, which is due to absorption, reflection, transmission, and emission of radiation in the canopy (Goudriann 1977, Oke 1978:109-110, Baldocchi et al. 1983). As vegetation height and density declines, greater amounts of solar radiation penetrate closer to ground

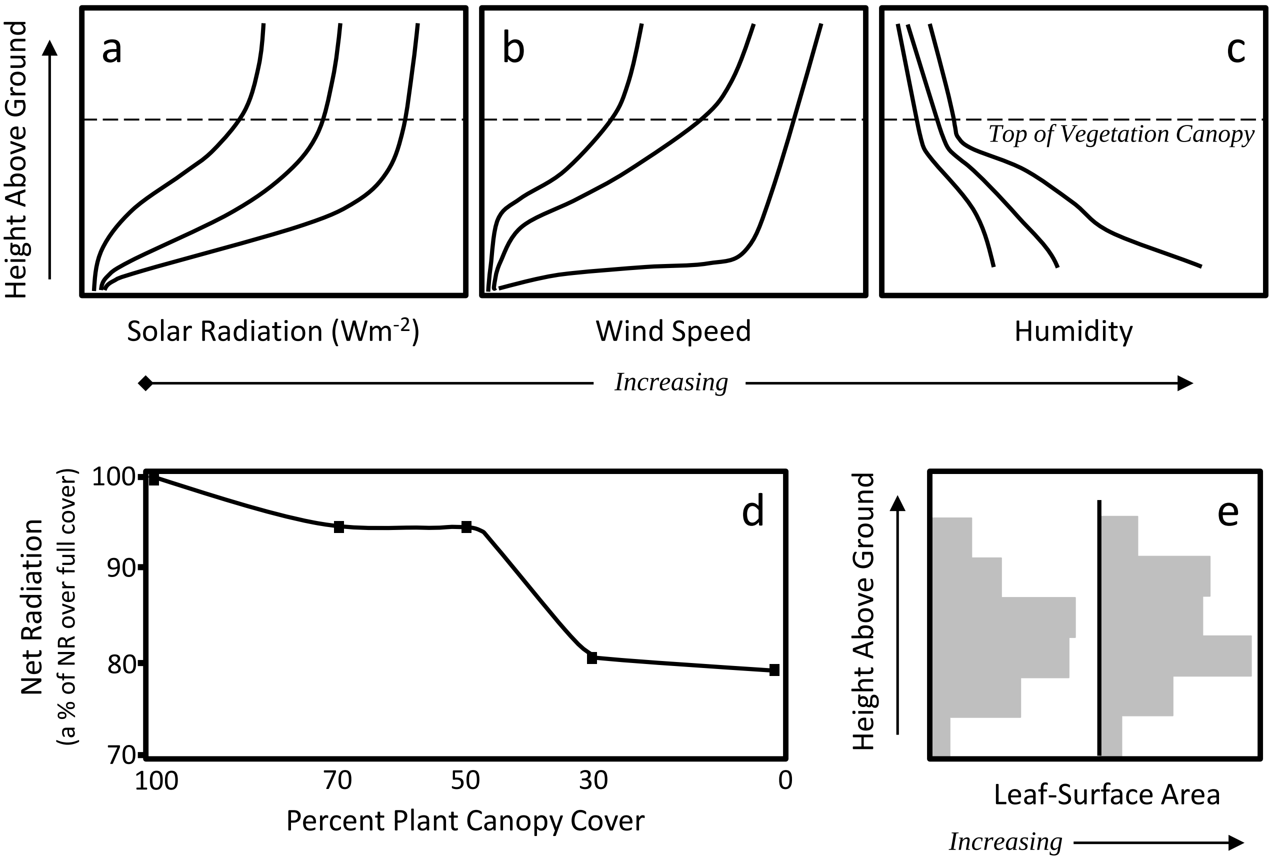

Figure A.12. Generalized examples of midday changes in (a) solar radiation, (b) wind speed, and (c) humidity with increas-ing height above the ground and in relation to the top of the vegetation canopy based on crop microclimate research by Marlatt (1961), Thom (1971), Cionco (1972), Goudriaan (1977), Oke (1978), Baldocchi et al. (1983); (d) differences in net radiation at different vegetation canopy covers from Marlatt (1961); and (e) example of a vertical profile of leaf area in a mixed-grass legume pasture (Wilson and Ludlow 1983) and of a soybean cultivar (from Baldocchi et al. 1983), as simplified representations of a meadow community and forb plant structure.

level. Burton et al. (2009:274) stated that "Although we did not measure differences in light intensity or ground temperature, it is reasonable to assume that these abiotic factors were greater along the shoreline at cattle-access wetlands due to increased exposure to solar radiation associated with less vegetation," and they concluded that conditions were less hospitable to green frogs than for American toads. An estimated average of approximately 40-50% of herbaceous vegetation was retained in their study.

Reduced wind speed near the grounds surface is contributing factor to moderated temperatures and higher humidity levels. Wind, which acts to bring near-ground humidity levels and temperatures closer to ambient humidity levels and temperatures, is considerably lower immediately above the ground surface in dense herbaceous communities compared to higher in the herbaceous canopy in these communities which in turn is lower than above the vegetation (Marlatt 1961, Thom 1971, Cionco 1972, Oke 1978:118-119, Baldocchi et al. 1983). Marlatt (1961) demonstrated that wind velocity at the ground surface was lower in grass cover than on bare sites and that wind velocity was considerably lower within 2-3 inches of the ground surface than higher in the grass canopy. Thom (1971) and Cionco (1972) showed that wind speed near the ground surface increased with decreasing canopy cover, and Thom (1971) demonstrated that complexity or roughness of the canopy influences wind speeds under the canopy. He found that wind speeds declined with increasing levels of roughness.

Two other factors that contribute to cooler temperatures and higher humidity levels near the ground surface are soil temperatures that are lower than air temperatures on warm to hot days and the evaporation of water from the soil surface and from litter/mulch (Oke 1978:118-120, Molinar 2001). Oke (1978:120) noted that the soil temperature regime below herbaceous vegetation is similar to that of non-vegetated surfaces, except that the amplitude of the temperature wave is dampened by the radiation shading of the canopy. (And the reverse happens on cold nights.)

The vegetation attributes that contribute to retaining humidity and moderating temperatures also contribute to shading and protection from the sun. Figure A.13 illustrates the role that herbaceous canopies play in providing shade for frogs and toads, and the negative effects of the absence of shade and protection from the sun. The figure presents somewhat of an extreme example, but it is not hypothetical because this can be fairly typical in some pastures, for example where nonnative bluegrasses dominate moist meadows.

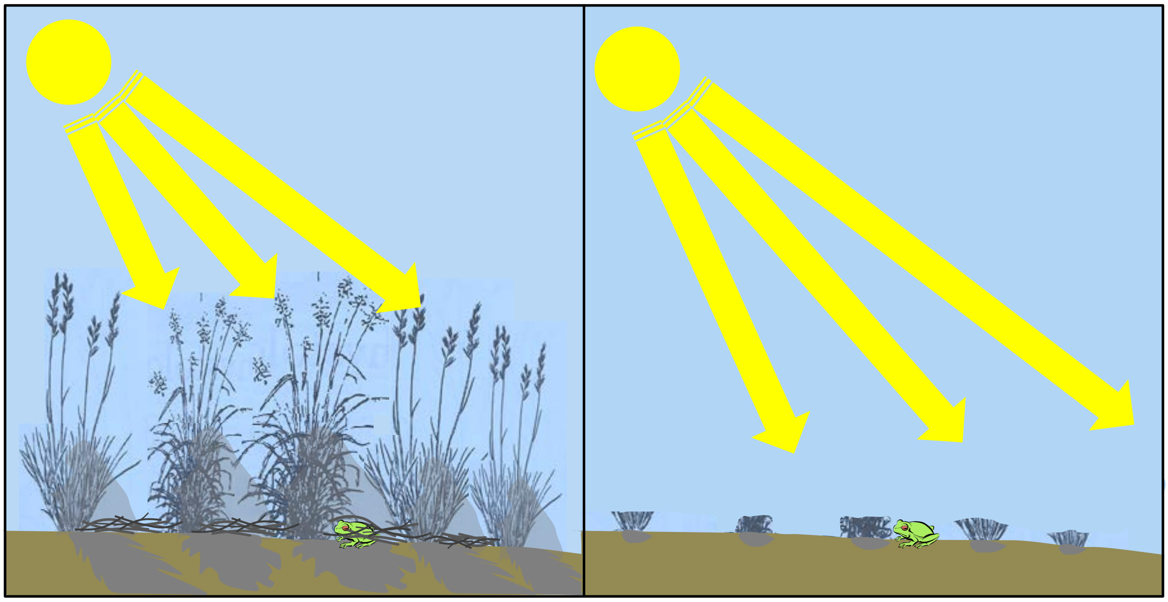

Figure A.13. Illustration of changes in vegetation structure and effects on the suitability for amphibians with respect to shading and protection from the sun. About 8 percent of the height was retained (0% above 2 inches), which can represent as little as about 25% retention of total herbaceous vegetation, depending on plant community and growing conditions.

The effects described above with respect to retaining humidity and moderating temperatures (as well as for providing shade) are most pronounced in plant communities having tall, dense herbaceous vegetation and least pronounced on sites with sparse and/or short herbaceous vegetation. Starting with 100% retention in a tall, dense herbaceous plant community and working downwards in retention levels, it stands to reason that there comes a point at which remaining vegetation provides little thermal protection and contributes little to maintaining higher humidity near the ground surface. Given the structure of herbaceous vegetation at different retention levels, this likely happens somewhere between about 80% and 60% retention of total herbaceous vegetation; by 60% retention, effective canopy cover (i.e., not including vegetation grazed to 2-3 inches) has declined to an estimated one-third to half of the original canopy cover (see Table A.2, Figure A.14, and DeLong 2009b), which would retain little humidity and would be ineffective at moderating temperature.

Hiding and Escape Cover

A fundamental principle of wildlife ecology is that, as hiding and escape cover provided by herbaceous vegetation declines, predation rates generally increase (Leopold 1933, Braun et al. 1978, Dasmann 1981, Bailey 1984, Peek 1986, Beintema and Müskens 1987, Warkentin 1992, Olson 1992, Fagerstone and Ramey 1996, Gilbert et al. 1996, Choate 2007).

In herbaceous plant communities, herbaceous vegetation **IS** hiding and escape cover (Robel 1970, Birney et al. 1976, Kirsch 1978, Peek 1986, Beintema and Müskens 1987, Ohmart 1996, Dwire et al. 2004, Patla and Keinath 2005, Shovlain et al. 2006).

Live and dead herbaceous vegetation provides visual and structural barriers that hide frogs, toads, and tadpoles from predators, and it provides structure that decreases the difficulty of predators catching tadpole and adult frogs and toads where they rest or forage. This hiding and escape cover (which exists both in and above the water column in wetlands) is important for tadpoles and for adult frogs and toads when they are in wetlands (Warkentin 1992, Jansen and Healey 2003, Muths 2005, Shovlain et al. 2006, Schmutzer et al. 2008), is important on shorelines for metamorphs and adult frogs and toads when they inhabit shorelines (Jansen and Healey 2003, Burton et al. 2009), and is important in wet meadows, moist meadows, silver sagebrush, and open willow-graminoid communities for metamorph, juvenile, and adult frogs and toads (Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006, Shovlain et al. 2006, Bull 2009). Browne et al. (2009:218) assessed that “a greater density of understory vegetation could provide more cover to protect amphibians from predation and desiccation” (their study included western toads, chorus frogs, and wood frogs). Pilliod and Scherer (2015) suggested that reduction in emergent vegetation in wetlands and on shorelines can expose tadpoles and metamorphs to greater predation. Also, Rodríguez-Prieto and Fernández-Juricic (2005) found that distances at which flight-response was elicited in Iberian frogs declined with increasing levels of herbaceous canopy cover and herbaceous height.

The apparent preference of spotted frogs and boreal toads for selecting breeding ponds that contain substantial amounts of sedges and other emergent vegetation and the propensity for them to lay their eggs in marshy parts of wetlands (Keinath and McGee 2005, Patla and Keinath 2005, Reaser and Pilliod 2005, unpublished amphibian monitoring data of BTNF) may in part be explained by the contributions of emergent vegetation to protecting adult frogs and toads and tadpoles from predators. Emergent vegetation has not yet started growing to any large degree when eggs are laid, but residual vegetation from previous growing seasons contributes to hiding cover at the beginning of the season. In part, Schmuzter et al. (2008) attributed markedly higher tadpole diversity and markedly higher abundance of some tadpole species in ungrazed wetlands to a 10.9x greater biomass of detritus in these wetlands — which provides escape cover, as well as feeding sites and forage — compared to grazed wetlands. Lower biomass of detritus likely resulted from cattle grazing (an estimated 75% reduction in the height of emergent vegetation during the study); also, although not discussed in Schmutzer et al.(2008), trampling of emergent vegetation into the substrate also likely contributed to the significantly higher amount of detritus in ungrazed wetlands. Warkentin (1992) provides a literature review of studies that have shown predation risk influencing microhabitat selection by tadpoles; i.e. selection of microsites within wetlands to reduce the risk of predation. Muths (2005:394) reported that boreal toad tadpoles “…will swim to cover, rocks, vegetation, or shadows when disturbed,” which likely contributes to lower predation rates. Also, spotted frogs in many parts of their range breed in permanent water bodies (Reaser and Pilliod 2005), and Wasserbug (1974) made the hypothesized that tadpoles of frog taxa that typically breed in permanent water bodies “…make use of structural complexity to hide from predators…” In many wetlands, the most prominent or only source of hiding and escape cover is that provided by herbaceous vegetation. Selection of sites with taller herbaceous vegetation by adult spotted frogs (e.g., Shovlain et al. 2006) may also be in response to reduced predation risk, in part.

Except when they inhabit dense willow communities and forests with substantial amounts of large woody debris and/or shrubs, herbaceous vegetation, including residual vegetation and litter, is the main source of hiding cover. Keinath and McGee (2005), Muths (2005), and Patla and Keinath (2005), and Reaser and Pilliod (2005) listed many of the large number of known predators of spotted frogs and boreal toads. When they inhabit willow-herb and dense willow communities, willow canopies obviously contribute to hiding cover; the denser the willow

Table A.2. Estimated effects of changes in percent retention of total herbaceous vegetation on several indicators of the suitability of wildlife forage and cover related to herbaceous vegetation. Numbers in all cells are percentages. The bottom part of the table represents changes in percent canopy cover of relatively-intact herbaceous vegetation (based on information on graminoids) as retention levels decline across any given row at different starting, pre-grazed levels of percent canopy cover (different rows). Calculations were derived based on information in DeLong (2009b), as well as in Kinney and Clary (1994), McKinney (1997), and BLM et al. (1999:118).

	Percent Retention of Total Herbaceous Vegetation										
Indicators	(a) **100%**	(b) **90%**	(c) **80%**	(d) **70%**	(e) **60%**	(f) **50%**	(g) **40%**	(h) **30%**	(i) **20%**	(j) **10%**	(k) **0%**
Total Herb Veg.											
Weight of Herb Veg. Above about 2” [A]	100	75-88	50-76	25-65	0-53	0-41	0-29	0-18	0-6	0	0
Amt. Canopy Cover of Relatively-intact Veg. [A,B]	100	85-100[B]	70-95[B]	50-65[B]	35-50[B]	20-35[B]	0-15[B]	0-5[B]	0	0	0
% Visual Obstruction Retained (from 4m)	100	80-100	60-85	35-70	25-50	10-40	0-30	0-20	0-10	0	0
% Visual Obstruction Retained (from 1m)	100	70-100	50-85	20-60	10-50	0-40	0-30	0-20	0-10	0	0
Height of Sedges Above 2” if Grazed at Even Ht.	100	65-80	53-65	41-50	29-38	21-30	12-20	5-13	0-7	0	0
Height of All Graminoids Above 2” if Grazed Evenly	*100*	*45-80*	*25-60*	*15-45*	*10-40*	*5-30*	*4-15*	*2-10*	*1-6*	*<1*	*0*
Ave. (w/o Gramin. Height)	100	75-94	57-81	34-62	20-48	10-37	2-25	1-15	0-5	0	0
Degree of Change Across the Indicators	None	Small	Mod.	Large	Major	Major	Severe	Severe	Severe	Severe	Severe
Starting Canopy Cover of Herbaceous Veg.:											
100%	100	85-100[A]	70-100[A]	50-65	35-50	20-35	0-15	0-5	0	0	0
90%	90	77-90	63-90	45-59	32-45	18-32	0-14	0-05	0	0	0
80%	80	68-80	56-80	40-52	28-40	16-28	0-12	0-4	0	0	0
70%	70	60-70	49-70	35-46	25-35	14-25	0-11	0-4	0	0	0
60%	60	51-60	42-60	30-39	21-30	12-21	0-9	0-3	0	0	0
50%	50	43-50	35-50	25-33	18-25	10-18	0-8	0-3	0	0	0
40%	40	34-40	28-40	20-26	14-20	8-14	0-6	0-2	0	0	0
30%	30	26-30	21-30	15-20	11-12	6-11	0-5	0-2	0	0	0
20%	20	17-20	14-20	10-13	7-10	4-7	0-3	0-1	0	0	0
10%	10	9-10	7-10	5-7	4-5	2-4	0-2	<1	0	0	0

░ = Percentages are greater than or predominantly greater than 50%.
□ = Percentages have a wide range with 50% being near the middle of this range.
▓ = Percentages are less than 50% or predominantly less than 50%.

[A] Percentages are based on figures for individual plants and does not account for shorter plants in plant communities. Therefore, percentages are overestimated; i.e., accounting for total plant material in a plant community, percentages would be lower.

[B] Based directly on the basal area of herbaceous vegetation above 2 inches. Note: some of the herbaceous vegetation qualifying as canopy cover under this indicator may be as short as 4-6 inches, meaning that some of what is counted as canopy cover even though this may contribute only marginally to humidity retention, temperature moderation, and hiding cover and escape cover. This is one reason for some of the difference between biomass and canopy cover figures. 95% is used for 80% retention recognizing that canopy cover could be very high (approaching 100%) to the extent that grazing is limited to skimming and topping, but there would be at least some reduced canopy cover due to trampling, at a minimum.

[C] Based on Table 11 of DeLong (2009b:105), assuming that the basal area remaining ungrazed equates to the percent of seedheads remaining.

[D] Assumes composition of key forage species is 25-75% of the total herbaceous vegetation.

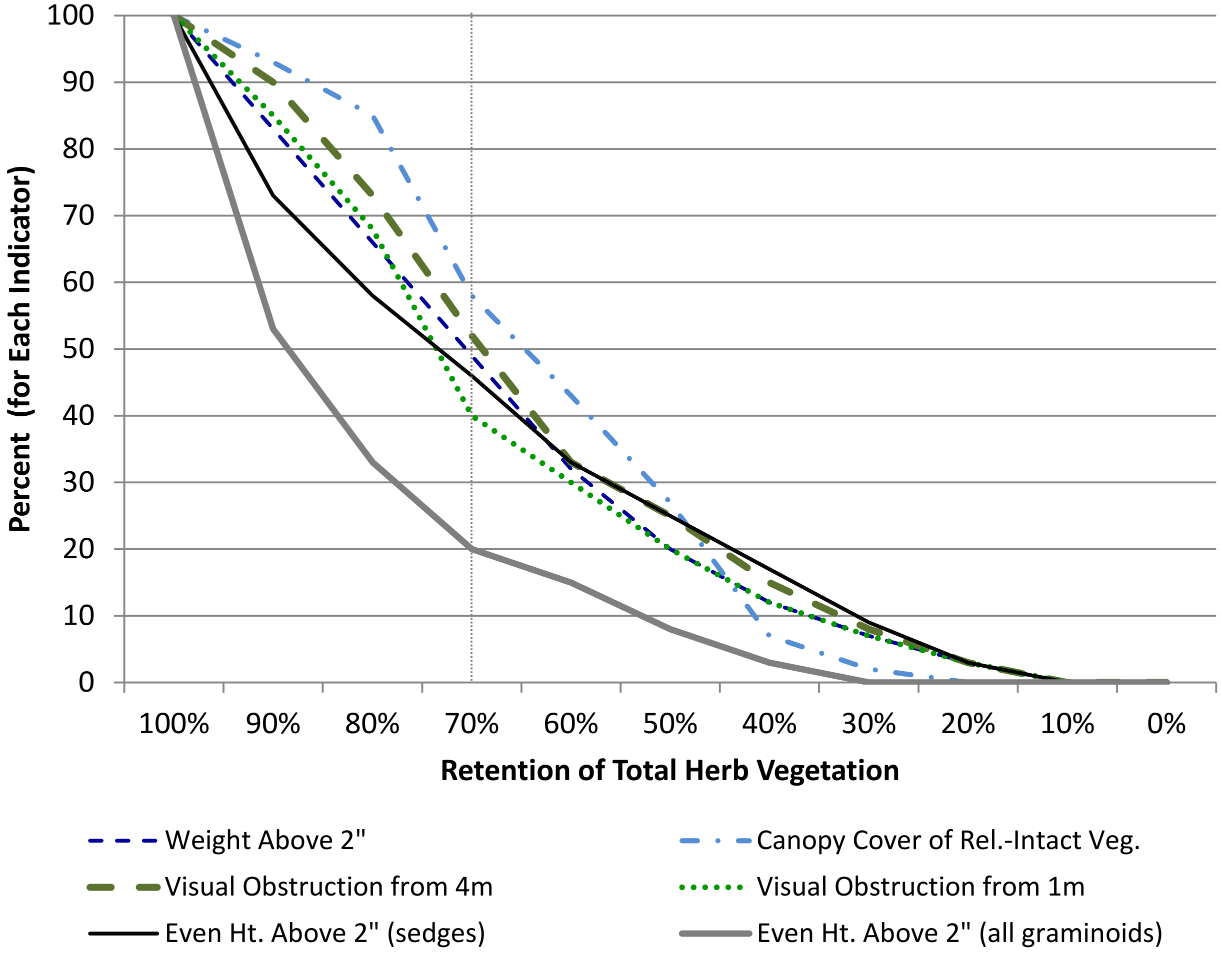

Figure A.14. Relationship between percent retention and the extent to which several herbaceous habitat attributes meaningful to small wildlife are retained at each retention level; based on mid-points from Table A.1.

canopy cover, the greater the differential contribution that willow canopies make relative to herbaceous vegetation. However, dense willow communities (particular tall, dense willow communities) would not appear to have sufficient basking sites for toads and likely are not heavily used. With lower levels of canopy cover, herbaceous vegetation plays a greater role in providing hiding cover. As an example, in wolf willow-herb communities, where herbaceous production can be substantive (Youngblood et al. 1985), herbaceous vegetation likely plays an important role in providing hiding cover.

A long standing, fundamental principle of wildlife conservation is that as hiding cover declines, survival rates and reproductive success decline due to increased predation (Leopold 1933, Dasmann 1981, Bailey 1984, Peek 1986, Robinson and Bolen 1989), and this has been born out in numerous studies on a wide range of species (e.g., Braun et al. 1978, Beinema and Müskens 1987, Olson 1992, Gregg et al. 1994, DeLong et al. 1995, Gilbert et al. 1996, Fagerstone and Ramey 1996, Choate 2007).

Wildlife that use or depend on herbaceous vegetation for hiding cover can be divided into two categories and it appears that spotted frogs and boreal toads fall into the first category. This first category consists of wildlife species that favor areas with suitable hiding cover, but that will tolerate and use a range of vegetation heights and densities. However, when they use less-than-suitable cover, their survival rate and/or reproductive success declines (Braun et al. 1978, Beinema and Müskens 1987, Gregg et al. 1994, Fagerstone and Ramey 1996, Shovlain et al. 2006, Schmutzer et al. 2008). The other category consists of secretive or semi-secretive species that avoid short, sparse vegetation, and that move out of suitable cover conditions when height and density decline (Pettingill 1970:252-253, Krebs 1978:40-46, Alcock 1984:85-87, 223-230); these animals are behaviorally hardwired to inhabit tall, dense vegetation with overhead canopies.

Although not directly applicable, the large volume of studies on the effects of changes in herbaceous vegetation structure on nest success of ground-nesting birds provides at least some indication of changes in the potential for mortality of frogs and toads as the amount of cover provided by herbaceous vegetation declines. In an examination of the effects of livestock grazing, predation, and trampling on 18,000 ground nests in meadow habitat, Beintema and Müskens (1987) found clear relationships between livestock density/duration and nest success, with predation rates and trampling rates increasing with incrementally higher livestock densities and longer durations of livestock grazing use. They found a significant relationship between the degree to which nests were hidden and nest depredation; with higher livestock densities and longer durations of grazing, the amount of herbaceous vegetation hiding nests declined. At a density of 1 cow per 2.5 acres (0.4 cows/acre) through the nesting period, nest loss to predation, trampling, and other factors averaged about 30% or less for each of the 5 bird species studied in detail. At a density of 1.6 cows per acre nest loss increased to an average of 50-100% for each species, and depending on whether cattle were yearlings or adults (for yearlings, nest loss at this density was about 70-100%). It is not uncommon for cattle densities in meadows on some allotments on the BTNF to be 1 cow per 1-2 acres for several weeks.

The effects described above are most pronounced in plant communities having tall, dense herbaceous vegetation and least pronounced on sites with sparse and/or short herbaceous vegetation. Starting with 100% retention in a tall, dense herbaceous plant community and working downwards in retention levels, it stands to reason that there comes a point at which remaining vegetation provides little hiding and escape cover. Given the structure of herbaceous vegetation at different retention levels, there is a fairly steep decline in hiding cover between about 80% and 60% retention of total herbaceous vegetation; by 60% retention, effective canopy cover (i.e., not including vegetation grazed to 2-3 inches) has declined to an estimated one-third to half of the original canopy cover (see Table A.2, Figure A.14, and DeLong 2009b), which would retain little hiding cover.

The assessment that toads may need less hiding and escape cover than frogs is questionable. Some authors contend that toads do not need the same level of hiding cover as frogs because, as assessed by Burton et al. (2009) with several supporting references, adult toads have many glands that produce toxins that make them unpalatable to most vertebrate predators. Muths (2005) also discussed the mild toxin secreted by adult boreal toads and that they general are unpalatable to vertebrate predators. On the other hand, Wind and Dupuis (2002) explained that, while juvenile and adult western toads secrete a poison from their parotoid glands and warts to deter predators, they are preyed upon by coyotes, skunks, raccoons, ravens, and garter snakes, citing three supporting references, with metamorphs being particularly vulnerable to garter snakes and birds (e.g., ravens). Keinath and McGee (2005) and Muths added several others, based on nine references: gray jays, robins, spotted sandpipers, red-tailed hawks, tiger salamanders, badgers, and red foxes. Bull (2009) observed gray jays, robins, and killdeer eating metamorphs. Carey et al. (2005:228) asserted that “Predation is a major source of mortality of boreal toad larvae,” noting that sandpipers consumed numerous metamorphosing toadlets at one breeding site and virtually eliminated toadlets at another breeding site. They also found that mallards consumed all tadpoles at several sites in one drainage. Wind and Dupuis (2002:17) continued by stating that “The highest predation pressure on adult toads comes during the breeding season when they are exposed and vulnerable in the shallow water margins of lands and ponds.” They also reported that tadpoles are eaten by ravens, crows, herons, garter snakes, backswimmers, and giant water bugs, citing three supporting references. Muths (2005) assessed that tadpoles are palatable to invertebrate predators. Residual sedge cover, if at high enough levels, would lessen predation pressure on adults, juveniles, and tadpoles. While boreal toads may be somewhat less vulnerable to predators than spotted frogs, there is not clear indication of this.

In herbaceous plant communities, a combination of vegetation height and the density of plant material influence visual obstruction, which is central to hiding cover (Robel 1970, Reece et al. 2001, Uresk and Juntti 2008, Toledo et al. 2010). Given the grazing behavior of cattle, percent canopy cover of intact and relatively-intact vegetation is a key attribute in moist-meadow type communities and stubble height is a key attribute in sedge communities.

This is because, (1) where bunchgrasses and moist-meadow sedges (e.g., small-winged sedge) predominate, cows typically bite plants near the ground (McKinney 1997) which reduces the canopy cover of intact and relatively-intact vegetation as grazing progresses; and (2) where wetland sedges (e.g., beaked sedge, water sedge) predominate, cows many times graze plants from the top down, which reduces plant-community height as grazing progresses. Combinations of the two can occur depending on plant species composition, season, and other factors. For all of these situations, visual obstruction as measured by a Robel pole provides a direct index to hiding and escape cover (Robel 1970, Reece et al. 2001, Toledo et al. 2010). As herbaceous height and/or canopy cover of intact and relatively-intact vegetation declines, visual obstructions declines and, therefore, hiding cover declines (Robel 1970, Reece et al. 2001, Uresk and Benzon 2007, Uresk and Juntti 2008, Toledo et al. 2010).

Forage for Tadpoles

Tadpoles appear to be omnivorous, with an apparently large portion of their diet coming from decaying vegetation. They feed on green algae and planktonic material they either filter from the water or scrape from vegetation or sediment; detritus they obtain from the bottom of wetlands; dead tadpoles; and possibly bacteria and dissolved nutrients (Warkentin 1992, Keinath and McGee 2005, Patla and Keinath 2005, Reaser and Pilliod 2005, Schmutzer et al. 2008). Herbaceous vegetation (including detritus) is important for tadpole forage (Warkentin 1992, Jansen and Healey 2003, Schmutzer et al. 2008). Shovlain et al. (2006:17) noted that "…emergent vegetation may provide food for tadpoles (Morris and Tanner 1969)." In wetlands in which the plant community is dominated by herbaceous vegetation, detritus originates primarily from herbaceous plant material.

Because much of what tadpoles eat appears to stem from detritus, most of which in many wetlands ultimately originates from herbaceous vegetation, the availability of tadpole food has the potential to be inversely proportional to the intensity of livestock use in wetlands (e.g., percent of herbaceous vegetation removed plus the percent that is trampled into and buried in the sediment). Schmuzter et al. (2008) attributed markedly higher tadpole species diversity and markedly higher abundance of some tadpole species in ungrazed wetlands, in part, to a 10.9x greater biomass of detritus in these wetlands — which provides feeding sites and forage, as well as escape cover — compared to grazed wetlands. They did not detect any differences in the biomass of filamentous algae at the P = 0.35 level. They recommended managing the intensity of livestock use to limit effects on tadpole communities.

Litter and Mulch

Another important feature of spotted frog and boreal toad habitat in herbaceous communities is the presence of well-developed litter layers and mulch. This is important in the provision of moist microsites. Lower retention levels bring with it reduced accumulations of litter, which in turn reduces the amount of mulch (Molinar et al. 2001). In meadow-willow, willow-herb, silver sagebrush, and shrubby cinquefoil communities, leaves and branches also contribute to litter and mulch.

Forage, Cover, and Substrate for Invertebrate Prey

Having a sufficient invertebrate prey base is important in conserving spotted frogs and boreal toads (Patla and Keinath 2005, Browne et al. 2009, Bull 2009) and other amphibians (Bishop et al. 2014), and many invertebrate species are tied to herbaceous vegetation, recognizing that shrubs also contribute to meeting the needs of many invertebrate species (this is discussed in detail below). Spotted frogs are opportunistic predators, and variety appears to be an important aspect of their prey base. They feed on a large variety of insects, spiders, and worms (several studies cited in Patla and Keinath 2005, Reaser and Pilliod 2005). Wetlands, wet meadow, and moist terrestrial habitats are important for spotted frogs for feeding (Patla and Keinath 2005, Reaser and Pilliod 2005, Bishop et al. 2014). Patla and Keinath (2005:32) assessed that, "…From this, we may infer that food shortages could become an important limiting factor for adult and juvenile spotted frog populations during drought years, in areas where chemical pesticides severely reduce insect prey, or where human-caused or natural factors reduce vegetation and the moist conditions that support high invertebrate density." Shovlain et al. (2006:17) noted that "…Pearl et al. (2005) observed R. pretiosa using floating and emergent vegetation to effectively ambush prey such as adult Odonata (dragonflies and damselflies) which oviposit among aquatic vegetation."

Boreal toads feed on a wide variety of insects, spiders, and worms in terrestrial habitats (Campbell 1970, Barrentine, 1991, Leonard et al. 1993, Luce et al. 1997, Keinath andMcGee 2005, Muths 2005). In discussing wet meadow habitat used by metamorph boreal toads, Bull (2009:245) assessed that "…moisture and solar radiation resulted in dense growth of grasses, forbs, and mosses, which likely provided abundant cover and prey for toads." At two study sites, boreal toads fed nearly exclusively on ants and beetles (Bartelt 2000), but it is not clear how such a limited diet may affect survival and reproduction.

Two approaches were taken in addressing invertebrates as prey for spotted frogs and boreal toads:

Invertebrates as Part of Wetland, Meadow, Silver Sagebrush, Meadow-Willow, and Willow-Herb Communities

Introduction

This approach is consistent with direction in the 2012 Planning Rule since it starts with a coarse-filter approach to conserving wildlife that depend on invertebrates, and then stepping this down to ascertain whether this approach would also meet the needs of spotted frogs and boreal toads (fine-filter assessment). The approach involves conserving a relatively-natural invertebrate species diversity in riparian areas, wetlands, meadows, and adjoining habitats in recognition that (1) a wide variety of invertebrate taxa are eaten by spotted frogs and boreal toads, (2) invertebrate diversity (i.e., species richness and relative abundance of each species) is probably important to these amphibian species, (3) there is a relatively poor understanding of the seasonal dietary needs of spotted frogs and boreal toads and of the effects that diet has on growth rates of juveniles and the probability of surviving hibernation and successful reproduction the following spring, (4) invertebrates are pivotal to conserving a large variety and number of other wildlife species, and (5) invertebrates serve a wide range and large number of ecosystem services central to maintaining riparian, meadow, and wetland ecological communities.

A wide variety of invertebrate taxa are eaten by spotted frogs and boreal toads (Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, and Reaser and Pilliod 2005), and a diverse invertebrate prey base is important for several reasons. Access to a variety of forage items better provides for the nutritional needs of individuals than access to only a small number of forage items. For some wildlife species, restricted diets may not meet the seasonal nutritional needs of individuals. It is not known, for example, whether a diet of ants supplemented by beetles throughout the summer is sufficient to carry boreal toads through hibernation and to facilitate reproduction the following spring. It is also not known the degree to which different prey taxa facilitate growth of metamorphs and juveniles. Approximating a natural diversity of invertebrates would constitute a conservative approach in recognition of incomplete understanding. Second, a diverse invertebrate community would be better able to meet the dietary needs of spotted frogs and boreal toads as individual invertebrate species increase and decrease in abundance from May through October. Third, a diverse invertebrate community provides some insulation or buffer against reductions in the abundance of prey species that may be heavily used by spotted frogs or boreal toads.

Invertebrates are pivotal to conserving a large variety and number of amphibian, reptile, small mammal, bat, and migratory bird species (Zeveloff and Collett 1988, Vickery et al. 2001, Wyo. Partners in Flight 2003, Hester and Grenier 2005). Different amphibian, reptile, small mammal, bat, and bird species using wetlands, riparian areas, meadows, and silver sagebrush communities favor or depend on different invertebrate taxa. In many cases, different animal species favor particular invertebrate taxa, size classes of invertebrates, particular behaviors, and/or invertebrates in particular microsites or strata. Biological communities with food webs having more species and more links per species are more resilient (Pimentel et al. 2000, Zander et a. 2006). As such, this approach blends the conservation of the invertebrate prey base for spotted frogs and boreal toads with the conservation of the invertebrate prey base for other amphibians, reptiles, small mammals, bats, and migratory birds and for predators that feed on wildlife species that feed on invertebrates. It would be unrealistic to attempt to independently conserve invertebrates for individual species or groups of wildlife.

Many invertebrate species play central roles in maintaining plant communities that sustain vegetative components of habitat for amphibians, reptile, small mammal, bat, and bird habitat, including habitat for invertebrate prey, flowers, and seeds (Krebs 1978, Samways 2005, Losey and Vaughn 2006, National Research Council 2007, Gilgert and Vaughan 2011). Invertebrates perform or contribute to many important ecosystem processes such as pollination, decomposition, and soil aeration, and they exert grazing and other pressure on specific plant species (Samways 2005, National Research Council 2007).

No information was obtained indicating that any fine-filter adjustments were needed to better meet the needs of spotted frogs and boreal toads, beyond what would be provided by relatively natural conditions. It would not be realistic to attempt to increase invertebrate diversity beyond the natural potential of the land, and there does not appear to be a need, based on dietary requirements of spotted frogs or boreal toads, to increase any given taxa of invertebrates beyond their natural population levels or distribution. Also, recognizing that a relatively-natural diversity of invertebrates appears to meet their dietary needs (as well as that of the rest of the native wildlife-community), there is no overriding need to narrow or reduce the invertebrate diversity based on the dietary needs of spotted frogs and boreal toads.

Suitability of Conditions

A fundamental principle of conserving biological diversity is the restoration and maintenance of the conditions under which native wildlife-communities developed or evolved in an area (Diamond 1981, Reid and Miller 1989, Keystone 1991, Noss and Cooperider 1994, Hunter 1996, Hughes et al. 2000), and this also specifically applies to invertebrate communities (New 2004, Samways 2005, National Research Council 2007, and New 2009). This principle is particularly applicable for groups of wildlife for which species richness and abundance is poorly understood in a given area (e.g., nearly every taxa of invertebrates on the BTNF) and for species for which habitat-relationships are poorly understood (e.g., many invertebrate species that inhabit the BTNF). The range of conditions that developed and existed for thousands of years prior to Euro-American settlement are the conditions that resulted in the invertebrate species richness and relative abundance of each species in the area now encompassed within the BTNF, and it is this invertebrate diversity that existed during the development of amphibian communities and native wildlife-communities as a whole in this area.

Habitat conditions for invertebrates in wetland, wet and moist meadow, meadow-willow, and silver sagebrush communities are driven by the degree of wetness; the plant-species diversity, height, and canopy cover of vegetation; and amount of litter and mulch and attributes of the soil organic layer. These factors directly affect the amount and horizontal/vertical density of leaf, flower, seed, stem, and fallen material at different height categories by plant species that is available to different invertebrate species, and other attributes like humidity levels and temperatures (e.g., at the ground surface, within the canopy, and above-canopy), shading, hiding and escape cover, and the amount and horizontal/vertical distribution of different types of plant-material substrate. All of these and other attributes, in combination, form the habitat conditions available to invertebrates on a given site; most are discussed individually in previous sections (e.g., "Humidity Retention…," Hiding and Escape Cover") in the context of frog and toad habitat. East and Pottinger (1983) discussed the "severe" reduction in microclimate conditions, including greater diurnal fluctuations in temperatures and reduced humidity and soil moisture, with increasing intensities of livestock grazing. To the extent the combination of attributes matches the conditions under which invertebrate communities formed, the greater will be the probability of sustaining the full complement of native invertebrate species of a given area over the long term and sustaining each of them at roughly comparable densities. To the extent the combination of attributes deviates from the conditions under which invertebrate communities formed, the lower will be the probability of sustaining the full complement of native invertebrate species of a given area over the long term and sustaining them at their natural abundance.

While this appendix focuses on herbaceous vegetation, it must be recognized that shrub canopies, especially in meadow-willow and willow-herb communities, contribute to invertebrate habitat as well. A large number of invertebrate species favor or depend on willows and would not exist on a site if it were not for willows. Dead stems, branches, and leaves contribute to litter and duff, which contribute to invertebrate habitat. Where willows are short enough and/or where percent willow canopy cover is low enough to allow substantive herbaceous production, herbaceous vegetation and associated litter contribute substantively to invertebrate communities. There likely are fewer invertebrate species associated with silver sagebrush and shrubby cinquefoil plants, and most invertebrate species in these communities likely are associated with herbaceous vegetation.

As a general rule in wetland, wet and moist meadow, meadow-willow, and silver sagebrush communities that were typically minimally grazed or were only sporadically grazed more than lightly prior to the onset of livestock grazing in the late 1800s, reductions in herbaceous height and structural density as a consequence of grazing or mowing beyond natural levels result in reductions in the abundance of a wide range of invertebrate taxa, including but not limited to leafhoppers and planthoppers, leaf-miners, dragonflies, damselflies, butterflies, moths, bees, beetles, true bugs, spiders, snails, and slugs (Morris 1983, Welch et al. 1991, Morris 2000, Kruess and Tscharntke 2002, New 2004, Poyry et al. 2004, Ringwood et al. 2004, Foote and Rice Hornung 2005, Samways 2005, Janz et al. 2006, Baur et al. 2007, Black et al. 2007, Yamamoto et al. 2007, Dennis et al. 2008, Littlewood 2008, Kimoto 2010, Black et al. 2011, Bennett and O'Grady 2012). For some taxa, rapid declines begin at / shortly after roughly 80% retention of herbaceous vegetation (Hornung and Rice 2003, Foote and Rice Hornung 2005, Kimoto 2012). This general rule is supported by findings of studies on the effects of livestock grazing on several taxa of invertebrates:

- No scientific studies were found demonstrating or indicating that native invertebrate-community diversity is enhanced by grazing levels above-and-beyond what the communities developed under. The studies cited in the previous paragraph represent a wide range of locations and different types of herbaceous communities. Results from these studies are consistent with the expectation that invertebrate species richness and abundance would decline as herbaceous height and canopy cover of relatively-intact vegetation decline in wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities. This expectation is outlined in the section, "Near-100% Herbaceous Retention as a Starting Point of Assessment."
- Foote and Rice Hornung (2005) determined that dragonfly and damselfly species diversity declined with the decreasing Robel pole readings in sedge and hardstem bulrush communities, and found there to be statistically significant correlations. Below a sedge height of about 16 inches (40 cm) — compared to ungrazed heights of about 18-28 inches — species richness and abundance quickly declined to half or less and possibly as much as an 80-90% reduction on some sites (Figures 4 and 6 of Foote and Rice Hornung 2005). Compared to ungrazed heights of about 18 to 28 inches, the apparent 16-inch threshold appears to occur in the neighborhood of 80% or possibly as low as 70% retention of total herbaceous vegetation because the 16-inch threshold represents a retention of 57-89% of Robel pole readings (Table A.2). In a previous study that involved fewer wetlands, the diversity of dragonflies and damselflies declined as grazing intensity increased ($p = 0.06$, $r^2 = 0.23$) according to the Shannon-Weiner Diversity Index (Hornung and Rice 2003), but a threshold was not apparent.
- Dennis et al. (2008) found that the abundance and biomass of several groups of foliar arthropods (e.g., beetles, true bugs, moth caterpillars, spiders) decreased (in terms of biomass) with increasing levels of grazing, and that the highest abundance and biomass were associated with ungrazed sites.
- Dennis et al. (2008) determined that Lepidoptera larvae were more abundant with lower levels of grazing pressure.
- The highest-intensity livestock grazing treatments in Littlewood (2008) produced the lowest species richness and abundance of adult moths, and ungrazed and low-intensity sheep grazing treatments produced the highest species richness and abundance of adult moths.
- Littlewood (2008:155) surmised that conclusions about arthropods and, more specifically, Lepidoptera being more abundant at lower levels of grazing pressure "…are consistent with findings of Pöyry et al. (2006) who argued that, in terms of species richness, Lepidoptera are less tolerant to disturbance (in this case grazing) than are plants. This result may also be a reflection of the reduced vegetation biomass available for Lepidoptera larvae in more intensely grazed treatments (Rambo and Faeth 1999)" (Littlewood 2008:155).
- Welch et al. (1991) found that lightly grazed pastures had more grasshoppers than heavily grazed pastures, and Batary et al. (2007) found that grasshopper abundance was higher with taller grass height (relative to cattle grazing pressure). However, Holmes et al. (1979) found that some species of grasshoppers were more abundant on sites that were heavily to severely grazed by livestock compared to sites grazed lightly and moderately.

- Brown et al. (1992) found that most species of leaf hoppers studied declined in abundance as a result of reductions in vegetation height and structure, and they reached their greatest abundance in ungrazed treatments and reached their lowest abundance in the heavily grazed treatments.
- Nickel and Hildebrandt (2003) found cicada species richness and abundance of individual species to be highest in fallow fields and meadows with low intensity management and lowest in pastures with high intensity management. Generalist species were least affected by management and specialists were most affected.
- Kruess and Tscharntke (2002) studied the effects of different intensities and durations of rest on insect species richness and abundance in grassland vegetation types in Germany. The major predictor of differences in species diversity was vegetation height, although they also found vegetation complexity (plant species richness, vegetation height, vegetation heterogeneity) to be significantly higher on ungrazed grasslands compared to grazed pastures. Vegetation height was an average of about 34% and 48% lower in extensively grazed fields than in short-term (3-year) and long-term (>5 years) ungrazed fields (12.6 inches vs. 19.0 and 24.0 inches, respectively), and it was an average of about 40% and 53% shorter in intensively grazed fields than in short-term and long-term ungrazed fields (11.4 inches vs. 19.0 and 24.0 inches). Reductions in the number of species and abundance of grassland specialists were even larger. Extensively grazed fields involved about 0.57 cattle/acre (or, just over 1 cow/2 acres) from May to November, and intensively grazed fields involved an average of 2.23 cows/acre. Average utilization across extensively and intensively grazed fields appeared to be low based on differences in average vegetation height between these treatments and the short-term (3-year) ungrazed fields; using height weight curves in BLM et al. (1999), average retention levels appear to have as high as 75-80%. With average retained heights of about 12.6 and 11.4 inches, a substantial amount of vegetation remained after livestock grazing.

  Key results were as follows:

  a. "Insect diversity increased across the four treatments in the following order: intensively grazed<extensively grazed<short-term ungrazed<long-term ungrazed..." (Kruess and Tscharntke 2002:293). Insect species richness was twice as high and insect abundance was four-fold higher in the long-term ungrazed fields than in the intensively grazed fields.
  b. "Differences in insect species richness and abundance between intensively and extensively grazed pastures and ungrazed grasslands showed a very consistent pattern for all insect taxa" (Kruess and Tscharntke 2002:298).
  c. Differences were most dramatic when only grassland specialists were considered; species richness of grassland specialists was about three times higher in the long-term ungrazed fields than in the intensively grazed fields, and abundance of grassland specialist insects was eight-fold higher in the long-term ungrazed fields than in the intensively grazed fields.
  d. Insect species richness and abundance were not statistically different among the extensively grazed, short-term ungrazed, and long-term ungrazed fields, although there was an upward trend.
  e. All of these results are particularly interesting given the relatively high retention levels in the intensively grazed fields (average retained height of 11.4 inches) and in the extensively grazed fields (average retained height of 12.6 inches), which translates to relatively-high percent retention levels (retention levels as high as 65-80% based on information in BLM et al. 1999).
- East and Pottinger (1983) assessed that a large number of invertebrate species in 26 invertebrate families/orders responded negatively to increasing grazing intensities in New Zealand, species in 3 families/orders (Diptera, flies; Oligochaeta, worms; and Scarabaeidae, scarab beetles) initially respond positively and then negatively at higher grazing intensities, and species in 3 families/orders (Coleoptera, beetles; Hymenoptera, ants; and several species of Homoptera, leafhoppers and planthoppers) respond positively with increasing grazing intensities. While variety of beetles and ants consistently responded

positively to increasing grazing pressure, results for leafhoppers and planthoppers was mixed; some responded positively and others responded negatively.

- Baur et al. (2006) found there to be a significantly higher invertebrate species richness in hay meadows that had been abandoned for 3-7 years than in hay meadows being mowed once per year.
- In general as livestock grazing intensity increases, species richness and abundance of moths[C] declines (Hutchingson and King 1980, as cited by Black et al. 2009; Littlewood 2008; Ringwood et al. 2004), with at least some of this attributed to effects on eggs, caterpillars, and pupae. Moderate to heavy livestock grazing or mowing has been shown to adversely affect moth communities and a range of individual moth species (Ringwood et al. 2004, Littlewood 2008). Light grazing may have neutral effects on moth communities and it may have beneficial effects in some cases, especially if times of natural flower shortage are avoided or if conducted in the fall when there is less competition for flower resources with pollinators (Littlewood 2008, Black et al. 2011:10).
- Increases in livestock grazing intensity generally causes a reduction in bee species richness and abundance (Morris 1967, Snugden 1985, Carvell 2002, and Vazquez and Simberloff 2003, as cited by Black et al. 2009; Kimoto 2010).
- Browne et al. (2009:218) found terrestrial invertebrate density to be positively related with density of herbaceous vegetation.
- For many taxa of insects, species richness has been shown to be positively correlated with plant species diversity (species richness and relative abundance of each species) (White 1991, Siemann et al. 1998, New 2004, Poyry et al. 2004, Samways 2005, Janz et al. 2006, Yamamoto et al. 2007, New 2009, Bennett and O’Grady 2012). From the standpoint of affected insects, it matters little whether reductions in the availability of preferred or required plant parts of host plant species is due to a long-term reduction in plant species diversity or due to reduction or removal due to grazing. Effective plant species diversity declines with increasing grazing intensity as a result of leaves, stalks, seedheads, and flowers of particular plant species increasingly being removed and the number of affected plant species cumulatively decreasing as grazing progresses. As such, studies on correlations between insect diversity and plant species diversity further indicate and substantiate a relationship between invertebrate diversity and grazing intensity in mountain meadows, wetlands, and riparian areas.
- Yamamoto et al. (2007) found a highly significant correlation between the biomass of the edible parts of a host plant species and butterfly species that used the host plant and between the biomass of edible parts of host plants and butterfly abundance in general. Their findings essentially show that butterfly abundance increases with availability of foraging habitat. Although they did not assess the effects of grazing, an implication of their results is that reductions in the biomass of host plants through grazing (or other mechanism) reduces butterfly abundance.
- Because some invertebrate taxa respond positively to increasing intensities of grazing by herbivores until some level of grazing is reached (e.g., some species and genera of grasshoppers; Holmes et al. 1979, Kantrud 1990), this needs to be understood when evaluating the overall effects on invertebrate communities; i.e., effects on these taxa can mask the effects on invertebrate species that depend on native meadow conditions.

There are several other ways in which invertebrate populations and diversity of herbaceous communities and understories are negatively affected by grazing, in addition to responding negatively to changes in height and structure of herbaceous vegetation. Depending on invertebrate species, egg-laying periods, and the timing of grazing, grazing can reduce egg-laying or pupation substrate before egg-laying/pupation and, if grazing happens after egg-laying or formation of chrysalis, eggs, pupae, larva, and even adults can be eaten or otherwise injured or killed through the grazing of the plant parts upon which they were attached or were inhabiting (Warren 1993; Smallridge and Leopold 1997 as cited by Black et al. 2011; Samways 2005; Evans 2008). If livestock grazing use

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[C] Moth information obtained from an assessment of livestock grazing on bat species that key in on moths is included here as a representative taxa of invertebrates.

removes and/or tramples a substantial portion of plant parts of host-plants — for the wide range and large number of invertebrate species that lay their eggs on particular plant taxa — this either (depending on timing) can result in these invertebrate species not breeding or laying eggs due to lack of egg-laying substrate of the appropriate plant species or genera; overabundance of eggs on a relatively small number of host plants (which would have negative effects on both the larvae and host plants); or larvae dying due to insufficient forage of the correct species or genera. These impacts can disproportionately affect invertebrate species whose host-plant species are favored by livestock. Each invertebrate species has their specific timing of egg laying and, depending on species, can range from late spring to fall, and some invertebrate species relying on eggs over-wintering. Similarly, timing of the pupae stage ranges from early summer for some species to late summer/fall for other moth species, the latter of which rely on pupas to over-winter.

Smallridge and Leopold (1997, as cited by Black et al. 2009:19) noted that grazing during spring can remove nectar resources for butterflies, and this also applies to moths and other species that feed on nectar. Grazing during seasons when flower resources are already scarce (e.g, mid-summer in some places) may result in insufficient forage for pollinators and other insects (Black et al. 2007). Black et al. (2011) noted that light grazing for short periods in the fall has the least amount of negative impacts on pollinators.

Relatively light grazing of wetlands, wet and moist meadows, and shrub-herb communities can positively affect a range of invertebrate species, even in plant communities where grazing did not historically exert a large influence on plant communities (Samways 2005, Vulliamy et al. 2006, Littlewood 2008 Black et al. 2011).

Different intensities of grazing directly affect the extent to which herbaceous plant communities retain the height and structure of pre-grazed plant communities. Herbaceous vegetation structure in wetlands, wet and moist meadows, meadow-willow, and silver sagebrush communities begins to substantively shift away from pre-grazed conditions — in terms of habitat elements like canopy cover of relatively intact vegetation, weight of plant material above about 2 inches, height of leaf tufts, and density of flowers — somewhere in the neighborhood of 85% retention of total herbaceous vegetation (+/- about 5%) (Table A.2, Figure A.14). For example, by the time grazing reduces total herbaceous retention to about 80%, canopy cover of relatively-intact herbaceous vegetation can decline by as much as 30% and the weight of plant material above about 2 inches can decline by an estimated 25-50%, which is reinforced by Robel pole readings dropping by as much as about 40-50% (Table A.2). At 70% retention of total herbaceous vegetation, canopy cover of relatively-intact herbaceous vegetation declines by an estimated 30-50% and the weight of plant material above about 2 inches declines by an estimated 25-65% of the pre-grazing canopy cover and weight above 2 inches, which is reinforced by Robel pole readings of approximately 20-70% of pre-grazing readings. This constitutes a large change in the composition and structure of herbaceous plant communities and understories, which would expectedly have an altered invertebrate community based on studies cited in previous paragraphs. At 50% retention of total herbaceous vegetation, canopy cover and weight of plant material above about 2 inches is approximately 0-40% of the pre-grazing canopy cover and weight above 2 inches, which is reinforced by Robel pole readings of approximately 0-40% of pre-grazing readings. At this level of retention, there is no semblance of composition and structure of the pre-grazed plant community and the invertebrate community would expectedly be highly altered.

Residual vegetation and litter are important for many species of invertebrates and, therefore, any vegetation that is not grazed in a particular season will contribute to these needs in subsequent years. Black et al. (2009:12) identified the following shelter as being needed by moths and butterflies: “Protected site such as a bush, tall grass, a pile of leaves or sticks or, in the case of some moths, underground.”

Results of studies on the effects of grazing on bees has been mixed, with some studies indicating positive effects and some studies indicating negative effects (see Vulliamy et al. 2006 for review). Variability in effects likely is due to factors such as whether bee communities originally formed with or without high influences of grazing, recent history of grazing (the past several decades), differential responses of flowering plants and grazed plants to grazing, and the behavior and habits of bees taxa. On their study area in northern Isreal, Vulliamy et al. (2006) found that bee species richness increased with livestock grazing intensity.

Not only is herbaceous vegetation important to invertebrates, it may also be important for spotted frogs in being able to successfully ambush some species. Pearl et al. (2005) observed Oregon spotted frogs using floating and emergent vegetation to effectively ambush prey such as adult dragonflies and damselflies which typically oviposit on sites with aquatic vegetation.

Invertebrate Communities Resulting from Increased Structural Diversity and Eutrophicaton

Introduction

While it is recognized that relatively-natural invertebrate communities are within suitable conditions for spotted frogs and toads with respect to their prey base, and while no fine-filter adjustments are needed to improve their prey base, it is recognized that invertebrate species richness and relative abundance can be altered to some degree and still provide for the forage needs of spotted frogs and boreal toads. The purpose for evaluating this approach is exclusively to ascertain whether their prey base would remain sufficient where livestock are grazed. From this standpoint, this approach accommodates livestock grazing use.

Under this approach, no attempt is made to fit the conservation of the invertebrate prey base of spotted frogs and boreal toads into a more holistic approach of providing for the invertebrate-prey needs of amphibian, reptile, small mammal, bat, and migratory bird species as a whole, as well as providing for the many ecosystem services provided by native invertebrate-communities. Not only is it tailored after a single species approach **—** since invertebrates are treated purely as a food source for spotted frogs and boreal toads **—** the approach only looks to meet the minimum dietary needs of spotted frogs and boreal toads.

Suitability of Conditions

Available information indicates that light to conservative grazing can contribute to increases in the abundance of some invertebrate species (Kantrud 1990, Welch et al. 1991, Rambo and Faeth 1999, Saunders and Fausch 2009, and several references in Vickery et al. 2001). Holmes et al. (1979) found that some species of grasshoppers were more abundant on sites that were heavily to severely grazed by livestock, compared to sites grazed lightly and moderately, although Welch et al. (1991) found that lightly grazed pastures had more grasshoppers than heavily grazed pastures. If species experiencing increases in abundance due to grazing contribute to the prey base of spotted frogs and boreal toads and if the net effect is at least neutral with respect to availability of prey, the level and season of livestock grazing producing these results would appear to be compatible with this specific aspect of spotted frog and boreal toad ecology. Even in meadows, grasslands, shrub-herb, and wetlands where grazing did not historically exert a large influence on plant communities, relatively light grazing can have positive effects on a range of invertebrate species (Samways 2005, Vulliamy et al. 2006, Black et al. 2011).

It appears that spotted frogs and boreal toads (especially the latter) can adjust to somewhat altered invertebrate communities, so long as a range of prey species remain common enough throughout the summer season to meet the dietary needs of adults, juveniles, and metamorphs. Keinath and McGee (2005:50) assessed that “Boreal toads appear to be very flexible in their diet and, therefore, may shift prey items if one group of prey becomes locally scarce due to habitat changes.” Boreal toads may be able to subsist largely on ants, secondarily on beetles, and with few apparent additional species in their diet as appeared to have occurred, at least for some period of time, in a study by Bartelt and Peterson (1997) and Bartelt (2000), as cited by Patla (2001). However, the relative health of individuals, growth rate of juveniles, survival, and reproductive output have not been studied to determine whether a diet heavily dominated by ants is sufficient to adequately meet the physiological needs of individuals, including surviving hibernation and successfully reproducing the following spring. This is particularly important given the range of stressors currently affecting boreal toads.

Patla and Keinath (2005:65) assessed that “Frogs are opportunistic and flexible feeders, shifting prey type if one group of prey becomes locally scarce due to habitat changes” (but Patla and Keinath 2005:32 also discussed food shortages being a limiting factor for spotted frogs). However, unlike for boreal toads, no documentation was found of populations of spotted frogs subsisting on only one or two taxa of invertebrates, but Turner (1959, as cited by Patla and Keinath 2005) documented that 70-90% of food items collected from the gut contents of 178 spotted frogs in Yellowstone National Park were spiders and representatives of four orders of insects: Hemiptera (bugs), Coleoptera (beetles), Diptera (flies), and Hymenoptera (ants, wasps, and bees). Six families of insects (Carabidae, Chrysomelidae, Cordiluridae, Curculionidae, Formicidae, and Gerridae) accounted for 55% of all food items. Spotted frogs are opportunistic and flexible predators (Pilliod and Reaser 2005, Patla and Keinath

2005), and it is possible that, where invertebrate species diversity is low, spotted frogs would adjust and survive on a relatively few species. However, no documentation was found in support of this.

Howard and Munger (2003) did not detect any statistically-significant difference in invertebrate biomass diversity between grazed portions of sites and ungrazed portions of sites, as part of a study on Columbia spotted frogs, but they did not measure or estimate percent utilization or retention and they listed several reasons for "lack of effect:" small sample size and high variability, possible masking of effects by increases in grasshoppers at grazed sites, late timing of grazing (late August and early September), and closeness of grazed and ungrazed sample sites. They characterized grazing as "modest," but there was only one reference to this. They sampled invertebrates at one ungrazed pond (all other ungrazed sites were small exclosures) away from where grazing occurred, and invertebrate biomass was 4-16x higher than at all other sites; insect diversity was also higher, but not by much. Again, however, it is difficult to apply their results because they did not provide any measures of livestock grazing utilization.

This information provides at least a preliminary answer to the question of whether invertebrate species richness and abundance can be sufficient for spotted frogs and boreal toads where livestock are grazed, so long as grazing is light or conservative, but in no way does this information tell us that livestock should be grazed for the benefit of spotted frogs or boreal toads.

OTHER FACTORS DIRECTLY RELATED TO GRAZING USE INTENSITY

Maintaining livestock grazing intensity at low enough levels to not impact several habitat effectiveness and survival elements is central to meeting Objectives 3.3(a) and 4.7(d) and the Sensitive Species Management Standard on the BTNF from the standpoint of spotted frogs and boreal toads. Percent herbaceous retention is inversely related to the intensity of livestock grazing use. As such, percent retention of total herbaceous vegetation plays an additional role as an indicator of the extent to which water quality, duration of surface water in small pools, survival as influenced by trampling, soil looseness and porosity, integrity of near-surface burrows and streambanks, and willow habitat remain in suitable condition. This relationship exists because *percent* herbaceous retention is used and not an absolute minimum height or Robel pole reading. Percentages are on par with rates; they can be cross-walked back-and-forth. Intensity of grazing use can be expressed as either a rate or percentage.

Expressing herbaceous retention as a minimum stubble height or minimum Robel pole reading would forego the opportunity to use herbaceous retention as a proxy for the habitat and survival elements discussed in this section, and may require individual monitoring of some of them. Monitoring one or two of these factors (e.g., water quality, mortality caused by trampling), in addition to monitoring percent utilization of key forage and monitoring stubble height or herbaceous cover (using a Robel pole), would be a large time commitment, compared to only monitoring percent retention/ utilization of herbaceous vegetation. If a cross-walk were developed for each monitoring site between percent utilization of key forage species and percent retention of total herbaceous vegetation, only one monitoring method would be needed, with percent retention of herbaceous vegetation being the most straightforward and accurate. Not only would limiting monitoring to one element be a major time saver, measuring or estimating herbaceous retention is straightforward and quick.

The importance of each factor and suitable conditions of each are discussed in more detail in pertinent sections of the main report. Discussions on the importance of each of these factors, below, focus on the relevance and importance of using percent retention of herbaceous vegetation as a proxy for maintaining suitable conditions of each factor.

For several factors (effects on water quality, surface-water duration, and survival as affected by trampling), two important and interrelated consideration are the (1) probability of negative effects being caused by incrementally higher levels of livestock grazing intensity, and (2) variability in effects at incrementally higher levels of livestock grazing intensity (Figure A.15). Each wetland has a different probability of being affected by livestock use given its unique combination of physical setting attributes, size and depth patterns, inflow/outflow patterns, chemical makeup, plant communities, vegetation production levels, and characteristics of surrounding uplands, among others. For example, Gahl and Calhoun (2010:108) assessed that "Our results suggest that each wetland, because of varied physical, biological, and chemical settings, will have its own suite of stressors that sublethally affect amphibians." Starting at no-use by livestock (near 100% retention of herbaceous vegetation), the probability of negative effects on water quality, surface-water retention, and trampling-induced mortality increases at incrementally higher livestock grazing intensity. At both very low and very high livestock grazing intensities, the variability in effects is low; i.e., very consistently no or low effects at no livestock use or very low intensities, and consistently large effects at high intensities associated with severe livestock use. As intensity increases beyond low intensity, the chance of negative effects occurring in any given wetland may still be relatively low, but the potential for adverse effects increases with incrementally higher levels of livestock use. This continues until the potential in any given wetland for adverse effects is roughly equivalent to the potential for neutral or minor effects, after which the potential for adverse is higher than the potential for neutral effects or minor effects. Then, as the potential for adverse effects increasingly outpaces the potential for neutral or minor effects, variability in effects declines until grazing intensity is so severe that there is near 100% assurance of adverse effects.

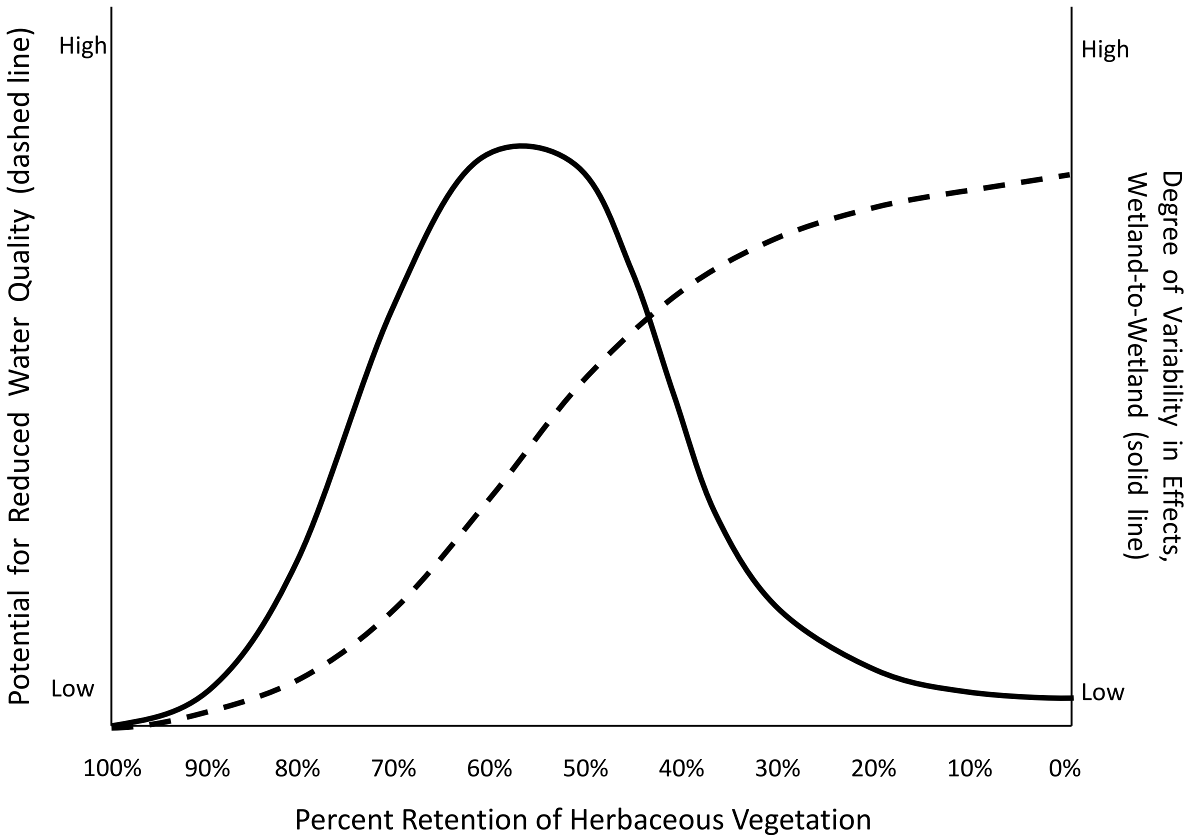

Figure A.15. Hypothetical illustration of the relationship between the potential for reduced water quality in any given wetland and the degree of variability in effects of livestock grazing on water quality, relative to percent retention of total herbaceous vegetation.

This is important because (1) even at low intensities of livestock grazing use (e.g., intensities associated with 80% retention of herbaceous vegetation), livestock grazing use will substantively reduce water quality, accelerate the decline of surface-water levels, and reduce survival due to trampling in a small proportion of wetlands that are used by livestock; and (2) reductions in water quality, accelerated declines in water levels, and reductions in survival due to trampling, even at a small proportion of breeding wetlands has the potential to affect some metapopulations of spotted frogs and boreal toads, particularly in combination with other stressors. Then, as the intensity of livestock grazing use increases beyond a low level (i.e., <80% herbaceous retention), the chance that a given metapopulation will be affected increases and the degree of impacts, where impacts occur, increases.

Based on concepts illustrated in Figure A.15, variability in the results of scientific studies on the effects of livestock grazing use on water quality (e.g., Hornung and Rice 2003 and Schmutzer et al 2008 vs. Adams et al. 2009), does not necessarily bring into question the results of specific studies (e.g., methodology, sample size). Rather, variability in results could very well be heavily influenced by variability that actually occurs under different situations, including different seasons and different years. As livestock grazing intensities move beyond low levels (Figure A.15), risk rises fairly rapidly.

While shrub canopies and litter from bushes play a role in elements covered in the previous section ("Herbaceous Habitat Conditions"), shrubs play a much lesser role in elements covered in this section because this section deals with water and survival elements that are tied to livestock grazing intensity.

In shrubby cinquefoil, silver sagebrush, meadow-willow, and willow-herb communities, livestock grazing intensity is best indicated by percent use of herbaceous vegetation, not by percent use of woody vegetation. Cattle graze on herbaceous vegetation before browsing on willows (Clary and Webster 1989, Clary and Leininger 2000, Univ. Idaho Stubble Height Review Team 2004), and silver sagebrush and cinquefoil are browsed even less. Herbaceous production can be high in meadow-willow and willow-herb communities; for example average herbaceous production in Booth's willow/beaked sedge, Geyer willow/fowl bluegrass, Wolf's willow/beaked sedge were 2,000 to 3,000 pounds/acre (Youngblood et al. 1985). Average herbaceous production in Booth's willow/starry solomon-plume communities averaged more than 5,000 pounds/acre.

Intensity of livestock grazing use is inversely related to the percent retention of herbaceous vegetation in these communities, just as in herbaceous communities. Low herbaceous retention levels on sites with high herbaceous production levels equates to considerable time spent by livestock on the site, which results in relatively high potential for reduced water quality and accelerated water-level declines (if the site includes aquatic habitat), reduced survival as affected by trampling, and reduced integrity of near-surface burrows. If percent retention of herbaceous *and* woody vegetation (e.g., percent retention of annual leaders) were combined in measurements of percent retention, this would have the potential to dilute the estimated effects of livestock on water quality, water level declines, trampling, and integrity of shallow burrows.

Water Quality

A large volume of scientific literature has demonstrated the negative effects of high levels nitrate, nitrite, ammonia, phosphorus, and dissolved solids and reductions in dissolved oxygen on frogs and toads (e.g., Hecnar 1995, Marco et al. 1999, Marco and Blaustein 1999, Scrimgeour and Kendall 2002, Knutson et al. 2004, Camargo et al. 2006, Punzo and Law 2006, Hayes et al. 2008, Schmutzer et al. 2008). Effects of reduced water quality on amphibians includes reduced hatching rates, altered behavior, reduced growth rates of tadpoles, deformities, increased mortality, and diminished prey base of adults (Ricklefs 1979, Hecnar 1995, Marco et al. 1999, Hatch and Blaustein 2000, Hatch and Blaustein 2003, Hogrefe et al. 2005:15, Camargo et al. 2006, Schmutzer et al. 2008). These impacts are discussed in more detail in the subsections that follow.

Water quality in wetlands declines with increasing intensity of livestock grazing use and this is due to urination, defecation, and trampling in and immediately around wetlands and increased soil erosion further from wetlands (Moore et al. 1979, Mosley et al. 1999, Scrimgeor and Kendall 2002, Holechek et al. 2011). Not only does water quality decline with higher levels of urination and defecation directly into wetlands, nitrogen and phosphorus originating with urination and defecation in adjoining riparian areas and uplands can contribute to elevated levels of nitrate, nitrite, ammonium, and orthophosphates in wetlands (Stout et al. 1997, Hubbard et al. 2004, Agouridis et al. 2005, Carpenter et al. 1998, Vidon et al. 2008), and this is particularly true where shoreline vegetation has been reduced (Kaufman and Kruger 1994, Hubbard et al. 2004, Vidon et al. 2008). Livestock density and use increases with declining distance to water and they spend considerable time at water sources and in the water itself (Stuth 1979, Holechek et al. 2011:193-194).

Urine and manure have high concentrations of nitrogen and phosphorus (Ball et al. 1979, Stout et al. 1997, Hubbard et al. 2004), which leads to various forms of nitrogen (e.g., nitrate, nitrite, ammonium, ammonia) and orthophosphates increasing and dissolved oxygen decreasing commensurate with higher levels of livestock urination and defecation in and near ponds, streams, and other wetlands (Hubbard et al. 2004, Agouridis et al. 2005, Carpenter et al. 1998, Schmutzer et al. 2008, Vidon et al. 2008). Higher levels of livestock trampling within wetlands increases dissolved solid concentrations and turbidity (Hubbard et al. 2004, Knutson et al. 2004, Vidon et al. 2008). The smaller the volume of water at a given watering site, the smaller the number of livestock needed to reach given accumulations of nitrogen and phosphorus and concentrations of dissolved solids. Livestock concentration areas like watering areas accumulate nitrogen and phosphorus over time (Miller et al. 1992).

Hubbard et al. (2004:259), published in the *Journal of Animal Science*, noted that concerns about water quality exist even at low animal densities: “Concerns at low animal density primarily relate to the animals having free access to water bodies in which they deposit urine and manure, and the accompanying problems with N, P, pathogens, and organic matter, which affect biochemical oxygen demand and chemical oxygen demand…” The authors continued by stating that “Most environmental concerns with grazing animals occur at high animal densities.”

Nitrogen

Living tissue contains slightly more than 3% of nitrogen in active pools in ecosystems, with the rest distributed between detritus and nitrate (NO_3) in the soil and oceans and smaller amounts in the intermediate stages of protein decomposition; i.e., ammonia (NH_3) and nitrite (NO_2) (Ricklefs 1979). An immense pool of nitrogen (N_2) existing in the atmosphere cannot be assimilated by most organisms.

Nitrogen processes are complex, but the basic nitrogen cycle involves the stepwise breakdown of nitrogenous organic compounds (e.g., in fallen plant material, feces) by many kinds of organisms until nitrogen is finally converted to nitrate. In the nitrogen cycle as outlined by Rickleffs (1979:826), organic nitrogen (NH_2) is broken down to ammonia and/or ammonium through ammonification, and this is broken down to nitrite through nitrification, and in turn it is either broken down to nitrate through further nitrification or is released into the atmosphere as nitrous oxide. Some of the nitrogen in the atmosphere contributes to land- or water-based nitrate. To complete the cycle, nitrate (which is in a form that is available to plants) is assimilated into organic nitrogen. Plants obtain nitrogen from nitrate and ammonium in the soil and water, and nitrogen then is passed to decaying plant material and to herbivores, the latter of which contribute nitrogen (ammonium and ammonia) back to the soil and water through urination and defecation. Nitrogen in this ammonium and ammonia then continues cycling as described above.

In aquatic environments, the most common reactive forms of inorganic nitrogen occur as dissolved nitrate, nitrite, and ammonium, and in the detritus in sediments (Ricklefs 1979, Camargo et al. 2005, Camargo and Alonso 2006). Huey and Beitinger (1980) explained that ammonia, when excreted into water, nitrifies to nitrite which is then nitrified to nitrate. Hughes et al. (2013) described a different aspect of nitrogen processes in an aquatic system. They explained that the dominant nitrogen processes are denitrification of nitrate by organic anaerobic soils, uptake of ammonium and nitrate by aquatic plants, settling of particulates, adsorption of fine particulates onto the surfaces of plants and detritus, and mineralization of particulate organics to release ammonium and nitrate. Again, nitrogen processes are complex.

Part of the complexity is that the rates at which different forms of nitrogen are produced, assimilated and broken down can vary considerably from wetland to wetland, from site to site within a given wetland, and from season to season, depending on a large number of factors including pH, temperature, chloride concentrations, water volume, aeration and storage ventilation factors, and time (Ball et al. 1979, Ricklefs 1979, Stout 1997, Camargo et al. 2005, Camargo et al. 2006). This may explain the variability found in Scrimgeour and Kendall (2002). Camargo et al. (2006) describes effects of environmental variables in detail, and they cite numerous supporting references in their literature review. Some wetlands generate low amounts of ammonium, ammonia, nitrate, and/or nitrite, while other wetlands naturally produce relatively high amounts of these forms of nitrogen at some times of the year. Artificial influxes of nitrogen (e.g., through livestock urine and feces, and from elevated levels in the atmosphere) can compound this variability by elevating levels of nitrate, nitrite, ammonia, and ammonium. In some cases, for example where nitrate, nitrite, ammonia, and/or ammonium levels are already naturally high, it may only take small inputs of livestock urine, feces, and trampling to cause nitrate, nitrite, ammonia, and/or ammonium levels to exceed thresholds that negatively impact tadpoles and or aquatic invertebrates. Also, atmospheric nitrogen levels are currently artificially high in many parts of the U.S. due to a variety of reasons, including the burning of fossil fuels, and the deposition of inorganic nitrogen (mainly in the form of NO_3) contributes to elevated levels of nitrogen in some aquatic systems (Carpenter et al. 1998, Smith et al. 1999, Camargo et al. 2005), and Grenon et al. (2010) found this to be true also of the Wind River Ranger. Grenon et al. (2010) documented an upward trend in nitrate and ammonia deposition.

Another factor contributing to high complexity and variability among wetlands is that concentrations of NH_3 relative to concentrations of NH_4^+ varies depending on pH and temperature, and the toxicity of NH_3 varies depending on pH, temperature, and dissolved oxygen levels (Hatch and Blaustein 2000, Camargo et al. 2006). As pH and water temperature increase, the concentration of NH_3 increases and the concentration of NH_4^+ decreases. Un-ionized ammonia (NH_3) is highly toxic, while ionized ammonia (NH_4^+) is appreciably less toxic (Camargo et al. 2006). Increases in pH and water temperature can increase the concentration of ammonia that can be absorbed through gills, and reductions in dissolved oxygen can increase the susceptibility of fish (and likely tadpoles) to ammonia toxicity. In contrast, increases in salinity and calcium can reduce their susceptibility to ammonia toxicity.

Still another complicating factor is that nitrate toxicity in tadpoles apparently can be affected by UV-B radiation levels (Hatch and Blaustein 2000, Hatch and Blaustein 2003); see bullets below.

The potential for livestock urine and feces, in combination with elevated atmospheric nitrogen levels, to substantively elevate nitrate, nitrite, and ammonia concentrations in wetlands occurs when the combination of nitrogen inputs on a given site exceeds the nitrogen fertility needs of live vegetation (Hubbard et al. 2004). On the other hand, Adams et al. (2009) found nitrate and nitrite levels to be below detection levels wetlands used by cattle, recognizing these were spring fed and had constant water flow through the wetlands. The nitrogen processes were not examined in these situations, so it is not possible to examine why nitrate and nitrite levels were high in some wetlands and low in others, but it demonstrates the large amount of variability from situation to situation.

Few studies were located showing the full range of nitrate, nitrite, and ammonium concentrations that could be expected in small to large wetlands, wetlands with low to high canopy cover of herbaceous vegetation, low to high amounts of detritus, limited to high degree of water replenishment, and with low to high levels of livestock use; i.e., the range of variability that could be expected in wetlands across the BTNF. While results of some studies have indicated that livestock can use some types of wetlands in at least some situations at limited (McIlroy et al. 2013) to moderate or moderately-high rates (Adams et al. 2009) without nitrate, nitrite, and ammonium levels reaching levels that can negatively affect frog and toad tadpoles and adults, these types of situations do not need to be evaluated in detail since they do not appear to have potential to negatively affect spotted frogs and boreal toads.

As explained by Scrimgeour and Kendal (2002:840), “Livestock grazing can increase concentrations of N and P in streams by: (1) increasing the propensity of overland flow during precipitation events; (2) decreasing denitrification rates within the riparian zone; (3) reducing uptake by riparian vegetation; (4) increasing N and P inputs to stream channels, riparian zones and shallow groundwater from voided wastes; and (5) mobilizing N and P in stream sediments and stream banks (Platts and Nelson 1985, Platts and Rhinne 1985, Armour and others 1991, Lal 1997, Sheffield and others 1997, Quinn and others 1997).” Therefore, not only does percent retention of herbaceous vegetation provide an indirect proxy for water quality (i.e., water quality is affected by intensity of livestock use and intensity of livestock use affects percent retention), it can directly influence water quality because uptake of nitrate and ammonium by vegetation declines with declining amounts of vegetation; i.e., higher retention levels would maintain higher levels of uptake of nitrate and ammonium.

The following information demonstrates that moderate to high use of wetlands by livestock, as well as relatively low use in some situations, can contribute — depending on a range of factors — to nitrate, nitrite, and ammonia concentrations reaching levels that can negatively affect spotted frogs and boreal toads:

Impacts to Tadpoles

NITROGEN, GENERAL

- Larvae of a range of amphibian species have been found to be negatively impacted by elevated concentrations of nitrate, nitrite, and ammonia (Hecnar 1995, Marco et al. 1999, Punzo and Law 2006, Schmutzer et al. 2008). Some studies have demonstrated acute toxicity of nitrite and nitrate (e.g., Hecnar 1995, Marco et al. 1999). Marco et al. (1999) found strong sensitivity of Oregon spotted frog tadpoles to relatively low levels of both nitrite and nitrate.
- Knutsen et al. (2004) found that amphibian species richness declined with increasing levels of nitrogen and that relatively high species richness occurred where total nitrogen levels were ≥2.5 mg/L.
- Ricklefs (1979) asserted that differential sensitivity to nitrate, nitrite, and ammonium among different amphibian and invertebrate species — even small differences in behavioral and physiological alterations caused by them — can contribute to differences in competitive and other interactions and ultimately result in altered community structure.
- Hogrefe et al. (2005:15) reported that slower amphibian growth rates due to a diminished prey base and lowered reproductive success due to altered water temperature, water chemistry, and habitat structure may occur in several occupied boreal toad habitats in Utah.
- Altered behavior of tadpoles begins 2.5 mg/L – 10 mg/L (Hecnar et al. 1995, Marco et al. 1999).
- Increased mortality begins at approx. 5 mg/L, with substantial mortality at >10 mg/L (but thresholds may be higher for some toad populations) (Hecnar et al. 1995, Marco et al. 1999).
- Nitrate levels in ungrazed wetlands can range from 1 to 7 mg/L or higher (especially in shallow waters and small pools) (Maret et al. 1987, Schmutzer et al. 2008); this provides a limited snapshot.

NITRATE TOXICITY

- Punzo and Law (2006:187) explained:

  > "Nitrate-related compounds can have a wide range of adverse effects on larval amphibians including an impairment of growth and developmental processes (Hecnar, 1995; Marco et al., 1999), feeding (Kiesecker et al., 2004), respiratory physiology (Huey and Beitinger, 1980), and have been associated with carcinogenesis (Westin, 1974)."
  >
  > Acute toxicity can lead to death and chronic toxicity that causes impairment of growth, respiratory physiology, and deformities can contribute to elevated mortality rates (Marco et al. 1999).

- After 15 days of exposure, Marco et al. (1999) found that mortality of Oregon spotted frog tadpoles was just over 10% at 6.25 mg $N0_3$-N/L, approached 40% at 12.5 mg N-NO_3/L, and was approximately 60% at 25 mg $N0_3$-N/L. Mortality did not appear to increase in boreal toad tadpoles exposed to these concentrations. Marco et al. (1999) assessed that, although nitrates themselves are of low toxicity, they can create health problems for amphibian larvae when reduced to nitrites.
- The 4-day LC50 for American toad tadpoles ranged from 13.6 to 39.3 mg NO_3–N/L and was 17.0 mg/L for western chorus frog tadpoles, 22.6 mg/L for northern leopard frog tadpoles, and 32.4 mg/L for green frog tadpoles (Hecnar 1995). Hecnar (1995) suggested the large difference in LC50s for American toads suggests possible differences in resistance among populations within species. He argued that toxicity was likely primarily caused by nitrate ions (NO_3^-).
- In chronic experiments, Hecnar (1995) found that 10 mg NO_3–N/L led to mortality of chorus frog and leopard frog tadpoles, and found that fewer chorus frog tadpoles metamorphosed from 10 mg/L tanks than from the 0 mg/L and 2.5 mg/L tanks. Behavioral and physiological alterations in all species in all treatment levels (2.5 mg/L, 5 mg/L, and 10 mg/L) included sluggish behavior, delayed response to prodding, and paralysis.

- Smith et al. (2006) found that nitrate toxicity affected the competitive interrelationships between two frog species.
- "…several laboratory studies have shown that a nitrate concentration of 10 mg $N0_3$-N/L (USA federal maximum level for drinking water) can adversely affect, at least during long-term exposures, sensitive aquatic animals (Canadian Council of Ministers of the Environment, 2003; Camargo et al. 2005a)" (Camargo et al. 2006:840). Some amphibian species may be as sensitive to nitrate toxicity or more sensitive than sensitive freshwater invertebrates and fish (Camargo et al. (2006).
- Adamus (2007:16) noted that "There currently are no legal standards for nitrate concentrations in wetlands or other surface waters, although the USEPA (2000) recommended 2.62 mg/L as a maximum level for nitrogen in Puget Lowlands." It is unclear how concentrations of nitrogen relate to concentrations on nitrate.
- Based on a review of acute toxicity data, Camargo et al. (2005) proposed a maximum of 2 mg $N0_3$-N/L to protect sensitive aquatic animals.
- Based on a review of acute toxicity data, the Canadian Council of Ministers of the Environment (2003, as cited by Camargo et al. 2006) recommended a maximum of 2.9 – 3.6 mg $N0_3$-N/L to protect freshwater and marine life.
- In water with a pH level of 5, survival of Cascades frog tadpoles dropped from 90% (0 mg/L nitrate) to 45% (5 mg/L nitrate) to 40% (20 mg/L nitrate) where UV radiation was not blocked, and survival only dropped from 94% (0 mg/L nitrate) to 65% (5 mg/L nitrate) and up to 70% (20 mg/L nitrate) where UV radiation was blocked (Hatch and Blaustein 2000).
- In water with a pH level of 7, survival of Cascades frog tadpoles remained nearly identical (85-90%) even though nitrate concentrations ranged from 0 mg/L to 5 mg/L to 20 mg/L where UV radiation was not blocked, and survival only dropped from 99% (0 mg/L nitrate) to 94% (5 mg/L nitrate) and to 90% (20 mg/L nitrate) where UV radiation was blocked (Hatch and Blaustein 2000). Given results summarized in this and the previous bullet, the authors concluded that nitrate, pH, and UV radiation interacted in effects on tadpoles.
- Weight gain in Pacific tree frog tadpoles was slowed significantly at 20 mg/L nitrate, but actually increased slightly at 20 mg/L where UV-B radiation was blocked (Hatch and Blaustein 2003).
- In another experiment, survival of Pacific tree frogs was near 100% when exposed to 0 mg/L nitrate and dropped to 20% when exposed to 10/L nitrate, but survival was near 100% when exposed to 10 mg/L nitrate where UV-B radiation was blocked (Hatch and Blaustein 2003).

NITRITE TOXICITY

- Although few Oregon spotted frog tadpoles died by day 4 under any nitrite concentrations except the highest concentrations, more than 50% of tadpoles had died by day 7 in tanks with ≥1.75 mg $N0_2$-N/L and 100% died at concentrations of ≥3.5 mg $N0_2$-N/L. At day 15, more than 50% of tadpoles had died in tanks with ≥0.88 mg $N0_2$-N/L and 100% died at concentrations of ≥1.75 mg $N0_2$-N/L (Marco et al. 1999).
- Boreal toads were less sensitive to nitrite than Oregon spotted frog, but by day 15 of their experiment, 100% of boreal toad tadpoles had died at concentrations ≥3.5 mg $N0_2$-N/L. At day 4, mortality increased only slightly in tanks with 7.0 mg N-NO_2/L, and at day 7 mortality of boreal toad tadpoles in 3.5 mg $N0_2$-N/L tanks approached 20% and mortality in 7.0 mg $N0_2$-N/L tanks exceeded 50% (Marco et al. 1999). At day 15, mortality was slight in tanks with concentrations <1 mg N-NO_2/L, but jumped to 100% mortality in tanks with ≥3.5 mg $N0_2$-N/L.
- At day 15, 100% of both Oregon spotted frog and boreal toad tadpoles had died in tanks with ≥3.5 mg N-NO_2/L.

- Marco and Blaustein (1999) found that tadpoles of Cascades frog metamorphed more slowly and emerged at an earlier developmental stage when exposed to 3.5 mg/L of $N0_2$-N/L than did control tadpoles.
- Based on a review of acute toxicity data, Alonso (2005, as cited by Camargo et al. 2006) assessed that a maximum of 0.08 – 0.35 mg $N0_2$-N/L would be adequate to protect sensitive aquatic animals, at least during short-duration exposures.

AMMONIA TOXICITY

- The 7-day LC50 for northern red-legged frog tadpoles was 4.0 mg NH_3NO_3/L and the 15-day LC50 was 1.2 mg NH_3NO_3/L (Schuytema and Nebeker 1999, as cited in Hayes et al. 2008), and they ascertained it was the ammonium, not nitrate, producing the toxic effect. They also found significantly lower length and weight of these tadpoles at NH_3NO_3 concentrations of ≥13.2 mg/L and $NaNO_3$ concentrations of ≥29.1 mg/L.
- > 50 mg/L NH_4NO_3 Ammonium nitrate decreased survivorship of wood frog tadpoles. Activity level of Wood Frog tadpoles decreased when exposed to ammonium nitrate, as well as in the presence of predator (Burgett et al. 2007).
- EPA's (2013) national recommended acute water quality criteria for protecting freshwater organisms from potential effects of ammonia is 17 mg/L total ammonia nitrogen at pH 7.0 and 20 ºC, and the chronic criteria is 1.9 mg/L of total ammonia nitrogen at pH 7.0 and 20 ºC. For comparison the water quality standard for Wyoming waters supporting fish and drinking water uses is 4.15 mg/L at pH 7.0 and 20 ºC (Wyoming Dept. of Environmental Quality 2013:Appendix C).
- Based on a review of acute toxicity data, Camargo et al. (2006:839) identified a maximum of 0.05 – 0.35 mg NH_3-N/L would be adequate to protect sensitive aquatic animals during short-duration exposures and 0.01 – 0.02 mg NH_3-N/L for long-term exposures; they cited several sources (U.S. EPA 1986, U.S. EPA 1999, Environment Canada 2001, Constable et al. 2003, Alonso 2005).

<u>Examples of Nitrate and Nitrite and Ammonia/Ammonium Levels in Wetlands</u>

- Nitrate and nitrite can be relatively high in shallow waters along shorelines due to high accumulations of organic matter (Marco et al. 1999), and feces and urine of livestock can compound this even at moderate levels of livestock use.
- Average nitrate concentrations in ungrazed wetlands in Schmutzer et al. (2008) were about 7 mg NO_3-N/L. At this base level, livestock feces and urine inputs would not need to be very high to substantively influence tadpole mortality in Columbia spotted frogs.
- In the study by Schmutzer et al. (2008), nitrate, nitrite, and ammonia were consistently higher (5–216% higher) in grazed wetlands (70-85% retention) than in cattle excluded wetlands, although results were not statistically significant at the $P<0.10$ level. They pointed out that ammonia may have reached levels that were biologically significant.
- Above, within, and below beaver pond complexes in a southwestern Wyoming, nitrate levels at five sample stations ranged from about 1.25 to 2.65 mg/L in 1984 and from about 0.2 to 0.8 mg/L in 1985 (Maret et al. 1987). There were fewer cattle in 1985 and conditions were drier, but livestock distribution and livestock grazing intensities were not reported.

  These samples were taken in beaver pond complexes which have a water flowing through them. Basin wetlands in similar environmental situations, except with no more than limited inflow and outflow, would likely have substantively higher nitrate concentrations (i.e., above the maximum levels recommended by Camargo et al. 2005 and would approach or exceed other recommended maximum levels).

Studies on the Influence of Cattle Urine & Feces on Nitrogen Levels (Mechanics of how N Increases)

- Stout et al. (1997:1787) noted that "…the bulk of the N consumed by the animal is excreted in the urine as urea (Ball and Ryden, 1984; Jarvis et al. 1989) and demonstrated that NO_3 from feces is a fraction of that coming from urine. Depending on temperature, some of this N is volatilized as NH_3 (Harper et al. 1983a,b); however, most of the urea rapidly nitrifies to NO_3... (Ball et al. 1979).
- Urine and fecal spots cover about a 2 ft. diameter area, and nitrogen concentrations under urine spots are often equivalent to about 620 pounds/acre fertilizer N applications (Stout 1997). Depending on the animal, about 30-60 grams (1-2 ounces) of nitrogen is deposited per 10 $ft.^2$ (Whitehead 1970, as cited by Ball et al. 1979). "Nitrate leaching from grazed grasslands has been shown to increase substantially when N application exceeds 425 kg/hectare (Barraclough et al. 1992)" (Stout et al. 1997). During the 3 years of the study by Stout et al. (1997), additional NO_3 leaching losses that could be attributed to spring-, summer-, and fall-applied urine were about 20.9, 22.9 and 30.3 grams (0.75, 0.82, and 1.08 ounces) per 10 $ft.^2$ respectively.
- In a study by Stout et al. (1997), NO_3 concentrations in the soil underneath cattle urine patches averaged 163 mg/L, while in a study by Frazier et al. (1994, as cited in Stout et al. 1997), concentrations averaged 42 mg/L. Stout et al. (1997) discussed the large amount of variability in the proportion of NO_3 leached downward through the soil profile depending on time of year and climatic conditions, including temperature. Depending on time of year and precipitation levels relative to evapotranspiration, leaching of nitrogen ranged from about 3% (e.g., growing season and relatively low precipitation) to as high as 75% (e.g., non-growing season and high levels of precipitation) in Stout et al. (1997) and studies cited therein (see also Ball et al. 1979). In some wetlands, little leaching occurs due to the impervious nature of nature of underlying soils, but the degree of leaching in these studies provides some indication of the degree to which the combination of pre-existing nitrate and added nitrate from urine and feces can contribute to the amount of nitrate in wetland waters.
- Stout et al. (1979) showed that NO_3 can accumulate over years of urine inputs when urine is applied to the same place year after year.
- "Nitrate-N concentrations averaged 25 mg/L in groundwater draining an intensive grazing area in New Zealand (Barber and Wilson 1972)" (Stout et al. 1997).
- An estimated 15% of pastures are affected at any given time by urine-nitrogen at a stocking level of 1 cow/acre (Peterson et al. 1956 and Jackman 1960; as cited by Ball et al. 1979). Small wetlands and the immediately surrounding area used by cattle for watering can receive higher stocking levels than this taking into account that each cow only visits a given wetland for a small portion of each day. As an example, a 0.05-acre wetland (roughly having a diameter of 50 ft.) would only need to have 8 cows visit the wetland for 1 hour/day each to attain "100% coverage" affected by urine-nitrogen. 100% coverage would not occur, but this information is included to help illustrate that it does not take many animals to affect a small wetland.

Eutrophication and Oxygen-Demanding Material

There are several compounds that can increase the rate of eutrophication, but this discussion focuses on nitrogen and phosphorus. In some wetlands and ponds, increases in eutrophication due to livestock use of wetlands can increase the production of algae (Ricklefs 1979, Smith et al. 1990), which has the capability to initially benefit tadpoles (Reaser 1996, Maxell 2000), but increased eutrophication is not always beneficial at low levels and it has negative impacts as it progresses (see discussion that follows). Reaser (1996) reported that green toads in Scandinavia and Syrian spadefoot toads seemed to favor eutrophic conditions, and Maxell (2000) had cited Reaser (1996).

In addition to nitrate having direct impacts on tadpoles, elevated nitrate levels also contributes to eutrophication (Ricklefs 1979, Carpenter et al. 1998, Smith et al. 1999, Anderson et al. 2002, Hubbard et al. 2004, Camargo et al. 2006, Adamus 2007, Anderson et al. 2008). See the "Nitrogen" subsection, above for discussion of nitrogen processes and contributions of livestock to increases in nitrate due to livestock urination and defecation in wetlands. The variability in nitrogen levels from wetland to wetland, from season to season, and in effects of livestock grazing use (see previous subsection) may contribute to variability in algae biomass found in Scrimgeour and Kendall (2002) among treatments of livestock grazing use. Grenon et al. (2010) identified a concern about increasing concentrations of nitrate and ammonia in lakes in the Wind River Ranger due in part to the potential for increased eutrophication.

Increase in phosphorus is also an important contributor to eutrophication (Ricklefs 1979, Carpenter et al. 1998, Smith et al. 1999, Anderson et al. 2002, Hubbard et al. 2004) and phosphorus has often been identified as the nutrient foremost in limiting algal growth (Camargo et al. 2006, citing eight supporting documents; Anderson et al. 2002). Although eutrophication can increase the growth of algae and aquatic vegetation, which is beneficial to tadpoles, reductions in dissolved oxygen reduce the oxygen available in water for respiration. The phosphorus cycle is less complicated than the nitrogen cycle. As explained by Ricklefs (1979:832), plants assimilate phosphorus as phosphate ion directly from the soil or water; animals eliminate excess organic phosphorus obtained in their diets by excreting phosphorus salts in urine; phosphatizing bacteria convert organic phosphorus in detritus to phosphate in the same way. Phosphorus does not typically enter the atmosphere. Although tadpoles can be negatively affected by elevated concentrations of phosphorus (Peltzer et al. 2008), the main problem with increased concentration of phosphorus in water is eutrophication and reduced levels of dissolved oxygen.

While naturally eutrophic aquatic systems are usually well balanced, the addition of artificial nutrients can alter the natural workings of a community and create major imbalances in the ecosystem (Ricklefs 1979). The combination of elevated nutrient loads and favorable conditions of light, temperature, and carbon dioxide stimulates rapid algae growth, which can lead to algae blooms (Ricklefs 1979, Camargo et al. 2006, Anderson et al. 2008). When the wetland can no longer support dense algae populations, the algae that accumulated during the bloom die and begin to decay. The subsequent rapid decomposition of the organic detritus by bacteria depletes oxygen in the water, and this depletion can be so thorough that fish, tadpoles, and aquatic invertebrates suffocate (Ricklefs 1979, Anderson et al. 2002, Camargo et al. 2006,); Camargo et al. (2006) cited several supporting references. Wetlands are most susceptible to this type of imbalance during the peak of plant production when nutrients are naturally less available. Decline in dissolved oxygen concentrations can also lead to the formation of compounds such as H_2S, which is highly toxic and can cause acute mortalities in aquatic animals at relatively low concentrations (Camargo et al. 2006). It is not clear whether algae blooms themselves, on the BTNF, can become toxic like they can in many parts of the world; if so, this would add to the negative effects of algae blooms.

Nitrogen and phosphorus levels have been shown to artificially accumulate at livestock water sources, at sites with shade for livestock, and at other sites where livestock congregate (Mathews et al. 1994, as cited by Agourdis et al. 2005), and phosphorus from animal wastes can represent a substantive contribution to the phosphorus in a system where the number of livestock and the duration of use is high relative to the size of the system (Hubbard et al. 2004). As explained by Thomas (2002:6), "Up to 80% of fecal P has been found to be in an inorganic and highly soluble form (Haynes and Williams, 1993). Phosphorus loads from cow defecation can be quite substantial. Cows defecate 11 to 16 times day$_{-1}$ with each event averaging 1.5 to 2.7 kg (Haynes and Williams, 1993). Thus, there is a possible fecal load of 16.5 to 43.2 kg of feces cow^{-1} day$_{-1}$ containing 1.2% total P by fresh weight (Safley et al., 1984 *in* Haynes and Williams, 1993). This indicates a possible fecal P load of 198 to 518.4 g P cow^{-1} day^{-1}. because there is a strong correlation between total P intake and total fecal P (Bromfield and Jones, 1970 *in* Haynes and Williams, 1993), the use of feeds or nutritional supplements high in P could further increase the fecal P load."

Vidon et al. (2008) documented a statistically-significant five-fold increase in total phosphorus in a section of a stream with unrestricted access by cattle, compared to the section of stream immediately above without any livestock grazing.

Also, the smaller the volume of water in a wetland and the lesser the amount of inflow (e.g., ground-water and surface-water recharge) and outflow, the greater the concentration of nitrogen and phosphorus at a given number and duration of livestock.

Reduced survival of amphibian larvae resulting from declines in oxygen levels caused by eutrophication have been documented (Peltzer et al. 2008, Ryan et al. 2012). Fish die-offs are more easily detected than die-offs of tadpoles, but the mechanisms of fish die-offs caused by eutrophication are the same (too little oxygen available to be taken up by gills) and numerous fish die-offs due to algae blooms have been documented (Anderson et al. 2002, Adamus 2007, Anderson et al. 2008). Adamus (2007) reported that "Nitrate concentrations as low as 1 mg/L can change the structure of freshwater algae communities of streams (Pan et al. 2004)…" There may other, synergistic effects of eutrophication. For example, Bull (2005) reported that the most heavily grazed of their study sites contained the highest level of organic pollution of any of the study sites investigated in this study, and that this may have been the cause of deformities in metamorphs. In discussing these results Bull (2005:34) explained that "It is believed that these frogs were infected at the larval stage with a nematode parasite (*Ribeiroia*) of the snail genus (Johnson et al. 1999). Johnson et al. (1999) suggested that accelerated eutrophication of water as a result of organic pollution may cause numbers of the planorbid snail (an intermediate host of *Ribeiroia*) to increase, which could increase the rate of parasite infection and deformities in frogs." Patla and Keinath (2004:47) listed Johnson and Chase (2004) and another supporting source.

Only two studies examining the effects of livestock grazing on spotted frogs, boreal toads, or similar species was found to have sampled dissolved oxygen. Bull and Hayes (2000) did not detect any statistically significant difference in dissolved oxygen, but average grazing levels were light, with most wetlands receiving very light to light grazing use, an estimated retention level of approximately 80%. Schmutzer et al. (2008) found significant reductions in dissolved oxygen (39% lower) in grazed wetlands than in cattle-excluded wetlands, and retention of herbaceous vegetation in wetlands was estimated to be approximately ≥70-85%.

Nitrate and phosphorus levels provide an indirect indicator of dissolved oxygen levels, and nitrate and phosphorus were sampled in several amphibian-livestock grazing studies. Adams et al. (2009) reported that nitrate and orthophosphates were at or below detectable limits in most wetlands, both in grazed and ungrazed wetlands, and herbaceous retention at grazed wetlands is estimated to have been approximately 50-60%. Bull and Hayes (2000) also did not detect any statistically significant difference in nitrate concentrations, but average grazing levels were light. In the study by Schmutzer et al. (2008), nitrate was consistently higher in grazed wetlands (estimated 70-85% retention) than in cattle excluded wetlands. Hornung and Rice (2003) found orthophosphates to be significantly higher ($p = 0.085$ in mid July and $p = 0.066$ in late August) in grazed wetlands than in ungrazed wetlands; they did not measure nitrate levels.

The reversal of eutrophication requires reduction in the nitrogen and phosphorus inputs (Carpenter et al. 1998). Adamus (2007:18) assessed that "There currently are no legal standards for phosphorus concentrations in wetlands or other surface waters, but the USEPA (2000) suggested 1.8 mg/L total phosphorus as an appropriate level."

Dissolved Solids and Turbidity

Elevated levels of dissolved solids in the water column in wetlands inhabited by tadpoles can stem from soil erosion in uplands, erosion of stream channels (e.g., where water flows into beaver ponds), and from trampling by livestock within wetlands. Numerous studies have documented the link between lowered ground cover levels caused by livestock grazing and elevated erosion rates in uplands that contribute to higher sedimentation rates in wetlands (Thurow 1991, Line 2003, Hubbard et al. 2004, Vidon et al. 2008, Holechek et al. 2011). Elevated soil compaction can contribute to this by reducing infiltration and percolation levels and higher levels of overland flow (Thurow 1991). Livestock walking in wetlands can entrain substrate material, resulting in increased fluxes of sediment and organic material in the water column, and resultant higher levels of dissolved solids in the water column has been documented (Jansen and Healey 2003, Hornung and Rice 2003, Foote and Rice Hornung 2005, Schmutzer et al. 2008).

Line et al. (2003) documented total dissolved solids that were nearly 3 times higher and turbidity that was 42% higher in a stream open to grazing compared to the same stream after exclusion of livestock; both findings were statistically significant. Vidon et al. (2008) documented a statistically-significant 13-fold increase in turbidity and 11-fold increase in total suspended solids in an section of a stream with unrestricted access by cattle, compared to the section of stream immediately above without any livestock grazing. Schmutzer et al. (2008) found significant increases in specific conductivity (70% greater) and turbidity (about 3.3x greater) in grazed wetlands than in cattle-excluded wetlands. Water quality in Jansen and Healey (2003) was assessed by sampling turbidity and conductivity. A water quality score was derived for each wetland for each year using measures of turbidity and conductivity, but the authors did not explain how scores were developed. The water quality scores were significantly lower in wetlands grazed at high intensity in 1998 than in wetlands grazed at low intensity (but did not differ statistically in 1999).

On the other hand, no differences were detected in turbidity and conductivity between grazed and ungrazed wetlands in at least two studies (Bull and Hayes 2002, Adams et al. 2009). However, livestock grazing was light (e.g., in the neighborhood of 80% retention) in the former study and Adams et al. (2009) identified spring flow-through as a possible reason for water quality not declining in grazed wetlands.

High levels of suspended sediment can interfere with the respiration and reproduction of tadpoles and reduce their growth and survival (Knutson et al. 2004; Power 1984, Gillespie et al. 2002, and Green et al. 2004, as cited by Wood 2005). In her study of western toads, Wood (2005:37) found that, "Although tadpoles were able to cope and experienced few deleterious physiological effects of sediment at low loading rates (130 mg/L), higher loading rates (260 mg/L) caused slower growth, lower survival and moderately smaller metamorphs."

Other Contaminants

A range of contaminants originating from livestock have been identified. "Veterinary products released into ponds and streams by the urine and manure of livestock may negatively affect amphibian health and survival (Bishop et al. 2003)" (Patla and Keinath 2005). Also, salt concentrations can build in small wetlands where livestock are supplemented with salt.

Surface Water Duration in Small Pools

It is possible for drinking by livestock to accelerate the drying of small breeding wetlands, thereby reducing reproductive output, which ultimately has the potential to contribute to reductions in small populations. Declining water levels is a natural wetland process, and wetlands can naturally dry before metamorphosis (Carey et al. 2005, Bull 2009, Laubhan et al. 2012), but removal of water by cattle, sheep, and horses as mentioned by Patla and Keinath (2005) and Bull (2009) can affect the retention of surface water in breeding pools during mid to late summer. This has not been examined in any detail in the literature, but it likely is a factor in at least some of the smaller breeding pools on the BTNF. Reques and Tejedo (1997:831) asserted that "The duration of the pond is clearly a potential cause of mortality for amphibians (Shoop 1974, Smith 1983, Newman 1989, Tejedo and Reques 1994)" and Laubhan et al. 2012:120 was more blunt: "If wetlands dry prior to metamorphosis, larvae die." Carey et al. (2005) assessed that "Desiccation of egg masses appears to be the single largest source of egg mortality" in boreal toads. Bull (2009:243) documented the "…more than 20,000 dead [boreal toad] larvae on the dry reservoir in 2008 after it was drained for irrigation just prior to transformation." Bull (2009:246) observed that "There appeared to be a detrimental impact of cattle on the survival of [boreal toad] toadlets and juveniles in this study because of their use of water from the few remaining pools in stream beds during dispersal in a dry year. Cattle were observed drinking in small pools with toadlets at Balm that were subsequently dry and did not have toadlets on subsequent surveys. If survival of toadlets and juveniles is a conservation objective, particularly if toad numbers are low and water is limiting, it would be beneficial to prohibit cattle from accessing dispersal routes of toadlets to retain water in the drainages."

The degree to which drinking by livestock shortens the length of time that a given small pool maintains surface water for developing tadpoles is a simple function of the number of livestock and amount of time they spend at the pool, all other factors (e.g., air temperature, day length, groundwater inflow) being equal. For small pools that can be affected by the consumption of water by livestock, the larger the number of livestock and the more time they spend drinking from a given pool (i.e., the higher the intensity of use), the shorter the duration that the pool will maintain water levels suitable for tadpole survival.

The following calculations are provided to demonstrate that the drinking of water in small pools by livestock very likely speeds up the desiccation of some breeding pools and wetlands used by summering frogs and toads. Cattle can drink up to 10-15 gallons/day during summer when temperatures are up to 80°F, but can approach 20 gallons/day when temperatures reach 95°F (Gadberry 2010). Even if only 20-30 cattle are watering at a small pool (e.g., containing 1,000-10,000 gallons of water) that has limited subsurface hydrologic input, they can impart major reductions in the amount of water if they use the pool for an extended period of time, particularly when water inputs are low and evapotranspiration rates are high. An evapotranspiration rate of 2-3 feet/year in small wetlands is probably not outside the norm for this area when in the full sun, and drinking by cattle would be a major contributing factor in these small pools. As a hypothetical example, say that a given pool has a surface area of 700 ft^2 and it holds 3,500 gallons (467 ft^3) of water at its peak, has a diameter of approximately 30 feet, and has an average depth of 8 inches and a maximum depth of 18 inches. (There are 7.5 gallons per cubic foot.) If this pool lost an estimated 3,500 gallons of water during June through August or September (based on an evapotranspiration rate of 2-3 feet/year), it could lose a similar volume of water to 16-25 cattle (12-20 cow/calf pairs) within two weeks if this was their only water source.

In many situations, wetland water is augmented by subsurface recharge, but the main point of the calculations in the previous paragraph is to illustrate that drinking by cattle has a very real potential of accelerating the decline in surface-water levels in small wetlands where water outflow is already exceeding water inflow and where water inflow is barely keeping pace with water outflow. Where surface water in wetlands would last until after metamorphosis, drinking by livestock likely results in surface water disappearing before metamorphosis is completed. In small breeding wetlands, this may not be an uncommon occurrence where cattle drink from them. Additionally, drinking by cattle toward the end of the growth period of tadpoles has a comparatively greater impact than drinking by cattle near the beginning of the growth period when subsurface recharge may still be occurring. At the end of the growth period, groundwater recharge may be lacking and the volume of water is substantially less and evapotranspiration is higher. For example if a 5,000-7,500 ft^2 pool has naturally shrunk, by late August, to 200 ft^2 with an average depth of 4 inches and volume of 500 gallons, a group of 11-17 cows (8-12 cow/calf pairs) could drink this amount of water in 3 days, which would have an effect on tadpoles that would have otherwise have successfully completed metamorphosis. Thus, even a relatively small amount of drinking by livestock can have major effects on completion of metamorphosis by spotted frogs and boreal toads in some situations.

As an example, small pools of approximately 100-250 ft^2 and isolated from surface-flow channels are common in some places like the Blind Trail/South Fork/McCain Meadow portion of the Little Greys watershed. Many of these are used by breeding spotted frogs. Dead tadpoles have been documented in the bottom of some of these dried pools. Numerous other small breeding wetlands occur in other parts of the BTNF within livestock allotments.

In addition to tadpole mortality due to desiccation after drying of breeding wetlands, lowered water levels can indirectly impact tadpoles and possibly cause higher levels of mortality. For example, “Kiesecker et al. (2001)… reported that reductions in water depth caused high mortality of embryos by increasing their exposure to UV-B radiation and vulnerability to *Saprolegnia ferax* infections.” Reduced water levels, especially when accelerated by livestock use, can increase concentrations of nitrate, nitrite, phosphorus, and other contaminants, which exacerbates water level reductions.

As temperatures warm and summer-time precipitation declines as a result of climate change (Schoennagel et al. 2004, Kaufmann et al. 2008, PARC 2008, Rieman and Isaak 2010, Glick et al. 2011:39-40, 46), some wetlands will dry out earlier, which will result in drinking by livestock grazing compounding impacts even further.

Survival as Influenced by Trampling

Trampling by livestock where tadpoles, metamorphs, and adults are concentrated has the potential to substantively increase mortality, particularly where high rates of mortality can happen when high densities of livestock occur at breeding wetlands when large numbers of tadpoles or metamorphs are concentrated on shorelines. The threat posed by livestock trampling was identified by Maxell (2000), Keinath and McGee (2005), Muths (2005), Patla and Keinath (2005), and others. Specific references to trampling as a threat include the following:

- While Keinath and McGee (2005) identified several ways to conserve boreal toads while accommodating some level of livestock grazing, they provided the following recommendation on the subject of trampling: “Minimize incidences of trampling by livestock by fencing critical habitat areas” (Keinath and McGee 2005:44). The most critical area they identified in their conservation assessment was breeding habitat and they identified the emergence of metamorphs as the period when boreal toads are most susceptible to trampling by livestock.

- In a conservation assessment for boreal toads on the BTNF, Patla (2001:11) stated that "…mortality due to trampling can be considerable."
- In the *Yosemite Toad Conservation Assessment*, Brown et al. (2015:74-75, 49-50) identified livestock grazing as one of two high priority risk factors, and identified trampling by livestock as one of the highest risks associated with livestock grazing. They assessed that "Livestock trampling has the potential to impact all life stages of Yosemite toads… In shallow water habitats, tadpoles may also be vulnerable to trampling… Perhaps the life history stage most at risk are the small metamorphosing and recently metamorphosed juvenile toads (often <10 mm in size), which aggregate en masse, in wetland habitats often at the time when cattle are present…" They further assessed that, "To minimize trampling risk, livestock could be actively managed to avoid areas of meadows occupied by the less mobile Yosemite toad life stages (tadpoles and new metamorphs).
- In their petition to list "a distinct population segment of the boreal toad (*Anaxyrus boreas boreas*) as endangered or threatened," the Center for Biological Diversity (2011) asserted that "Trampling by livestock may be a significant source of mortality for all amphibian life stages, especially for tadpoles and metamorphs that lack mobility and congregate near water margins (Hogrefe et al. 2005, p. 15)," and they also cited Bartelt (1998) and Bartelt (2000). In their response, USFWS (2012) responded by stating that the petitioners did not provide references to support most of these and other claims and that they did not have data readily available in their files to support such claims.
- Utah's Boreal Toad Conservation Plan assessed that "Trampling by livestock may be a significant source of mortality for all amphibian life stages, especially for tadpoles and metamorphs that lack mobility and congregate near water margins" (Hogrefe et al. 2005).
- Bartelt (1998) documented an instance of major mortality of boreal toad metamorphs due to trampling by sheep nearby on the Caribou-Targhee National Forest. Hundreds of metamorphs died as a consequence of one incidence of trampling.
- "Ross et al. (1999) found crushed [spotted frog] individuals at the bottom of the hoove prints of cattle…" (Maxell 2000:136).
- Maxell (2000:15) asserted that "In some instances trampling can result in severe population-level impacts."
- In a study of the effects of livestock grazing use and livestock exclosures on Columbia spotted frogs, Pilliod and Scherer (2015:586) assessed that "Trampling may also increase mortality directly (Reaser 2000)…"
- For amphibians in general, Maxell (2000:16) recommended that "Livestock should be fenced from all or portions of water bodies that are critical breeding habitat in order to prevent mass mortality as a result of disease or trampling at or prior to the time of metamorphosis." Specific to boreal toads, he recommended that "Known toad breeding sites that are within grazing allotments should have livestock removed or fenced from the area at the time of breeding and at the time of metamorphosis in order to prevent mass mortality of aggregations of adults or metamorphs as a result of trampling" (Maxell 2000:88).
- In their assessment and status report for western toads in Canada, Wind and Dupuis (2002:12,16), stated that "Cattle can have a major impact on… the survival of young amphibians through trampling and grazing (Friend and Cellier 1990)," and "The ability of toadlets to disperse may also be impacted by the persistence of PMAs [post-metamorphic aggregations], especially in riparian areas which receive a lot of trampling by people and/or cattle and near roads where there is a high risk of injury or mortality."

  Note: References to fencing breeding areas, above, were not included as a recommendation to fence breeding wetlands on the BTNF, but rather to show there is a very real concern by amphibian experts about trampling by livestock.

The level of concern raised by amphibian experts about livestock trampling warrants a detailed examination of this issue. Of most concern is trampling of metamorphs, given large congregations (Bartelt 1998, Maxell 2000, Hogrefe et al. 2001, Wind and Dupuis 2002, Keinath and McGee 2005, Bull 2009), as outlined above. Also of concern is trampling of adults for reasons outline below.

While the effects of livestock trampling on survival of frogs and toads has not been experimentally studied, studies on the effects of vehicles on mortality of amphibians and the effects of trampling on artificial nests/trout redds improve our understanding of the effects of livestock trampling on spotted frogs and boreal toads.

A wide range of studies have shown that, as vehicle-traffic volumes increase, mortality rates of amphibians on roads increase, especially when and where higher traffic volumes coincide with high densities of amphibians on roads (deMaynadier and Hunter 1995, Carr and Fahrig 2001, Pilliod et al. 2003, Bull 2009; and several studies cited by Maxell and Hokit 1999 and Patla and Keinath 2005). Although there are clear differences between vehicles and livestock, and while it may be possible for vehicles to take a higher toll on metamorphs and adults when roads are near breeding wetlands (e.g., due to the "footprint" of crushing zone being greater with vehicles in part due to constant contact of tires with the road, and relatively high speeds), there are aspects of livestock grazing that have the potential to result in a greater capacity for livestock to crush tadpole, metamorph, and adult frogs and toads: (1) roads exist as linear features while livestock occur across larger areas, (2) each vehicle occurs in areas occupied by amphibians for a short period of time (several seconds) versus livestock that can be walking in the area for minutes to hours or longer, and (3) roads are not located in or on shorelines of wetlands whereas livestock wade into wetlands and commonly walk on shorelines and surrounding habitat.

There likely are two levels of impacts in any given year. The first is high frequency, relatively low impact. It is likely that livestock step on a small proportion of tadpole, metamorph, and/or adult frogs or toads in most years when livestock distribution overlaps with breeding wetlands, migration corridors, and summering habitat. As an example, Maxell (2000) and Bull (2009) observed adult and juvenile frogs and toads that had been stepped upon by livestock. Where livestock grazing intensity or livestock density is relatively high, more than a small proportion is possible (i.e., high frequency, moderate impact). Once boreal toads reach adulthood, life expectancy is high (Muths 2005, citing 6 supporting references). Keinath and McGee (2005:41) reported that females do not breed until they are six years old, probably only breed every other year, are likely to not live much beyond 9 years. Similarly, it appears that spotted frogs have high life expectancy once they reach breeding age, as first breeding does not occur until 5-6 years (females) and 4 years (males) and individuals may live as long as 10-13 years or more (Reaser and Pilliod 2005). Therefore, even a small increase in the mortality rate of adults due to trampling by livestock has the potential to have population level effects, and this is compounded by other artificial and natural stressors affecting survival of spotted frogs and boreal toads. Keinath and McGee (2005:41) made the following assessment:

> "…the survival of adult toads is most critical to a population being able to withstand short-duration variability, because they are the "reservoir" through which the population is re-seeded. Therefore, (in the absence of outside influences) populations are more likely to grow if survival of young stages can be increased, and a stable crop of adults is necessary for long-term persistence in a variable environment. This is a huge hurdle, because it depends on a multitude of factors unique to the amphibian life cycle. Eggs and tadpoles depend on aquatic conditions, metamorphs depend on both aquatic and terrestrial conditions, and juvenile and adult toads depend on suitable upland habitat and hibernacula. This is compounded by the fact that, as described above, the reproductive window for boreal toads is very narrow. This implies that only a few successive mortality events among pre-reproductive toads may effectively cause a population to crash, whereas a species that produced more clutches in its lifetime would better be able to recover from a few years of poor recruitment."

The second level of impact from livestock trampling is low frequency, high impact to high frequency/high impact. This occurs when relatively high livestock grazing intensity or livestock density occurs where there is a large concentration of tadpole, metamorph, and/or adult frogs or toads, major reductions in survival are possible. During an emergence of metamorphs, it can be very difficult for a person trying to avoid stepping on metamorphs to step without stepping on metamorphs. Bartelt (1998) documented one instance of sheep that killed hundreds of boreal toad metamorphs on the Caribou-Targhee National Forest in one watering. Keinath and McGee (2005:44) assessed that "…livestock concentration around breeding sites can result in reduced survival or significant direct mortality even after hatching."

High concentrations of metamorphs on the shoreline of a given wetland can last for several days. At very low concentrations of livestock at breeding wetlands when metamorph emergence episodes occur, the chance of high mortality may be relatively low and the variability in effects is probably fairly low (Figure A.15 as applied to trampling effects). Conversely, at high concentrations of livestock at breeding wetlands when such episodes occur, the chance of high mortality is high and the variability in effects is probably low. At livestock concentrations between very low and high, effects would fall between these two extremes and the variability in effects would likely be higher.

Experiments on Trampling Rates of Small Objects

Studies on effects of livestock trampling on simulated ground nests (clay pigeons, pheasant eggs) and trout redds (clay pigeons) contribute to a better understanding of the effects of livestock density and duration of grazing use on the trampling of tadpole, metamorph, and adult frogs and toads by livestock. In general, Guthery and Bingham (1996) asserted that these studies can be used in assessing trampling effects on endangered plants and sensitive animal species, although they did not specifically address frogs or toads. Because clay pigeons and pheasant eggs are stationary, trampling effects in the studies described below would appear to represent a maximum or greater level of effect on mortality of tadpole, metamorph, and adult frogs and toads at the given stocking rates and duration of livestock grazing use. Although clay pigeons are larger than metamorphs, juveniles, and small frogs and toads, the size of clay pigeons relative to the size of metamorphs, juveniles, and small frogs and toads does not appear to be a substantive issue. Results of Paine (1996), in which pheasant eggs were used, fit in with results of Jensen et al. (1990), in which clay pigeons were used (Table A.3).

Table A.3. Trampling rates of small, stationary objectives at different livestock densities for different durations, based on studies cited below the table.

No. Cows/ Acre	**Duration of Grazing Period (Days)**									
	1	**3**	**4**	**7**	**9**	**14**	**21**	**28**	**35**	**48**
0.05				5[A]		6[A]	8[A]		14[A]	14[A]
0.18							10[B]			
0.36							17[B]			
1.3		9[A]								
1.6		10[C]		30[C]	46[C]	*53*[F]		*75*[F]		
2.0		15[C]		40[C]	73[C]	*75*[F]		*85*[F]		
3.1				41[D]						
3.2		26[C]		53[C]	77[C]	*85*[F]		*95*[F]		
5.3	18[E]	45[C]		58[C]	93[C]	*97* [F]				
6.1	23[E]	58[C]	52[D]	87[C]	96[C]	*100*[F]		*100*[F]		
6.9	49[E]	78[C]		98[C]	100[C]					
10		88[C]		93[C]	100[C]					
20	60[E]	90[C]		93[C]	98[C]					
24	63[D]									

[A] Koerth et al. (1983)
[B] Mandema et al. (2013)
[C] Jensen et al. (1990)
[D] Paine (1996)
[E] Guthery and Bingham (1996), using data from Jensen (1990)
[F] Projections of graphs in Jensen et al. (1990)

While results of studies on trampling of simulated nests likely represent greater-than-maximum levels of effects on frogs and toads (except possibly with respect to metamorph concentrations), several published accounts of frogs and toads being crushed by livestock demonstrate that frogs and toads do get stepped on by livestock. In a study on metamorph boreal toads, Bull (2009:243) found "More than 50 toadlets and one juvenile were found dead in cattle tracks" at one breeding site. Maxell (2000:15,36) personally observed that "Individual northern leopard frogs (*Rana pipiens*) and woodhouse's toads (*Bufo woodhousii*) have been found crushed at the bottoms of cattle hoove prints at the margins of several wetlands in eastern Montana," and reported on other authors that have reported crushing of adult spotted frogs by livestock. "Bartelt (1998) documented the deaths of thousands of western toad metamorphs when 500-1,000 sheep were herded through the drying pond the toadlets were concentrated around. He found that hundreds of animals had been directly killed underfoot and hundreds more died soon afterward as a result of dessication because the vegetation they had been hiding in had been trampled to the point that it no longer provided a moist microhabitat" (Maxell 2000:88).

These published accounts demonstrate that frogs and toads do get stepped on by livestock, but the small number of accounts that were found should not be surprising because, as noted by Bull (2009:239), "Dead toads were typically difficult to find, so my observations are opportunistic and may not be accurate counts of mortality that occurred." Pilliod and Scherer (2015:586) assessed that "…empirical evidence [of mortality of frogs due to trampling by livestock] is lacking because of the difficulty of documenting trampling events."

Even with concerted effort, it is likely that only a small percentage would be found. This is due to the difficulty of seeing small, dried amphibians which may be difficult to distinguish from surroundings and carcasses being located under vegetation. Removal of carcasses by scavengers can also affect the potential of observing dead frogs and toads (Bechman and Shine 2015). Additionally, only a limited amount of time was spent searching for specific accounts of crushed frogs and toads.

There are several factors showing that results of studies on trampling of simulated nests provide at least some indication of the level of trampling effects at different densities and grazing durations, depending on particular situations:

- When individual frogs and toads react to the movement of the legs of livestock or livestock as a whole, they likely do not accurately anticipate the exact placement of hooves and it likely is not uncommon for individuals to hop to the spot where a hoof is brought down, especially where vegetation can impede jumping by frogs/toads, when livestock are in a group, and in high concentrations of metamorphs. It is possible that destination microsites of flight-response hops of metamorphs in a high concentration area are not all that different than random locations in relation hoof placement.
- Some frogs and toads may hide and "freeze" rather than jump when livestock approach and some frogs and toads probably hide and freeze after jumping several times in response to one or more moving livestock; when they hide and freeze, this makes them comparable to a small stationary object for the period of time they stay hidden or frozen. No literature was found on "fight, flight, or freeze" behavior in frogs and toads, but a study of two small mammal species showed that the flight or freeze response in voles varied among individuals and, for some individuals, it varied from situation to situation (Eilam 2005). Also, Rodríguez-Prieto and Fernández-Juricic (2005) found that small proportion (10%) of Iberian frogs did not jump away until people were about 1 foot away, about 70% of frogs jumped when people approached to within 3 feet, and nearly 100% jumped when people approached to within 6 feet. These are close distances, and distances at which flight-response was elicited declined with increasing levels of herbaceous canopy cover and herbaceous height (i.e., they likely were the frogs that waited to jump until people were 1-3 feet away). A To the extent responses are similar for spotted frogs and boreal toads, it could allow livestock to approach close to them before they attempt to escape, which would increase the potential of being crushed.
- Concentrations of moving livestock, especially when they are walking or running, makes escape hops by metamorphs and adults immaterial; survival and mortality become a matter of chance.

- Fast movements by livestock and running livestock do not provide opportunity for metamorphs and adults to successfully escape. Herding livestock from one location to another (e.g., moving cattle out of a riparian area, moving sheep to and from a water source) is an example of a combination of concentrated livestock and walking or running livestock. Also, at water sources, high densities of livestock can be compounded by interactions among animals (e.g., jockeying for position, aggressive interactions causing quicker and more movements, an increasing number of livestock going further into the water to minimize interaction and possibly to access herbaceous vegetation not yet grazed), which can increase trampling impacts.
- In high concentrations of metamorphs, it is possible for one step by a cow to crush or injure more than one metamorph.

Authors of the *Yosemite Toad Conservation Assessment* (Brown et al. 2015:49-50) assessed that trampling rates of metamorph Yosemite toads could be higher than rates modeled by Guthery and Bingham (1996). They specifically stated that “The Yosemite toad’s life history suggests that the risk of trampling may be higher than levels indicated in [Guthery and Bingham 1996] because the study used randomly placed inanimate objects to test the model whereas some toad life stages aggregate in large numbers.”

Although the percentages in Table A.3, below, do not directly translate into mortality rates of spotted frogs and boreal toads, the information shows that the potential for tadpole, metamorph, juvenile, and adult frogs and toads increases as livestock density increases. It is not uncommon for cattle densities in meadows on some allotments on the BTNF to be 1 cow per 1-2 acres for several weeks. When this occurs where juveniles and adults are migrating from breeding wetlands or where boreal toads are summering, it is conceivable for the percent of boreal toads being trampled to be in the single digits and possibly in some situations into the teens. In situations where high cattle densities occur when and where metamorphs are concentrated, this can lead to substantive mortality rates of a given cohort, conceivably as high as 25%, 50%, or 75%. Cattle densities in the immediate vicinity of wetlands can be high (e.g., ≥1-5 cattle in a 1,000 ft.^{2} area; 45-200 cattle/acre in this small area) for short periods (or longer), and densities of metamorphs can be orders of magnitude higher than densities of artificial nests in the studies described below; e.g., densities can be >1 metamorphs/10 ft^2 (>5,000/acre) or even >5 metamorphs/ft^2 (>200,000/acre) on portions of shorelines, for example, on the order of 200 ft^2 (0.004 acres) to 1,000 ft^2 (0.02 acre) for several days or more when metemorphs are emerging. Muths (2005:394) reported that aggregations of metamorphs on shorelines are “…sometimes two or more individuals deep (Wassersug, 1974; Livo, personal communication)…,” which results in much greater concentrations identified above. When metamorphs are concentrated on shorelines, the trampling percentages in Table A.3 for given livestock densities for given time intervals would appear to provide good indication of mortality rates of metamorphs from trampling, with Bartelt (1998) providing a documented incident of high mortality of metamorphs. This level of potential impact supports the recommendation by Keinath and McGee (2005 :44) to fence critical habitat areas (e.g., breeding sites) to protect boreal toads from trampling.

Several relationships between livestock density, duration of grazing period, and trampling of small objectives can be made based on results of studies on effects of livestock trampling on simulated ground nests and trout redds:

- *Trampling rate of small objects increases with higher livestock densities at a set length of the grazing period* (Koerth et al. 1983, Beintema and Müskens 1987, Guthery and Bingham 1996, Paine 1996, Mandema et al. 2013). Table A.3 summarizes the percent of clay pigeons and, for one study, pheasant eggs, that were trampled under different livestock densities and duration of the grazing period. Each of the studies are discussed below. While studies were conducted in different vegetation types, in pastures of different sizes, different types of cattle, and involved a wide range of small-object densities, all of the results presented in Table A.3, with very few exceptions, demonstrate there is a relatively low amount of variability at given livestock densities and duration of grazing (i.e., it comes down to mathematical probabilities). Interestingly, in a study involving 18,000 real ground nests in meadows during 1974-1983, similar patterns were documented in Beintema and Müskens (1987:Fig. 6), except that nest loss was higher than shown in Table A.3 in many cases due primarily to predation and there were differences among bird species.

Koerth et al. (1983) assessed the effects of livestock trampling under continuous grazing (80-acre pasture) and short duration, high intensity grazing (16 7-acre paddocks in 120-acre pasture) for a 48-day grazing period. Paddocks were each grazed for 3 days. The continuously grazed pasture had 1 steer per 20 acres (0.05 steers/acre), and the short duration, high intensity pasture had 1 steer per 13 acres (0.08 steers/acre) for the entire 80-acre pasture. Density in the 7-acre paddocks was about 1 steer per 0.78 acres (1.3 steers/acre). Clay pigeon densities in trials were about 0.4/acre, 0.8/acre, and 1.2/acre. An average of 14% of clay pigeons were trampled in 48 days in the continuously grazed pasture, and an average of 9% were trampled in the short-duration, high intensity pasture during the 48-day period. The average of 9% clay pigeons trampled also applies to each 7-acre paddock for a 3-day grazing period. If the same stocking rate was extrapolated either in the same 7-acre paddock for 48 days or across the entire 120-acre pasture for 48 days, their information indicates that 100% of clay pigeons would have been trampled.

Mandema et al. (2013) found that an average of about 10% of clay pigeons were trampled in a 21-day period at a stocking density of 0.18 cows/acre and a clay pigeon density of about 1.8 clay pigeons per acre (5 cows and 50 clay pigeons in a 28-acre paddock), compared to an average of about 17% of clay pigeons trampled at a stocking density of 0.36 cows/acre and the same density of clay pigeons (10 cows in a 28-acre paddock). In the three replicates, 3, 4, and 6 clay pigeons were trampled in the 0.18 cows/acre paddocks; and 7, 8, and 9 clay pigeons were trampled in the 0.36 cows/acre paddock. Mandema (et al. (2013) found that trampling rates in horse pastures were approximately double that of cattle pastures given the same animal numbers and duration. They attributed the significantly higher trampling rates to a combination of horses consuming larger amounts of food per unit body weight and being more active, including being more apt to run.

Jensen et al. (1990) assessed the trampling effects of 8 different cattle densities during 10-day trials, for which results were presented for each 2-day period (Table A.3). Clay pigeon density ranged from 10/acre to 40/acre.

Paine (1996) examined the effects of three stocking densities and grazing durations on the survival of simulated ground nests (3 pheasant eggs). Stocking rates were about 24 cows/acre for 1 day per paddock, about 6 cows/acre for 4 days per paddock, and about 3.1 cows/acre for 7 days per paddock (i.e., the first two treatments represent 24 animal unit days and the third treatment represents about 22 animal unit days). Each of 12 paddocks were about 3 acres and artificial-nest density was about 5/acre. Because of their small size, pheasant eggs may better represent the size of metamorph frogs and toads.

Using data from Jensen (1990), Guthery and Bingham (1996) estimated that 13 head, 15 head, 17 head, and 50 head of cattle in a 2.5-acre paddock (5.1, 6.0, 6.8, and 20.0 cattle/acre, respectively) for 1 day would result in probabilities of trampling of 18%, 23%, 49%, and 60%, respectively.

As part of their study, Beintema and Müskens (1987) examined the relationship between livestock trampling and nest success of 5 species of meadow nesting birds in pasture having different densities and classes of livestock. The total sample size of nests for all bird species was 18,000 (1974-1983); while the number of nests of the 5 species is unknown, it is clear the sample size was high. They found relatively strong correlations between the percent of nests lost (to trampling and predation) and the density of livestock during the course of the nesting season. Some of their results are summarized in Figure A.16. Figure A.16 suggests that trampling rates of real bird nests is comparable to trampling rates of small stationary objects, recognizing that results of Beintema and Müskens (1987) summarized in the figure had a heavy component of predation; it is likely that trampling had a proportionally higher effect early on and then a proportionally lower effect as predation rates increased due to lower amounts of nest cover.

Mandema et al. (2013) also found that trampling rates of real bird nests was comparable to trampling rates of artificial nests; they examined both in their study.

Densities of livestock in the upper part of Table A.3 (1 cow per 2 to 20 acres) likely are within the range of densities of cattle in riparian areas and non-riparian meadows where cattle prefer to feed, shade, and rest.

- *Trampling rate of small objects increases with longer grazing periods at a set livestock density* (Guthery and Bingham 1996). It stands to reason that, over time, livestock will step on an increasing proportion of small objects on the ground. Jensen et al. (1990) demonstrates this in their experiment. In a model developed by Guthery and Bingham (1996), based on data from other studies, they estimated that, in a 247-acre pasture with 20 animals (0.08 livestock/acre), the probability of trampling increases rapidly for the first 20 days, increased at a moderate rate between 20 and 40 days, and then slowly to very slowly beyond this through the 100-day modeled period.
- *Trampling rate of small objects increases with higher livestock densities and length of the grazing period* (all studies cited above). One of the main patterns shown Table A.3 is for the percent of trampled small objects to increase with livestock densities and with increasing amount of time, and Jensen et al. (1990) and Paine (1996) demonstrate this within each of their studies.
- *Substantive proportions of small objects can be trampled in plant communities with high percent retention of total herbaceous vegetation* (Paine 1996). Robel pole readings were recorded at each simulated nest location just before and just after each grazing period of 1, 4, or 7 days in Paine (1996). Retention of Robel pole readings from pre- to post-grazing averaged approximately 63%, 76% (or 87% without outlier), and 97%, respectively for 1-day, 4-day, and 7-day treatments. These Robel pole retention estimates were based on information in Fig. 4.A-C of Paine (1996). They in turn correspond to an estimated 70% retention of herbaceous vegetation, 80-90% retention of herbaceous vegetation, and ≥90% retention of herbaceous vegetation, except these estimates do not account for vegetation growth during the grazing period. These estimated retention levels correspond to 63%, 52%, and 41% trampling rates, respectively. The authors noted that growth may have partially offset grazing effects during the 4-day and 7-day treatments, meaning that Robel retention levels (and estimated percent herbaceous retention levels) should have been lower, but the degree to which the above estimates overestimate percent retention for the 4-day and 7-day treatments is unknown. Based on the relationship between Robel pole readings and pounds/acre of herbaceous vegetation in Idaho fescue communities (Uresk and Juntti 2008), vegetation production in the study by Paine (1996) study appears to be roughly in the neighborhood of 2,500-5,000 pounds/acre[D]. See also Figure A.16 (after Tables A.4 and A.5).
- *The probability of being trampled increased markedly with a declining distance to water* (Mandema et al. 2013, Koerth et al. 1983). Substantially more than 10% and 17% of clay pigeons were trampled near the water source in each pasture (Mandema et al. 2013). Koerth et al. (1983) found that trampling rate was highest closest to water (higher than the averages they provided). In the vicinity of wetlands used by cattle for feeding and watering, cattle densities are at least comparable to densities at the bottom of Table A.3, and can easily exceed these densities for short periods to several hours during the day. If, for example, 5 cows inhabited a 10,000 ft^2 shoreline for ½ to 1 hour each day, the daily density would be 10-20 animals/acre. For some wetlands, this is likely a low density estimate.

  While Keinath and McGee (2005) identified several ways to conserve boreal toads while accommodating some level of livestock grazing, they recommended fencing critical habitat areas to protect boreal toads from trampling. The most critical area they identified in their conservation assessment was breeding habitat and they identified the emergence of metamorphs as the period when boreal toads are most susceptible to trampling by livestock. Results of studies cited above confirm their concern and demonstrate that, even at conservative utilization levels, boreal toads can be at risk of high mortality at certain times.

Livestock Densities at Different Retention Levels

Cattle densities were estimated for four different plant-community production levels (500 lbs/acre, 1,000 lbs/acre, 2,000 lbs/acre, and 3,000 lbs/acre) at 7 different retention levels for each of 6 grazing durations (1 week to 8

[D] This is a very rough comparison because the herbaceous plant community in the study by Paine (1996) is unknown and the relationship between Robel pole readings and pounds per acre of herbaceous vegetation in Uresk and Juntti (2008) specifically applies to Idaho fescue communities. However, their information provides some indication of pounds per acre.

weeks) (Tables A.4 and A.5). Herbaceous production in tufted hairgrass, small-winged sedge, and shrubby cinquefoil-tufted hairgrass communities, from Youngblood et al. (1985:Appendix C), was approximately 2,800-3,700 pounds/acre, 1,900-5,900 pounds/acre, and 400-800 pounds/acre, respectively. This is similar to production in tufted hairgrass communities measured by Kovalchik (1987) in Oregon (1,500-3,000 pounds/acre at low elevations, 500-1,500 pounds/acre at high elevations) and Volland (1976, as cited by Kovalchik 1987) in Oregon (an average of about 1,950 pounds/acre). There likely are few spotted frogs and boreal toads inhabiting areas producing as little as 500 pounds/acre given the low amount of cover provided and many low producing sites are dominated by nonnative bluegrasses, meaning they receive disproportionately high use by cattle.

Livestock densities were calculated by determining how much forage each cow and cow-calf pair typically eats during each of the 6 grazing durations (based on consumption rates of 800 lbs/month and 1,000 lbs/month; Lyons et al. 1999, Pratt and Rasmussen 2001) and calculating the number of cows and cow-calf pairs that can be fed pounds/month and they were in the meadow for 2 weeks, this would require 1.25 cows/acre to hit the 50% retention mark.

Table A.4. Density of cows (cows/acre) in plant communities of differing production levels (pounds/acre), at different retention levels (percent retention of total herbaceous vegetation), and for different durations of grazing. Forage consumption rate assumes that a cow consumes ranges from 800 pounds/acre (for a 1,000-pound cow) to 1,000 pounds per acre (same consumption per pound of animal for a 1,200-pound cow).

Forage Prod. % Retention	**Available Forage (lbs/acre)**	**Duration of Grazing Period**					
		1 Week	**2 Weeks**	**3 Weeks**	**4 Weeks**	**6 Weeks**	**8 Weeks**
		(200-250 lbs)	*(400-500 lbs)*	*(600-750 lbs)*	*(800-1,000 lbs)*	*(1,200-1,500 lbs)*	*(1,600-1,800 lbs)*
500 lbs/acre							
90%	50	0.20-0.25	0.10-0.13	0.06-0.08	0.05-0.06	0.03-0.04	0.03
80%	100	0.40-0.50	0.20-0.25	0.13-0.17	0.10-0.13	0.07-0.08	0.05-0.06
70%	150	0.60-0.75	0.30-0.38	0.20-0.25	0.15-0.19	0.10-0.13	0.08-0.09
60%	200	0.80-1.00	0.40-0.50	0.27-0.34	0.20-0.25	0.14-0.16	0.11-0.13
50%	250	1.00-1.25	0.50-0.63	0.33-0.42	0.25-0.31	0.17-0.21	0.14-0.16
40%	300	1.20-1.50	0.60-0.75	0.40-0.50	0.30-0.38	0.20-0.25	0.17-0.19
30%	350	1.40-1.75	0.70-0.88	0.47-0.58	0.35-0.44	0.23-0.29	0.19-0.22
1,000 lbs/acre							
90%	100	0.40-0.50	0.20-0.25	0.13-0.17	0.10-0.13	0.07-0.08	0.05-0.06
80%	200	0.80-1.00	0.40-0.50	0.27-0.34	0.20-0.25	0.14-0.16	0.11-0.13
70%	300	1.20-1.50	0.60-0.75	0.40-0.50	0.30-0.38	0.20-0.25	0.17-0.19
60%	400	1.60-2.00	0.80-1.00	0.53-0.68	0.40-0.50	0.28-0.32	0.22-0.25
50%	500	2.00-2.50	1.00-1.25	0.67-0.83	0.50-0.63	0.33-0.42	0.28-0.31
40%	600	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
30%	700	2.80-3.50	1.40-1.75	0.93-1.17	0.70-0.88	0.47-0.58	0.39-0.44
2,000 lbs/acre							
90%	200	0.80-1.00	0.40-0.50	0.27-0.34	0.20-0.25	0.14-0.16	0.11-0.12
80%	400	1.60-2.00	0.80-1.00	0.53-0.68	0.40-0.50	0.28-0.32	0.22-0.25
70%	600	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
60%	800	3.20-4.00	1.60-2.00	1.06-1.36	0.80-1.00	0.56-0.64	0.44-0.50
50%	1,000	4.00-5.00	2.00-2.50	1.34-1.66	1.00-1.25	0.66-0.84	0.55-0.62
40%	1,200	4.80-6.00	2.40-3.00	1.60-2.00	1.20-1.50	0.80-1.00	0.67-0.75
30%	1,400	5.60-7.00	2.80-3.50	1.87-2.33	1.40-1.75	0.93-1.17	0.78-0.87
3,000 lbs/acre							
90%	300	1.20-1.50	0.60-0.75	0.40-0.50	0.30-0.38	0.20-0.25	0.17-0.19
80%	600	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
70%	900	3.60-4.50	1.80-2.25	1.20-1.50	1.00-1.13	0.60-0.75	0.50-0.56
60%	1,200	4.80-6.00	2.40-3.00	1.60-2.00	1.20-1.50	0.80-1.00	0.67-0.75
50%	1,500	6.00-7.50	3.00-3.75	2.00-2.50	1.50-1.88	1.00-1.25	0.83-0.94
40%	1,800	7.20-9.00	3.60-4.50	2.40-3.00	2.00-2.25	1.20-1.50	1.00-1.13
30%	2,100	8.40-10.5	4.20-5.25	2.80-3.50	2.50-2.63	1.40-1.75	1.17-1.31

Table A.5. Density of cows and calves (animals/acre) in plant communities of differing production levels (pounds/acre), at different retention levels (percent retention of total herbaceous vegetation), and for different durations of grazing. Forage consumption rate assumes that a cow-calf pair consumes 800 pounds/month (for a 1,000-pound cow and her calf) to 1,000 pounds per month (same consumption per pound of animal for a 1,200-pound cow and calf). Estimates in this table were calculated by multiplying estimates in Table A.4 by 2. A calf is closely associated with its mother and is smaller, but calves tend to do more walking and running than adults and a cow-calf pair consists of 8 hooves instead of 4. Italicized figures below each duration refers to the amount eaten

Forage Prod.	**Available Forage (lbs/acre)**	**Duration of Grazing Period**					
		1 Week	**2 Weeks**	**3 Weeks**	**4 Weeks**	**6 Weeks**	**8 Weeks**
% Retention		(*200-250 lbs*)	(*400-500 lbs*)	(*600-750 lbs*)	(*800-1,000 lbs*)	(*1,200-1,500 lbs*)	(*1,600-1,800 lbs*)
500 lbs/acre							
90%	50	0.40-0.50	0.20-0.25	0.13-0.17	0.10-0.13	0.07-0.08	0.05-0.06
80%	100	0.80-1.00	0.40-0.50	0.25-0.34	0.20-0.25	0.14-0.16	0.11-0.13
70%	150	1.20-1.50	0.60-0.75	0.40-0.50	0.30-0.38	0.20-0.25	0.15-0.19
60%	200	1.60-2.00	0.80-1.00	0.52-0.67	0.40-0.50	0.28-0.32	0.22-0.25
50%	250	2.00-2.50	1.00-1.75	0.67-0.83	0.50-0.63	0.33-0.42	0.25-0.31
40%	300	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
30%	350	2.80-3.50	1.40-1.75	0.93-1.17	0.70-0.88	0.47-0.58	0.39-0.44
1,000 lbs/acre							
90%	100	0.80-1.00	0.40-0.50	0.25-0.34	0.20-0.25	0.14-0.16	0.11-0.13
80%	200	1.60-2.00	0.80-1.00	0.52-0.67	0.40-0.50	0.28-0.32	0.22-0.25
70%	300	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
60%	400	3.20-4.00	1.60-2.00	1.06-1.36	0.80-1.00	0.56-0.64	0.44-0.50
50%	500	4.00-5.00	2.00-2.50	1.36-1.66	1.00-1.25	0.66-0.84	0.55-0.63
40%	600	4.80-6.00	2.40-3.00	1.60-2.00	1.20-1.50	0.80-1.00	0.67-0.75
30%	700	5.60-7.00	2.80-3.50	1.86-2.34	1.40-1.75	0.94-1.16	0.77-0.88
2,000 lbs/acre							
90%	200	1.60-2.00	0.80-1.00	0.52-0.67	0.40-0.50	0.28-0.32	0.22-0.25
80%	400	3.20-4.00	1.60-2.00	1.06-1.36	0.80-1.00	0.56-0.64	0.44-0.50
70%	600	4.80-6.00	2.40-3.00	1.60-2.00	1.20-1.50	0.80-1.00	0.67-0.75
60%	800	6.40-8.00	3.20-4.00	2.12-2.72	1.60-2.00	1.12-1.28	0.89-1.00
50%	1,000	8.00-10.00	4.00-5.00	2.68-3.32	2.00-2.50	1.32-1.68	1.11-1.25
40%	1,200	9.60-12.00	4.80-6.00	3.20-4.00	2.40-3.00	1.60-2.00	1.33-1.50
30%	1,400	11.20-14.00	5.60-7.00	3.75-4.67	2.80-3.50	1.86-2.33	1.56-1.75
3,000 lbs/acre							
90%	300	2.40-3.00	1.20-1.50	0.80-1.00	0.60-0.75	0.40-0.50	0.33-0.38
80%	600	4.80-6.00	2.40-3.00	0.80-1.00	1.20-1.50	0.80-1.00	0.67-0.75
70%	900	7.20-9.00	3.60-4.50	2.40-3.00	1.80-2.25	1.20-1.50	1.00-1.13
60%	1,200	9.60-12.00	4.80-6.00	3.20-4.00	2.40-3.00	1.60-2.00	1.33-1.50
50%	1,500	12.00-15.00	6.00-7.50	4.00-5.00	3.00-3.75	2.00-2.50	1.67-1.88
40%	1,800	14.40-18.00	7.20-9.00	4.80-6.00	3.60-4.50	2.40-3.00	2.00-2.25
30%	2,100	16.80-21.00	8.40-10.50	5.60-7.00	4.20-5.25	2.80-3.50	2.33-2.63

during each of these grazing durations at each retention level. For example, a meadow that produced 1,000 pounds/acre would have 500 pounds/acre available at a retention level of 50% and, assuming 1 cow eats 800

In estimating the approximate density of cattle at a given plant-community production level using information in Tables A.4 and A.5, recognition needs to be given to cattle grazing some meadows to a given retention level rather quickly, for example, within several days to a week even though the entire grazing period for the pasture may be several weeks and, in some cases, a few months (i.e., season-long grazing). If it only takes one week to reach a given retention level in a given meadow, 1 week should be used in estimating livestock densities for that meadow rather than the entire grazing period for that pasture. However, recognition also needs to be given to livestock moving through or bedding in these meadows after they are done grazing, as well as re-grazing as vegetation regrows (i.e., a sustained low density after the initial grazing-down of the vegetation).

This means that, in a meadow producing 1,000-2,000 pounds of forage/acre, densities of an estimated 2 to 12 animals/acre can be expected where meadows are grazed at 50-60% utilization of total herbaceous vegetation within 1-2 weeks (Table A.5), then densities would drop off for the remainder of the grazing season in that meadow. If it takes cow/calf pairs 3-4 weeks to graze a given meadow at 50-60% utilization of total herbaceous vegetation, densities would be an estimated 1-4 animals/acre during this period.

Where meadows are producing 3,000 pounds/acre, grazing at a level of 50-60% utilization of total herbaceous vegetation would require densities of 6-18 cows and calves/acre for a period of 1-2 weeks, and would require densities of 3-6 cows and calves/acre for a period of 3-4 weeks.

Where meadows are producing 1,000-2,000 pounds/acre, grazing at a level of 30% utilization of total herbaceous vegetation would require densities of about 1.2 – 6 cows and calves/acre for a period of 1-2 weeks, and would require densities of 0.6 – 2 cows and calves/acre for a period of 3-4 weeks (Table A.5). Where meadows are producing 3,000 pounds/acre, grazing at a level of 30% utilization of total herbaceous vegetation would require densities of 3.6 – 9 cows and calves/acre for a period of 1-2 weeks, and would require densities of 2 – 3 cows and calves/acre for a period of 3-4 weeks.

Trampling Rates at Different Retention Levels

While Figure A.16 overestimates livestock trampling rates of frogs and toads in summer and migration habitat, for reasons outlined above, they provide an index to actual trampling of frogs and toads in summer and migration habitat and some portions of the graphs (e.g., “1 Week” lines in Figure A.16) may not be far from trampling rates of metamorphs when and where the locations of livestock and metamorphs overlap, depending on how long the metamorph emergence period lasts.

Results of Bull and Hayes (2000) showed a positive relationship between the degree of trampling (hoof-print density) and degree of utilization by cattle. The degree of utilization in their rating system averaged about 1.3 (just over slight evidence of utilization) and the degree of trampling averaged 0.9 (just under slight evidence of trampling).

Because only one study (Paine 1996) provided information on Robel pole readings before and after cattle grazing along with trampling rates of small stationary objects, and because estimates of trampling by retention level was needed for this analysis, Figure A.16 was developed to support the analysis. This was made possible by information on trampling rates under different livestock densities (Koerth et al. 1983, Jensen et al. 1990, Guthery and Bingham 1996, Paine 1996, and Mandema et al. 2013; as summarized in Table A.3) and the cross-walk between livestock densities and percent herbaceous retention in Tables A.4 and A.5. Only 3 grazing durations from Tables A.4 and A.5 and only the foraging rate of 1,000 pounds[E] of forage per month were used in Figure A.16. Data in these cited papers were used to populate the graphs and then lines were visually fitted based on these points and slopes.

Because there may be some question as to whether a cow and a calf have equivalent trampling of 2 cows (an argument could be made that trampling rates of a cow-calf pair are less than 2 cows), estimates were provided both for 1 cow consuming 1,000 pounds of forage per month and a cow and calf pair consuming 1,000 pounds of forage per month. Trampling rates of cow-calf pairs likely fall between estimates for cow-calf pairs and for cows.

Three data points from Paine (1996) were added to graph ‘d’ of Figure A.16 as one small check on the information in the graphs. The source of data points were explained in the “Experiments on Trampling Rates of Small Objects,” above. Trampling rates of 41%, 52%, and 63% roughly correspond to estimated retention levels of ≥90%, 80-90%, and 70%, and they are depicted as stars in graph ‘d’. The authors felt that changes in Robel pole readings underestimated forage utilization for the first two trampling rates because vegetation was growing rapidly.

[E] Tables A.4 and A.5 include estimates for both 800 and 1,000 pounds of forage consumed per month, but only estimated derived using 1,000 pounds/month were used for Tables A.4 and A.5 Using 800 pounds per acre would have increased the estimates of percent trampling.

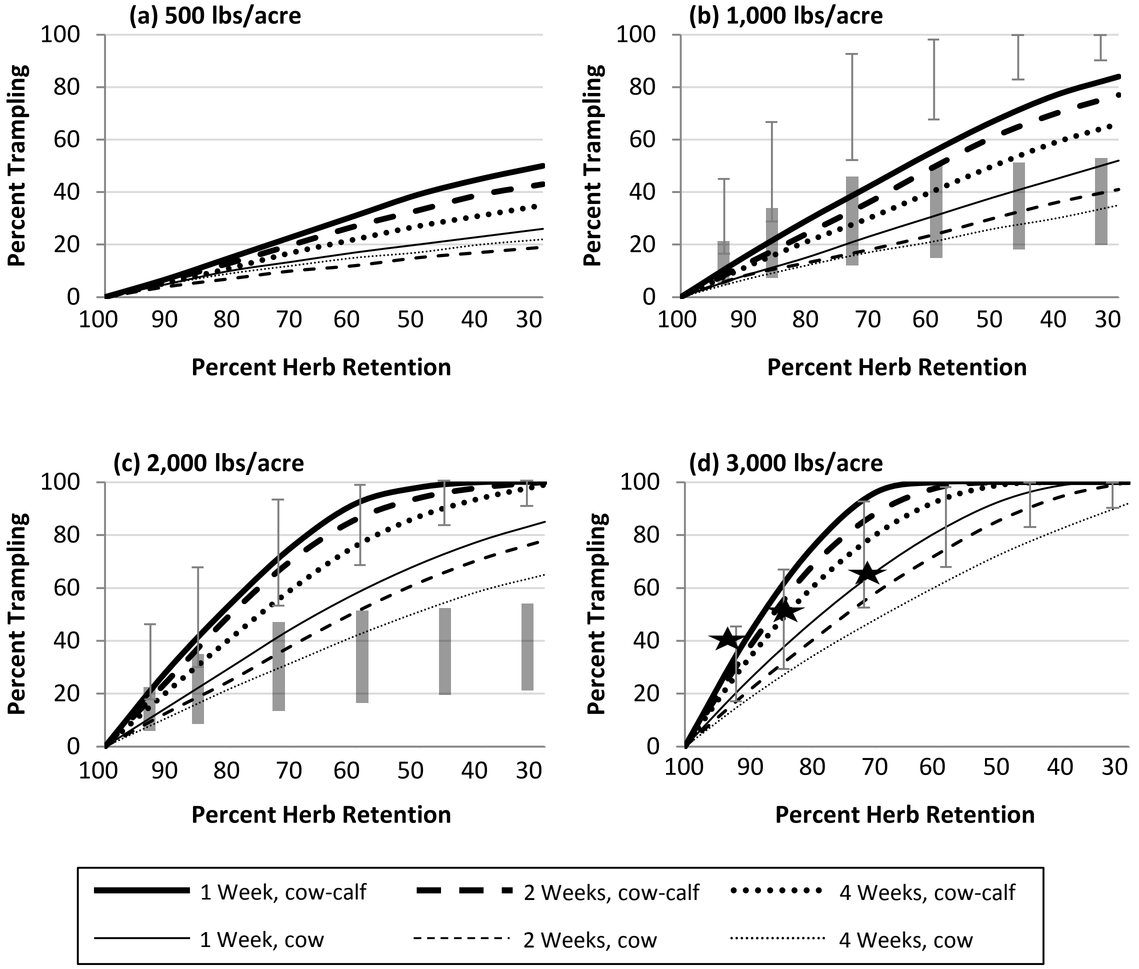

Figure A.16. Estimates of the percent of small stationary objects trampled at different levels of total herbaceous retention for different periods of time. Estimates of trampling were based on trampling rates under different livestock densities (Koerth et al. 1983, Jensen et al. 1990, Guthery and Bingham 1996, Paine et al. 1996, Mandema et al. 2013), with livestock densities converted to percent retention using information in Tables A.3 and A.4. The three stars in graph 'd' represent average trampling rates for three different livestock grazing intensities measured by changes in Robel pole readings (Paine et al. 1996), which were converted to percent herbaceous retention. Vertical gray bars depict trampling rates of meadow-nesting birds at 0.4, 0.8, 1.6, 2.4, 3.2, and 4.0 cows/acre, and the vertical lines above each gray bar depict total nest loss at each respective cow density (from Beintema and Müskens 1987; total sample size of nests = 18,000, but the number used in the model is unclear); vegetation production in the meadows likely was in the neighborhood of 1,000-2,000 pounds per acre.

Summary information from Beintema and Müskens (1987) was added to Figure A.16 in the form of vertical bars and lines, as another check on information derived from studies on artificial nests (clay pigeons and pheasant eggs). From left to right in graphs 'b' and 'c', the gray bars depict the percent of nests trampled at 0.4, 0.8, 1.6, 2.4, 3.2, and 4.0 cows/acre, based on a model that incorporated the outcome of thousands of a large sample size of nests of 4 meadow-nesting species that were monitored during 1974-1983. (About 18,000 nests were involved and a large proportion of these appeared to be of the 4 modeled species.) The bird species favor meadows that produce relatively short grass (that still provides cover) and, therefore, the information was displayed in the 1,000 pounds/acre graph, and it was also displayed in 2,000 pound/acre graph since vegetation production may have averaged over 1,000 pounds/acre. Because no information was presented on vegetation production or grazing duration, it was not possible to match cow density with percent retention. Instead, 4.0 cows/acre was assigned to

30% retention, with the assumption that grazing use was high (recognizing it could possibly be closer to 20% retention), and the other cow densities were spaced equally between 100% and 30% retention, except that 0.4 cows/acre fit between 0 and 0.8 cows/acre.

The vertical gray bars show the percent of nests trampled rising similarly as the graphed lines in graphs ‘b’ and ‘c’, but then the rate of increase slows and then levels off much quicker than for the graphed lines. This is because total nest loss is relatively high at 1.6 cows/acre (shown as roughly equivalent of 72% retention) and approaches 100% at 2.4 cows/acre (shown as roughly equivalent of 58% retention). Also displayed (in the vertical lines above each gray bar) is the total percent of nests lost at the same densities of cows. Few if any nests remained available to be trampled at densities of 2.4, 3.2, and 4.0 cows/acre; if it were not for predation, the percent of nest trampled would have continued climbing. Because of this relationship (percent trampling likely declined instead of leveling off as shown), it appears that percent trampling in the left-most gray bars are underestimated. The vertical gray bars were only added to graph ‘d’ because they have a strikingly similar pattern.

It needs to be recognized that cattle use wetlands for more than just grazing (e.g., some to many may use a wetland for watering and not grazing), and some cattle may remain at a wetland for periods of time without grazing or drinking. To the extent this occurs, the above estimates may underestimated trampling rates of small stationary objects in and immediately around wetlands. On the other hand, from the standpoint of estimating potential trampling effects on metamorphs, the cattle use of a given breeding wetlands can completely miss the short period when metamorphs emerge and concentrate on shorelines. Actual effects likely are highly variable and unpredictable.

Graphs in Figure A.16 provides indices to the percent of frogs and toads that could be trampled in summer and migration habitat (of the frogs and toads inhabiting habitat occupied by livestock) at different forage utilization levels in plant communities of different production levels, recognizing that actual percent trampling of frogs and toads at the different retention levels is unknown. Based on graphs in Figure A.16 the trampling rate of frogs and toads in summer and migration habitat having 80% retention is roughly 80-100% higher than at 90% retention; the trampling rate at 70% retention is roughly 25-50% higher than at 80% retention; the trampling rate at 60% retention is roughly 10-30% higher than at 70% retention; the trampling rate at 50% retention is roughly 5-25% higher than at 60% retention; and the trampling rate at 40% retention is roughly 0-20% higher than at 80% retention.

Synopsis

The information summarized above demonstrates that trampling by livestock likely (1) contributes to mortality of boreal toads, at least to a small extent, in non-breeding habitats like meadow, meadow-willow, and silver sagebrush communities; (2) contributes to mortality of spotted frogs along migration routes and along shorelines; and (2) greatly increases mortality rates of tadpoles and metamorphs, especially the latter, when and where groups of livestock congregate at breeding wetlands when tadpoles are concentrated near shorelines and during the peak of metamorphosis. Trampling rates for the first two may be in the single digits or possibly teens for the portion of a given local population occurring in these habitats while livestock occur there. For the third item, it is conceivable that the highest level of mortality caused by livestock trampling ― where livestock use at a breeding wetland occurs when metamorphosis is peaking, and when this involves groups of livestock spending time in the immediate vicinity of the breeding site ― is comparable to the percentages in Figure A.16, with Bartelt 1998 as one documented example of this.

Recognizing the potential for relatively high trampling mortality rates at relatively low or moderate livestock use levels, other elements of livestock grazing that can be managed at breeding wetlands, in migration habitat, and in summer-long habitat include timing of use, duration of use, and frequency of use (e.g., deferred rotation with and without rest among years), riparian pasture, and exclosures. For example, where cattle have potential to substantively elevate mortality rates by crushing metamorphs and adults in the vicinity of breeding wetlands, deferred rotation in a 4-pasture allotment would limit the potential for elevated mortality to one of every four years instead of four of four years. Another option is fencing, including the creation of small “riparian pasture” situations where the timing, intensity, and duration of grazing can be strictly controlled. The relatively high probability of trampling, even at moderate livestock densities is possibly why Keinath and McGee (2005:44) recommended fencing livestock out of critical habitat areas to protect boreal toads from trampling.

Soil Looseness and Porosity

Soil looseness and porosity is important to spotted frogs and boreal toads because they “self excavate,” which requires loose soil and is facilitated by a duff layer (Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006); maintenance of plant species composition requires a relatively natural soil structure (Thurow 1991, Holechek et al. 2011); and a natural plant species composition and naturally-loose and porous soils allow for more water infiltration and less overland flow (Thurow 1988, Thurow 1991, Holechek et al. 2011), which contributes to the maintenance of suitable water quality.

As a general rule, soil compaction increases with increasing livestock grazing intensities (Moore et al. 1979; Kaufman and Krueger 1984; Pluhar et al 1987, as cited by Hubbard et al. 2004; Leffert 2005:24-25). Kaufman and Krueger (1984), for example, cited four studies they said demonstrated soil compaction increases linearly with increases in livestock grazing intensity. Other studies (in the above-cited references) have not been able to distinguish soil compaction at lower livestock grazing intensities.

Several experts have identified a concern that soil compaction from livestock grazing can prevent frogs and toads from burrowing to prevent desiccation or freezing (Douglass et al. 1999, Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006). While some studies on the effects of soil compaction on infiltration rates have had mixed results (Haveren 1983, Abdel-Magid et al. 1987), no explanations have been given as to how soil compaction would not increase with increasing grazing intensity.

In addition to the soil compaction and herbaceous retention being connected by virtue of grazing intensity, they are also connected because lower retention levels will increase the tendency of soils to become compacted (Satterlund and Adams 1992).

Integrity of Near-Surface Burrows and Streambanks

Boreal toads and spotted frogs, especially the former, consistently use of small mammal and other burrows, are known to self-excavate shallow depressions, and use overhanging banks (Jones 2000, Bartelt 2000, Patla 2001, Wind and Dupuis 2002, Keinath and McGee 2005, Patla and Keinath 2005, Bull 2006, Browne and Paszkowski 2010, Long and Prepas 2012). These features can be important for thermoregulation and for maintaining body fluids, and for hiding from predators. Of all locations of boreal toads in Bull’s (2006) study, 18% were located in burrows, and another 8% were in self-excavated depressions; she also found that toad locations were significantly closer to burrows (average of 32 yards) than random locations (average of about 405 yards). In a study by Bartelt (2000 as cited in Patla 2001), boreal toads inhabited underground burrows over 26% of the time. Similarly, in a study by Long and Prepas (2012), 23% of refugia (humid microsites) used by boreal toads consisted of burrows, half of these were “shallow burrows in substrate” Nightly straightline distances from refugia ranged from 26 to 59 feet per night.

Overhanging banks are used by some spotted frogs and boreal toads for shade and for hibernation (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005). The prevalence of overhanging banks is a function of streambank stability (a long-term attribute) and streambank shearing (an annual indicator). Streambank stability indicates the overall degree to which overhanging banks are provided and sustained over the long term, and the extent of streambank shearing in any given year indicates the degree to which existing overhanging banks may have been caused to collapse.

The potential exists for burrows near the ground surface to be caved in (Maxell 2000, Keinath and McGee 2005) and the potential for streambanks to collapse as a consequence of livestock stepping on top of burrows and traveling on banks, stepping up onto banks, and stepping down from banks. The degree of this potential is a function of depth of burrows and the intensity of livestock use, all other factors being equal. The larger the number of livestock in frog and toad habitat and the greater the period of time they spend in this habitat, the greater the potential for burrows to be caved-in and for streambanks to become damaged. This has been shown with respect to streambank shearing (Simon 2008) and is consistent with studies on trampling (see the “Survival as Influenced by Trampling" section, above.) Studies on livestock trampling of small, artificial objects clearly demonstrate that higher numbers of livestock and increasing amounts of time translate into progressively higher potential for livestock stepping onto new ground. To illustrate the potential, 15-40% of clay pigeons would be expected to be stepped upon when livestock are in meadows (1,000 pounds/acre production) long enough to result in 30% utilization of total herbaceous vegetation (Figure A.16). In meadows with twice this amount of production, an estimated 35-80% of clay pigeons would be expected to be stepped upon. "Clay pigeons" in this case serve as proxies for near-surface burrows, meaning even at a conservative grazing level in moderate productivity meadows, the potential is high for near-surface burrows to be stepped upon.

Several species of rodents have the potential to provide burrows for boreal toads in habitats used by cattle, including Uinta ground squirrels and Wyoming ground squirrels (species occurrence based on Cerovski et al. 2004). Both of these species prefer meadows and open shrubland with short vegetation, and they favor meadows grazed by livestock (Zeveloff and Collett 1988). Uinta ground squirrels only occur to about 8,000 feet and Wyoming ground squirrels only inhabit the far southern end of the BTNF (Fagerstone and Ramey 1996). Elevations likely are too high for white-tailed prairie dogs and thirteen-lined ground squirrels, and burrows of prairie dogs typically would not be located where boreal toads typically would occur. It is possible for burrows created by microtine voles to be used by boreal toads, especially where soil is somewhat loose to enlarge openings; however, burrow size may be too small for adult boreal toads. Other species of small mammals that dig burrows (e.g., golden-mantled ground squirrels and several species of chipmunks) occur in and adjacent to forestland.

Maintenance of Willow Habitat

Clary and Webster (1989) pointed out that light to moderate grazing by livestock appears to have little adverse effects on willows and that severe grazing is almost always detrimental to willow communities. "Elmore [1988] also suggested that in some situations the use on willows begins when use on herbaceous plants reaches about 45 percent" (Clary and Webster 1989:7). Clary and Webster (1989:2) also pointed out that, for pastures grazed in the fall, maintain minimum stubble height of herbaceous vegetation will normally detour significant feeding on willows and most other riparian woody plants.

Managing stubble height on the green-line has become an accepted means of controlling browsing levels on willows (Clary and Webster 1989, Clary and Leininger 2000, Univ. Idaho Stubble Height Review Team 2004). The concept is that, by retaining green-line stubble height above some minimum level, cattle will be moved to the next pasture or off the allotment before they switch over to browsing on willows, recognizing the tendency by cattle to shift to willow browse is partially dependent on season. After explaining that initial minimum stubble heights are implemented and then adjusted upward or downward as needed to improve or maintain riparian functioning, Clary and Leininger (2000:562) noted that 6-8 inches "may be required to reduce browsing of willows…" On the other hand, Clary and Webster (1989:7) assessed that "...leaving a residual herbaceous stubble of about 4 inches usually results in little or no use of willows," but prefaced this by saying that it is based on observations and that little information was available at the time on how careful grazing affects willow communities. The University of Idaho Stubble Height Review Team (2004) identified the need to minimize willow browsing as one of several reasons for limiting stubble height on the green-line, but did not identify any specific minimum stubble heights.

Susceptibility to Diseases

Disease poses one of the biggest threats to spotted frogs and boreal toads, but it is increasingly being found that there are many synergistic factors that affect the susceptibility of amphibian populations to disease. For wildlife in general, Cleaveland et al. (2002:139) asserted that the effects of disease in wildlife populations already adversely affected by other factors (e.g., habitat loss and fragmentation) may be more pronounced, and that disease risks for wildlife are likely to increase "as contact with human and domestic animal populations become more frequent." Some experts studying the effects and causes of chytrid fungus infection in amphibians have pointed out that environmental stressors likely play a role in the overall effects of chytrid fungus on amphibian populations (Carey et al. 1999, Carey 2000). Additionally, it is possible that livestock have the potential to spread chitrid fungus and other disease vectors from one wetland system to another (Patla 2000).

One implication is that a given livestock grazing intensity and resultant habitat and survival conditions (e.g., in terms of herbaceous retention levels, water quality, surface-water duration, trampling effects) that may allow an amphibian population to persist in the absence of chytrid fungus or Ranavirus may be one of several factors that synergistically interact with these diseases to reduce population levels and make local populations susceptible to extirpation. Given the many types of negative effects of livestock grazing on amphibians and the potential synergistic effects with diseases such as chitrid fungus, the potential for negative synergist effects increases incrementally as higher grazing intensity increases, especially above some (unknown) level of grazing intensity. Restated, the potential for livestock grazing to contribute to negative effects associated with amphibian diseases increases with increasing grazing intensity. Gray et al. (2007, as cited by Schmutzer et al. 2008) "…reported that green frog tadpoles [in wetlands used by cattle] were 3.9x more likely to be infected with *Ranavirus* than those inhabiting [wetlands where cattle did not have access]." It is not clear whether this was due to transmission of disease vectors or increased stress on local populations due to livestock grazing effects on habitat.

OPENINGS PROVIDING SUN EXPOSURE

This section addresses shallow waters exposed to the sun and small openings in herbaceous communities to contribute to egg and tadpole development and to facilitate thermoregulation of metamorph, juvenile, and adult spotted frogs and boreal toads. The subject was only addressed to a minor degree in the previous version of the report. Several people during the past year have identified a need for livestock grazing for these purposes as (1) a reason for not starting with near-100% retention as a starting point in the analysis, and (2) a reason to continue livestock grazing in boreal toad and spotted frog habitat. No supporting scientific information was provided. These items are revisited at the end of this section.

Any reliance on livestock grazing and trampling to produce and maintain shallow waters exposed to the sun would need to be prescriptive to meet achieve desired results on specific parts of specific wetlands while avoiding or minimizing negative impacts at these and other wetlands.

Shallow Waters Exposed to the Sun to Facilitate Egg and Tadpole Development

Shallow water exposed to the sun are important for the development of eggs and tadpoles (Bull 2005, Carey et al. 2005, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, Reaser and Pilliod 2005), especially on the BTNF where elevations are high enough that the duration of relatively warm waters is fairly short. Carey et al. (2005) wrote at length about the importance of relatively high water temperatures to ensure that boreal toad tadpoles successfully complete metamorphosis prior to winter. In an experiment they conducted, Carey et al. (2005:227) found that — at four temperatures evaluated — tadpole development stopped at a constant temperature of about 50 ºF, development was slowest at about 55 ºF, development was most rapid at about 87 ºF, and development was intermediate at an alternating regime of about 50 ºF for 12 hours and about 87 ºF for 12 hours. They did not evaluate temperatures between 55 ºF and 87 ºF, but presumably temperatures at the upper end of this range (e.g., >70 ºF) are most beneficial.

Dumas (1964:179) reported that tadpoles of leopard frogs (a close relative of spotted frogs) develop normally in the laboratory at 50 °F, and that "Under field conditions at high altitudes where waters are cooler, the time necessary for metamorphosis at 10 °F [50 °F] is so long that freezing weather often kills all young frogs before they are ready for hibernation." The difference between leopard frogs and spotted frogs was not reported, but Dumas (1964) inferred that spotted frog tadpoles could tolerate somewhat colder temperatures than leopard frogs.

If water temperatures are low enough for long enough periods of time, this can result in tadpoles not completing metamorphosis before water temperatures drop in the fall, at which time tadpole development ceases (Carey et al. 2005). Although some authors have assumed tadpoles would complete metamorphosis the following year, Carey at al. (2005) assessed that over-winter survival of tadpoles was likely low in their study area in Colorado.

When dense enough, sedges and other herbaceous vegetation shade the water surface, thereby limiting heating of the water by solar radiation (Barton et al. 1985, as cited by Gregory et al. 1991; Line 2003).

In addition to warm water temperatures facilitating the development of tadpoles, sunlight waters also facilitate the eutrophication process, which Patla and Keinath (2005) assessed would increase tadpole forage. Increases in tadpole forage may contribute to faster rates of tadpole development, but many wetlands may already have sufficient food resources (i.e., eutrophication may not benefit tadpoles) and faster rates of growth may primarily be a function of water temperature.

Water depths and the ratio of open water to emergent vegetation are variable on the BTNF and depend on a range of factors. Some wetlands naturally "fill in" with emergent vegetation unless disturbance factors (e.g., changes in hydrology, grazing/trampling) affect this. Although sedges and rushes will grow into openings over time if left undisturbed where waters are shallow enough, this does not appear to be factor that negatively affects spotted frogs and boreal toads on more than a small proportion of wetlands on the BTNF. No scientific or other information was found indicating that filling-in of wetlands by emergent vegetation is an issue on the BTNF.

Although the "filling in" of wetlands by emergent vegetation is a natural process, there are three reasons why periodic creation of small openings in capable tadpole habitat should be considered as a fine-filter adjustment to coarse-filter conditions: (1) a large number of factors interact to negatively affect spotted frog and boreal toad populations on the BTNT and available information strongly indicates that habitat quality and survival on the BTNF are lower than prior to Euro-American settlement, (2) the "loss" of breeding-wetland habitat to overly-dense emergent vegetation likely has disproportionately higher impacts than it did prior to Euro-American settlement, and (3) reproductive output is highly important. No attempt was made to enumerate suitable ratios of emergent vegetation to open water in capable habitat for tadpole development and, therefore, this would need to be done before any attempts are made to create or maintain openings in emergent vegetation for breeding spotted frogs and/or boreal toads. Also, because the need to create openings for this purpose likely will be very limited and because there is a potential for negative impacts of cattle grazing use to be larger than benefits in terms of tadpole development (see "Implications of Livestock Grazing Use," below, any consideration of using cattle to meet this need would need to be critically evaluated and alternatives should be considered.

Small Open Patches for Basking

Extensive dense stands of herbaceous vegetation without any small pockets of open ground or open water may reduce suitability for spotted frogs and boreal toads due to the large amount of shade and no opportunity for basking in the sun (Maxell 2000, Watson et al. 2003, Bull 2005, Shovlain et al. 2006). Although these are only observations, and not results of research, they make sense biologically since spotted frogs and boreal toads have frequently been observed using basking sites and they are cold-blooded, relying on their environment for maintaining their body temperature at suitable levels. Being able to bask in the sun to help with thermoregulation is important to both spotted frogs and boreal toads (Bull and Hayes 2000, Wind and Dupuis 2002, Bartelt et al. 2004, Carey et al. 2005, Keinath and McGee 2005, Muths 2005, Patla and Keinath 2005, Reaser and Pilliod 2005). Similar situations exist where dense canopies of willow exist without any openings that allows sunlight to penetrate to the ground.

Shovlain et al. (2006) suggested that one reason for Oregon spotted frogs not selecting against low levels of grazing in their study may be because it created open patches of water in emergent vegetation. Watson et al. (2003) found that grazing by cattle created openings in reed canary-grass (which can become very tall and dense, and was mostly unused by Oregon spotted frogs when stands were consistently tall and dense without any open patches). Bull (2005) similarly assessed that some level of livestock grazing may benefit Columbia spotted frogs by creating openings in otherwise continuously dense marsh habitat, thereby providing basking sites and increasing solar radiation of water. Maxell (2000) identified two amphibian experts supporting the assessment that "In certain areas one possible positive impact may be that mechanical clearing of vegetation opens up basking areas that amphibians require.

On the other hand (1) extensive areas of relatively-tall, dense herbaceous vegetation did not appear to negatively affect spotted frogs, boreal toads, or related species in some studies; and (2) light grazing in herbaceous communities negatively affected spotted frogs in some studies. In the study by Roche et al. (2012b), tended to be incrementally higher with incrementally moister/wetter conditions, which correlated with incrementally lower grazing pressure by livestock, and their breeding wetlands received little if any use by livestock. Production in meadows within the study area ranged from about 892 to 2,856 pounds/acre, which is comparable to meadows on the BTNF (Youngblood et al. 1985). Roche et al. (2012a), Roche et al. (2012b), and McIlroy et al. (2013) did not identify any negatively effects of ungrazed meadow habitat on Yosemite toad adults or tadpoles. In Munger et al. (1996), wetlands used by spotted frogs had an average grazing rating of 0.769 on a scale of 0 to 3, which is between a rating of 0 (no evidence of grazing) and 1 (slight evidence of grazing), and wetlands unused by spotted frogs had an average rating of 1.262, which is somewhat above a rating of 1 (slight evidence of grazing) but well below a rating of moderate evidence of grazing. This difference in occupancy was statistically different. Although not statistically significant, similar patterns were observed by Munger et al. (1996).

In contrast to humidity-retention and temperature-moderation qualities of herbaceous vegetation that require comparatively large patches of contiguous herbaceous[F] canopies (see "Humidity Retention, Temperature Moderation, and Protection from the Sun" section, above), it only takes small openings on the order of 1 ft. wide to provide basking sites. This is important because reductions in intact and relatively-intact canopy cover substantially reduces the ability of herbaceous vegetation to trap humidity and moderate temperature below the canopy, and it takes very small reductions in canopy cover to provide basking sites. This means the two can readily be provided on the same site; humidity retention and temperature moderation could remain virtually unaffected while providing an abundance of basking sites (e.g., 1-4 ft^2) scattered throughout. If these small openings are provided in a herbaceous community having 100% canopy cover prior to openings being created, spacing created-openings 10-20 ft. apart would mean that canopy cover would be maintained at ≥95%. The point of presenting these numbers is not to infer that the ideal humidity-retention to basking sites is 95:5, but merely to demonstrate that it takes very little manipulation of sites with high canopy cover to provide basking sites, compared to the high level of canopy cover that is needed to retain humidity and moderate temperatures.

Although this appendix focuses on herbaceous vegetation, it is important to recognize that openings are likely important in areas having dense canopies of herbaceous vegetation and shrubs (combined) and having dense canopies of shrubs (with little or no herbaceous understories). Similar principles apply.

In contrast to considering the creation of small openings in extensive stand of emergent vegetation to facilitate tadpole development (previous subsection), there are three reasons why no fine-filter adjustments should be made to coarse-filter conditions that would include a minimum density of basking sites (e.g., in the neighborhood of approximately 1 - 10 ft.^{2} openings) in extensive areas of relatively-tall, dense herbaceous vegetation lacking such openings: (1) mountain meadow communities naturally have few openings (see the "A.4 Herbaceous Species Composition" section of the main report), (2) populations of spotted frogs and boreal toads appear to have persisted under these conditions, (3) availability of basking sites does not directly affect reproduction, (4) there are no scientific reasons to provide herbaceous conditions that are outside of the conditions under which the amphibian community developed in this area, and (5) altered herbaceous species composition in meadows and silver sagebrush communities in many parts of the BTNF already provide openings in herbaceous vegetation and short vegetation stature due to the altered conditions. Another consideration is that the availability of basking sites exceeds needs where herbaceous communities are grazed at 30% utilization (70% retention) of total herbaceous vegetation (see the "70% Retention of Total Herbaceous Vegetation" section), and this likely is the lowest utilization limit that would ever be implemented on the BTNF.

Implications of Livestock Grazing and Trampling

If managers take advantage of livestock grazing/trampling having the potential to prevent sedges and rushes from completely dominating certain breeding wetlands or if attempts are made to use livestock grazing/trampling to open extensive stands of herbaceous vegetation, this will need to be carefully coordinated with the need for relatively tall, dense herbaceous vegetation by frogs, toads, and a wide range of other wildlife species and the many negative impacts of livestock grazing use on spotted frogs, boreal toads, and many other wildlife species.

There are no documented instances on the BTNF in which spotted frogs or boreal toads have been negatively affected by livestock *not* created or maintaining openings in emergent vegetation or in other habitats.

[F] Contiguous canopies can also be provided by a combination of herbaceous vegetation and low willows and by dense tall willows, but this Appendix specifically addresses herbaceous vegetation.

None of the literature reviews, conservation assessments, plans, or other papers or reports reviewed for this appendix identified the use of livestock to produce or maintain larger openings in emergent vegetation in shallow water to facilitate egg and tadpole development, but several authors identified the use of livestock grazing use to create small openings for basking (Maxell 2000, Watson et al. 2003, Bull 2005, Shovlain et al. 2006).

Shallow Waters Exposed to the Sun to Facilitate Egg and Tadpole Development

Pilliod and Scherer (2015:588) noted that "…anecdotal evidence suggests that light grazing may help prevent some ponds from becoming overgrown with emergent vegetation, a condition that can lower habitat quality for Columbia spotted frogs under certain circumstances (Engle 2001)," and other authors have made similar assessments about low levels of livestock grazing helping ponds and other wetlands from becoming overgrown with emergent vegetation. However, it is not possible for light grazing to attain these results in wetlands where emergent vegetation is actively expanding in shallow waters or where it is already dense in shallow waters.

In extensive areas of relatively-tall, dense emergent vegetation, livestock grazing use and mowing/clipping, if heavy enough and partly depending on the timing of grazing/mowing/clipping, can reduce vegetation height or reduce the vigor and/or survival of emergent vegetation sufficiently to create and maintain conditions whereby shallow waters are open and heated by the sun. To the extent that dense herbaceous vegetation covering the water is removed, solar radiation is able to heat the water (Barton et al. 1985, as cited by Gregory et al. 1991; Line 2003). Use of herbicides is another option (Fredrickson and Laubhan 1994), but because of unintended consequences, the use of pesticides in wetlands would need to be further evaluated before its use.

There are two ways in which this can be accomplished with livestock grazing/trampling, mowing, and similar mechanisms.

Reduction in Vegetation Height and Trampling of Vegetation

This involves grazing/mowing/clipping (grazing) at a high enough percent utilization whereby height of emergent vegetation is reduced and vegetation is trampled into the mud sufficiently across large enough patches to allow sunlight to penetrate to the water in order to increase water temperatures. Kantrud (1990) and Holechek et al. (2011:283-284) generally stated that livestock grazing can be selectively grazed to open up dense stands of vegetation. This is temporary because emergent vegetation will regrow both during the current season if grazing occurs during the growing season and the following year. To maintain openings, therefore, grazing will need to occur during the vegetation growing season and during the egg and tadpole periods. Egg laying typically occurs in May at lower elevations and June at higher elevations (Keinath and McGee 2005, Patla and Keinath 2005, unpublished data BTNF), and tadpole development typically occurs during June through July or August. If grazing/trampling only occurred during the egg-development period or early tadpole period and not afterward, sedges and rushes would quickly grow back. Also, emergent vegetation height that is reduced the previous season would not result in reduced height during the tadpole period and possibly the egg period during the current season. The onset of livestock grazing on the BTNF is too late to reduce emergent vegetation height that would benefit egg development in that year.

The amount of grazing use depends on the height and density of emergent vegetation. Where the height is relatively short (e.g., ≤9 inches tall), little if any grazing would be needed because the vegetation likely would not be very dense and sunlight would likely heat the water in many situations. On the other hand, if the sedge community is 18-28 inches tall, approximately 40-60% utilization would be needed to reduce the average height to 6-8 inches and 60-80% use to reduce it to 4 inches (based on information in Kinney and Clary 1994).

Because the use of livestock to annually graze and trample the current year's annual production would involve substantive grazing and trampling during the egg and tadpole periods (i.e., to keep vegetation in shallow water grazed/trampled), this would pose considerable risk to eggs and tadpoles (see the "Survival as Influenced by Trampling" section, above) since this use of livestock would require livestock to graze when and where eggs and tadpoles occur. Therefore, annual grazing/trampling during the reproductive season to produce these results is impractical. Second, for livestock use to help maintaining longer-lasting openings in shallow waters of sedge- and rush-dominated wetlands (i.e., avoiding the need for grazing/trampling during the reproductive season), livestock grazing use would need to be high enough for enough years in a row to kill sedge and rush plants in a portion of shallow waters of a wetland. As such, this is not an issue of percent retention of annual production.

Reduction in Plant Vigor and Survival

This involves sufficiently heavy grazing and trampling or mowing/clipping of emergent vegetation at a time of year when emergent vegetation is susceptible to being impacted by grazing and trampling. Livestock grazing/trampling or mowing/clipping (grazing) over several years can keep emergent vegetation from completely taking over shallow portions of wetlands and can create openings in otherwise extensive stands of emergent vegetation in shallow waters (Duncan and D'Herbes 1982, Kantrud 1990, Holechek et al. 2011, Ausden et al. 2005, Jones et al. 2010). This is consistent with scientific literature on limiting grazing of sedges and other streambank vegetation in order to avoid reductions in vigor (Clary and Webster 1989, Briske 1991, Hall and Bryant 1995, Clary and Leininger 2000), with the implication that if sedges are grazed below the recommended minimum stubble heights, vigor and survival would decline. If stubble heights are short (e.g., from grazing, mowing, or clipping the previous late summer or fall) and/or leaves are trampled into the substrate in late summer or fall, being overtopped with deeper water starting in the spring and through the growing season could contribute to limiting the growth of emergent plants during the growing season (Fredrickson and Laubhan 1994); however, effectiveness may be limited on sites where spotted frogs and boreal toads lay eggs because waters likely are shallow enough that sufficient sunlight will reach the stubble to facilitate growth. Without killing or severely impacting plant vigor, livestock grazing and trampling would not create or maintain openings in emergent vegetation, except on an annual basis as explained in the "Reduction in Vegetation Height and Trampling of Vegetation" subsection, above. Creating openings by killing plants and reducing vigor has longer-lasting effects than merely reducing vegetation height, but effects may only last several years if grazing/trampling pressure is relaxed. Leopold (1933) may have been the first to write about the use of livestock grazing to reverse succession as a general principle.

A related effect is the prevention of sedges and rushes from expanding into open areas as a consequence of young plants being grazed sufficiently to kill them (Hayball and Pearce 2004).

Several papers were found that indicate openings in shallow waters can be created by moderate to severe livestock grazing/trampling. Jones et al. (2010), in their study of the effects of grazing on vegetation composition and structure in intermountain depressional wetlands, found that the cover of tall and medium-height species declined over time with increasing grazing intensity. Hayball and Pearce (2004) found that 100% clipping every 7 days during their 6-week study of young emergent plants resulted in virtually no above-ground biomass being produced, and that 50% clipping every 7 days resulted in marked reductions in the biomass of some species. Kantrud (1990) described the creation of openings in tall, dense emergent vegetation in marshes of the prairie pothole region by using prescribed burning and/or livestock grazing. His paper focused on the problems of excessively dense and tall emergent vegetation in the Prairie Pothole Region. Hogrefe et al. (2005:15) assessed that is possible for livestock grazing to "reverse or slow succession by controlling vegetation that would otherwise overtake and congest certain types of spring habitats (P. Thompson, personal communications). Properly managed grazing could potentially benefit toad habitat in this manner. However, the optimal level and frequency of grazing for most areas in Utah have not been determined." It is doubtful that "properly managed" grazing — in the way it is typically referenced — would create and maintain openings somewhat free of vegetation to allow for the sun to heat the water. Bull (2005:36) assessed that "Four breeding ponds in Wallowa were fenced to exclude cattle in 2003. In spring 2004, the vegetation had created dense mats reducing the amount of shallow water at the oviposition sites, and egg masses occurred at three of the four sites. In spring 2005, egg masses occurred at two of the four ponds. Protection from grazing reduced the open surface water used for egg laying at these oviposition sites." There is no indication that light or moderate grazing produced and maintained the openings. While the conclusion of Bull (2005) is observational and not scientifically based, it is consistent with marsh vegetation ecology. An important point is that cattle were not present until two month after eggs were laid, meaning that it was not grazing during the current breeding season that affected the amount of vegetation.

For livestock grazing/trampling to create and maintain open shallow-water conditions, grazing and trampling would be necessary during the growing season (e.g., May/June through July/August). If it occurs after the growing season, vigor of sedges and rushes may not be impacted and increased mortality would not result. This would allow sedges and rushes to grow relatively unimpeded the following spring with no apparent effect of grazing in previous years, with a result that no openings would be created and maintained by livestock grazing/trampling. Plant vigor and survival need to be impacted. It is not known whether vigor and survival of sedges and rushes would be impacted by plants being pushed totally down into the mud after the growing season. Under this scenario, the leaf portion of plants would die and photosynthesis would be eliminated many weeks before freezing, which has the potential to kill plants. No scientific literature was found to back this up.

The use of livestock for periodically reducing the extent of herbaceous vegetation in shallow-water areas on the northern, northeastern, and northwestern portions of breeding wetlands would, if implemented, need to be highly prescriptive to meet achieve desired results onin at specific wetlands while avoiding or minimizing negative impacts at these and other wetlands. General, non-prescriptive livestock grazing on allotments cannot be expected to created and/or maintain open conditions in the shallow waters of specific wetlands having extensive stands of tall, dense vegetation without having the same impacts on emergent vegetation in other wetlands that already have openings, and without having other negative impacts to other wetlands, riparian habitat, and upland habitats for spotted frogs, boreal toads, and other wildlife. This is because (1) substantial grazing/trampling pressure is needed to create unvegetated or lightly vegetated openings; (2) most wetlands on the BTNF are not in need of emergent vegetation being reduced in extent; (3) extensive stands of relatively-tall, dense emergent vegetation is a nature feature of some wetland types on the BTNF and some wildlife depend on or favor these conditions; (4) there would only be justification for treating a small proportion of wetlands in any given year; and (5) there is a large body of scientific literature (this appendix) demonstrating many negative impacts of livestock grazing/trampling at the level needed to impact emergent vegetation.

If the creation of openings in otherwise large, extensive stands of relatively-tall, dense emergent vegetation were to influence the management of livestock grazing on the BTNF, its use would by definition become a prescriptive use of livestock grazing/trampling to achieve a specific objective. It would be outside the realms of professional range and wildlife management to rely on chance for benefits to occur.

If livestock grazing/trampling were to be prescriptively used to reduce the extent of emergent vegetation for the benefit of spotted frogs and boreal toads — similar to what is done for any other vegetation management on the BTNF — the prescription would need to identify or define the following: (1) the specific wetlands where continued breeding by either species is threatened by overly dense emergent vegetation; (2) objective amount or proportion and location of openings in these wetlands; (3) the level of grazing, timing, and length of time needed to achieve the objective; (4) the number of seasons needed at this level of grazing; (5) timing that would avoid or greatly minimize trampling impacts, reductions in water quality, and accelerated water-level reductions during the reproduction period (i.e., through completion of metemorphosis phase); (6) the means to maintain herbaceous retention at suitable levels in all wetlands not in need of created openings (i.e., a large majority of wetlands in any given pasture); and (7) design features to avoid or greatly reduce negative impacts of livestock grazing/trampling on spotted frogs and boreal toads in the context of multiple stressors, and on other wildlife and other resources.

Several balancing acts would need to be performed. For livestock use to help maintain openings in shallow waters of sedge-dominated wetlands, livestock grazing use would need to be high enough for enough years in a row to kill at least a portion of sedge plants in a portion of shallow waters on northerly shores of a wetland. If livestock were to be annually used to graze and trample the current year’s annual production in a given wetland for a period of years, this would involve substantive grazing and trampling during the egg and tadpole periods (i.e., to keep vegetation in shallow water grazed/trampled), which would pose considerable risk to eggs and tadpoles (see the “Survival as Influenced by Trampling” section, above) since this use of livestock would require livestock to graze when and where eggs and tadpoles occur. It is unclear when livestock impact on sedges could be performed outside of the egg and tadpole development periods. Also, substantive grazing and trampling impacts brings with it elevated inputs of nitrate and ammonium and — in combination with greater exposure to UV radiation (via reduced vegetation), reduced uptake of nitrate by vegetation (due to reduced vegetation), and elevated levels of nitrate and ammonium from the atmosphere — increases the potential for altered behavior, deformities, and mortality (see “Water Quality” section, above).

In considering the prescriptive use of livestock to create and maintain openings in otherwise extensive stands of emergent vegetation in shallow waters, it is important to remember that most breeding wetlands on the BTNF and elsewhere provide sufficient natural openings in emergent vegetation in shallow waters. As an example, results of Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) provide at least some evidence that Yosemite toads are able to persist in wetlands having highly productive, tall, dense sedge communities with little or no grazing by livestock (e.g., ≥90-95% retention through mid-summer and ≥85-90% retention in late summer). Also, several studies have demonstrated negative effects livestock grazing, including light or moderate grazing use (Munger et al. 1996, Munger et al. 1994, Bull and Hayes 2000, Schmutzer et al. 2008, Burton et al. 2009) on spotted frogs and related frog species.

Another important consideration is that extensive stands of relatively tall, dense emergent vegetation is a natural condition and some wildlife species favor this condition over that of emergent marsh with openings.

Small Open Patches for Basking

Relatively light grazing by livestock can be used to create small openings for basking in otherwise extensive stands of tall, dense herbaceous vegetation that can provide, based on anecdotal observations of Maxell (2000), Watson et al. (2003), Bull (2005), and Shovlain et al. (2006). This requires grazing during or immediately before expected use by metamorphs, juveniles, and adults, which brings with it the risk of individuals being trampled. Much beyond 20% use of total herbaceous vegetation results in more than small patches being created (BLM et al. 2008; see also Table A.2, Figure A.8).

While small, scattered openings created by livestock grazing may be beneficial to spotted frogs and boreal toads in wetlands and meadow sites otherwise blanketed by uninterrupted stands of relatively-tall, dense herbaceous vegetation, there is no scientific information indicating this is needed as part of a conservation strategy at a landscape scale (e.g., taking into account the dynamics of wetlands and other factors under the metapopulation concept). Many wetlands in mountain meadows did not receive enough use by native ungulates to produce these conditions on a regular basis. Extensive stands of relatively tall, dense sedges in wetlands on the BTNF appear to be of relatively limited occurrence, although extensive stands of relatively tall, dense herbaceous vegetation is a common characteristic of moist and wet meadows under natural conditions.

As an example, results of Roche et al. (2012b) do not indicate that toads avoided meadows or parts of meadows with tall, dense herbaceous vegetation and, conversely, there was a general trend toward toads occupying wetter sites which tended to have high productivity of sedges and no grazing or lower levels of grazing.

Placement and Timing of Open Areas and Patches in Emergent Vegetation

Only a small minority of known breeding wetlands on the BTNF have extensive enough stands of emergent vegetation for spotted frogs and/or boreal toads to benefit from the creation or maintenance of openings in emergent vegetation through livestock grazing and trampling because most wetlands are comprised of a mix of open water and emergent vegetation and/or willows. Hundreds of cattle grazing in pastures (or allotments without pastures) measuring thousands of acres will not produce, by happenstance, suitable conditions for egg and tadpole development in these breeding wetlands, especially without having a wide range of negative effects on spotted frogs, boreal toads, and other wildlife in these breeding wetlands, other wetlands and riparian habitat, and other habitats.

This means that, if livestock grazing and trampling are going to be used to create and maintain suitable conditions for egg and tadpole development in a small number of wetlands, the use of livestock will need to be prescriptive, just like for any other vegetation treatment on National Forest System lands (e.g., mechanical treatment of forestland, noxious weed treatments). To produce desired conditions and to minimize negative impacts, mechanical treatments and logging are highly prescriptive. Desired habitat conditions — with respect to egg and tadpole development — are very specific and the potential for negative impacts of livestock grazing and trampling in wetlands is high, reinforcing the need to be highly prescriptive in any attempts to use livestock grazing and trampling to produce and maintain desired habitat conditions.

Several questions need to be answered when considering the use of livestock grazing and trampling to create and maintain openings in breeding wetlands that either currently have no natural openings in extensive stands of emergent vegetation or would lose openings in emergent vegetation without disturbance:

1. In which known existing breeding wetlands and known historic breeding wetlands (a) is relatively-tall, dense emergent vegetation currently too extensive to provide suitable egg and tadpole development sites, or (b) would expansion of relatively-tall, dense emergent vegetation eventually create a uniform carpet across all shallow waters if it were not for disturbance?
2. What are the objectives to be achieved at each of the wetlands identified under no. 1, above? This involves identifying the parts of wetlands where openings are desired (e.g., along northern shorelines), the desired size of openings, and the desired mix of open water and emergent vegetation.
3. What are the potential negative effects on spotted frogs, boreal toads, other wildlife, and other resources and uses of affected areas, and what are conservations actions that would need to be implemented to sufficiently mitigate these impacts?
4. What tools are available for producing desired conditions, and which would most effectively produce the habitat conditions sought with the least amount of negative effects on spotted frogs, boreal toads, other wildlife, and other resources?
5. If livestock are either used to meet the specific objectives or are allowed to graze in pastures/allotments containing breeding wetlands identified under no. 1, above, what is the timing, duration, and intensity of grazing/trampling that would meet the objectives while minimizing negative on other aspects of the ecology of spotted frogs, boreal toads, other wildlife, and other resources?

The following is a start of a list of potential negative effects that would need to be considered:

Spotted Frogs and Boreal Toads

- Reduced water quality due to relatively high intensity of livestock use within the wetland.
- Elevated potential for mortality of eggs, tadpoles, and/or metamorphs, depending on timing.
- Increased potential for crushing near-surface burrows, damaging streambanks, and compacting soil.
- Increased potential for accelerated decline in water.
- Reduction in emergent vegetation in wetlands in the pasture/allotment that already have natural openings or that have a larger proportion of open water or bare ground than emergent vegetation and/or willow cover.

Other Wildlife

- Increased potential for negative affecting wildlife that require or favor large stands of relatively-tall, dense emergent vegetation or meadow vegetation.
- Increased potential for negatively affecting wildlife due to reductions in water quality, mortality due to trampling, crushing of near-surface burrows, accelerated decline in water levels, and changes in habitat conditions outside of targeted wetlands.

Upshot

In the opening paragraph of this section, it was stated that “Several people during the past year have identified a need for livestock grazing for these purposes — to create and maintain open waters exposed to the sun and to create basking sites — as (1) a reason for not starting with near-100% retention as a starting point in the analysis, and (2) a reason to continue livestock grazing in boreal toad and spotted frog habitat.”

Although it is clear that livestock grazing and trampling can, depending on timing, level of use, and frequency, create and maintain open waters exposed to the sun and create basking sites, (1) no available information supports starting the analysis in this appendix with anything other than near-100% retention, and (2) these two potential benefits of livestock grazing provide no more than minor justification for continued livestock grazing. There are far more negative effects of livestock grazing use than positive effects, creation of basking sites only takes light grazing pressure, use of livestock to create and maintain open areas in otherwise dense emergent marsh — unless carefully controlled at a fine scale —has potential to cause substantially more negative effects than positive effects, and there are more cost-effective and means to create and maintain these openings with few negative impacts.

Suitable Conditions with Respect to Herbaceous Retention

The focus is on suitable herbaceous retention levels, as opposed to herbaceous vegetation height and structure, because herbaceous species composition, soil conditions, water availability, and plant vigor are the main drivers of the height and structure of herbaceous vegetation on any given site. Herbaceous species composition is addressed in a separate suitable-condition statement and water availability to plants and plant vigor are also beyond the scope of the analysis in this appendix. This appendix addresses the height, structure, and diversity of herbaceous vegetation that remains through the summer and into the fall and winter.

For each of the retention levels explored in detail below (90%, 80%, 70%, 60% and 50%), the discussion is divided into four main subdivisions:

- <u>Summary of Key Amphibian–Livestock Grazing Studies</u> — This subsection provides summaries of results of several amphibian-livestock grazing studies described earlier in the section entitled "Information on Key Amphibian-Livestock Grazing Studies Cited in this Report." In particular, cross-walks from changes in vegetation height, structure, and biomass to estimates of percent herbaceous retention are described in the quoted section.
- <u>Examination of Herbaceous Structural Attributes at ##% Retention</u>
  and
  <u>Examination of Other Factors Influenced by ##% Retention</u> — These two subsections provide detailed examinations of the suitability of each habitat and survival element (e.g., humidity retention, shading, hiding cover, invertebrate habitat, water quality, survival as affected by trampling; Figure A.17) relative to each of the retention levels assessed in detail in this appendix (90%, 80%, 70%, 60%, and 50%). A detailed examination of habitat and survival elements was carried out for several reason, including: (1) only one set of the studies summarized in the "Summary of Key Amphibian–Livestock Grazing Studies" sections applies to boreal toads (Yosemite toad–livestock grazing studies); (2) many studies on spotted frogs (Munger 1994, Munger 1996, Bull and Hayes 2000) and other frogs and toads (Schmutzer et al. 2008, Burton et al. 2009) involved relatively light grazing on average (an estimated average 20% utilization) to an estimated range from that includes light grazing (15-30% utilization of herbaceous vegetation); (3) the studies did not measure or address specific habitat and survival elements, except water quality; (4) livestock grazing, drinking, and trampling affect a large number and variety of habitat and survival elements, and the proportionate share of impacts stemming from individual elements can vary widely from area to area; (5) different studies examined different aspects of frog and toad breeding ecology; (6) none addressed non-breeding habitat and the non-breeding season; (7) results among studies differ; (8) spotted frogs and boreal

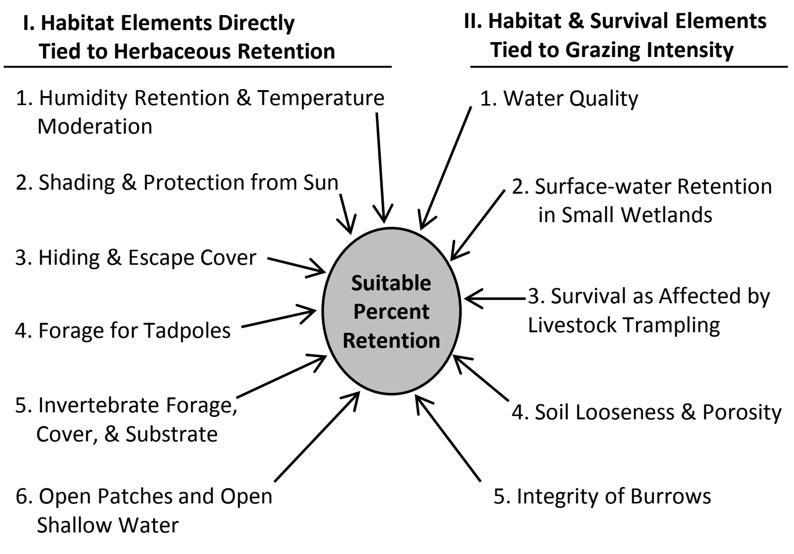

Figure A.17. Factors considered in determining suitable herbaceous retention level.

toads use a large number and variety of habitats that are not accounted for in the above studies; and (9) there is a wealth of information on individual habitat and survival elements from a large range of sources.

One of the main reasons for going into so much detail in these sections is the near lack of measurement of habitat and survival elements that could have contributed to differences in occurrence, abundance, survival, and diversity of adult and tadpole frogs and toads. Any of the 12 habitat and survival elements examined for each retention level, individually or in combination, had the potential to cause or contribute to differences detected in some of the studies.

- Confounding Variables and Implications of Livestock Grazing — This subsection was included to identify and discuss additional pertinent considerations.

This part of the appendix incorporated by reference all information outlined in all sections of the "Roles of Herbaceous Canopy/Retention and Openings" portion of the appendix, above.

INTRODUCTION AND BACKGROUND

Three important parts of the approach used in identifying a suitable range of herbaceous retention levels are as follows:

- The overriding need for identifying the lower-end threshold was to be able to accommodate at least some level of livestock grazing. Habitat needs of spotted frogs and boreal toads did not call for coarse-filter conditions (approximation of natural retention levels) to be adjusted downward. If it were not for the partial removal of herbaceous habitat through grazing and other effects correlated with grazing intensity (e.g., water quality, trampling mortality), there would be no need to identify a minimum threshold.
- The starting point for the analysis and the upper end of the suitability range was identified as near-100% retention of total herbaceous vegetation. The basis of near-100% is described below, in the "Near-100% Herbaceous Retention as a Starting Point of Assessment" subsection.
- At its most basic level, the process involved starting at near-100% retention and incrementally working downward in retention levels as scientific information demonstrated that (1) suitable herbaceous habitat would be retained at each successively lower retention level, (2) impacts to other related factors (e.g., water quality, surface water retention, survival as influence by trampling) would remain within acceptable limits at each successively lower retention level, and ultimately (3) Forest Plan Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads would still be met at each successively lower retention level.

Several principles, concepts, and pieces of natural history information, summarized below under individual subheadings, provide additional context and reasons for carrying out the process as it was carried out.

Range or Span of Consideration

One might at first think the range of consideration for deciding upon a minimum retention level is from 100% herbaceous retention down to 0% herbaceous retention. However, the actual range of consideration is roughly 50-90% or 50-95%, a range of about 40-45%. There are two reasons for this.

First, near-100% herbaceous retention comprises suitable habitat conditions for spotted frogs and boreal toads (see the "Near-100% Herbaceous Retention as a Starting Point" section, below) and by definition is within the range of consideration or comprises the upper boundary of this range. Because 50-60% herbaceous retention only maintains ≤25-33% of the herbaceous contributions to their habitat which contributes little if anything to important habitat elements for spotted frogs and boreal toads (see the "Why 50% and 60% Retention of Total Herbaceous Vegetation are Less-than-Suitable" section, below), there is no basis for considering any retention levels that are lower than this. Even at herbaceous retention levels as high as 50-60%, herbaceous contributions to spotted frog and boreal toad habitat are on average substantially lower than the conditions they inhabited prior to Euro-American settlement.

Second, the herbaceous vegetation attributes that are meaningful to small wildlife species in meadows do not gradually and consistently change as retention declines from 100% to 0% retention of total herbaceous vegetation, and this is illustrated in Figure A.14 and Table A.2. Rather, these attributes decline gradually at first until about 90% or 85%, and then they decline at a fairly rapid rate until retention levels reach about 50-60%, at which time herbaceous contributions to the habitat of small meadow wildlife species has declined to 25-33% or less and the rate of decline slows considerably (Figure A.14). The rate of decline slows further around 30% retention where herbaceous contributions to the habitat of these species are below 10%. These herbaceous contributions reach 0 between approximately 30% retention and 10% retention, although effective absence of herbaceous habitat for many small animals like spotted frogs and boreal toads occurs well before this. Information in this paragraph, as illustrated in Figure A.14, reinforces that range of consideration is roughly 50-95%.

The range of consideration (i.e., roughly 50-95%) is consistent with the characterization of retention levels in BLM et al. (2008:27). At 80-94% retention (6-20% use), it characterizes grazing use as merely "…appearance of very light grazing. The herbaceous plants may be topped or slightly used." For 60-79% retention (21-40% use) — a major transition phase — BLM et al. (2008:27) characterizes grazing use as either "…topped, skimmed…" or "…grazed in patches…" By 40-59% retention (41-60% use), grazing is characterized as "…entirely covered as uniformly as natural features and facilities will allow," which is getting close to the next category (20-39% retention, or 61-80% use): "The rangeland has the appearance of complete search."

Implications of Limited Monitoring Data

In an ideal world, population and habitat monitoring data collected on the BTNF — including data collected over time on the distribution and population levels of spotted frogs and boreal toads, herbaceous retention levels (or forage utilization rates), survival rates, livestock-use intensity at breeding wetlands — would, along with information on biologically-defensible population levels, play big roles in the identification of suitable herbaceous retention levels at and near breeding wetlands. However, this information is not available. There currently is no available data on population demographics/survival and corresponding information on retention levels and livestock grazing intensity, collected on the BTNF, that can be used to contribute to the process of identifying minimum herbaceous retention levels for spotted frogs and boreal toads.

One line of reasoning by livestock grazing proponents is that, because there is no monitoring data demonstrating that spotted frogs or boreal toads have declined in abundance on the BTNF or parts of the BTNF and because there is no data collected on the BTNF showing that livestock grazing is responsible for any possible declines, there is no reason to develop an objective for herbaceous retention that could limit utilization. Following through on this line of reasoning — e.g., by developing an objective for herbaceous retention that allows for current utilization levels — would err on the side of livestock grazing at the expense of spotted frogs and boreal toads, particularly in light of the large volume of literature demonstrating high potential for negative effects of livestock grazing.

This line of reasoning is indefensible because the absence of data showing a negative population trend has no meaning when there currently are no estimates of population trends (i.e., no data to demonstrate an downward, stable, or upward trend). It is especially indefensible given the volume of information the preponderance of information showing there to be a high probability that the distribution and abundance of spotted frogs and boreal toads have declined on the BTNF, including historic breeding sites no longer being used by these species and the large amount of scientific information showing that spotted frogs and boreal toads are negatively affected by livestock grazing where herbaceous retention levels are too low or where grazing intensity is otherwise too high (e.g., due to reduced water quality, elevated mortality due to trampling).

Also, the framework of monitoring program on the BTNF newly established by W. Estes-Zumpf (Wyoming Natural Diversity Database) and Z. Walker (WGFD), based on the USGS-ARMI approach outlined in Patla et al. (2008), will not allow population trends to be examined in relation to levels of livestock grazing. The monitoring program is a "mid-level" approach, designed by the USGS for the Amphibian Research and Monitoring Initiative, which is best for monitoring population changes of small animals across large areas (Patla et al. 2008). See text box for more detail. This approach is being used on Yellowstone National Park and Grand Teton National Park (both of which, by the way, have substantially higher funding for monitoring than the BTNF. Data collected using the "mid-level" approach is inadequate for answering questions at fine scale, for example, assessing effects of habitat changes on local populations (Patla et al. 2008). Answering these types of questions would require what they called "intensive research" at a small number of select sites. Also, determining pre-Euro-American-settlement population levels would require a large amount of funding.

> "The basic approach, guided by USGS-ARMI, is to apply statistical methods using species presence-absence data to estimate the proportion of sampling units (catchments and sites) occupied by each amphibian species. Sampling and analysis were designed to provide inference about amphibian status and trends (Corn et al. 2005a). The decision to use presence-absence data, rather than population estimates, was based on both practical and biological reasons. Practically speaking, population estimates are difficult, expensive, and nearly impossible to apply with acceptable accuracy to small animals over large areas. Biologically, the highly variable nature of amphibian populations results in large yearly fluctuations, resulting in low power to detect change (Corn et al. 2005a). Occupancy, as an alternative to estimating abundance, has a long history of use in wildlife studies. It can reveal changes in species status over large areas and is thought to be appropriate for species with wide, short-term population fluctuations (Bailey and Adams 2005)." (Patla et al. 2008; see this publication for citations)

The central question that drives the development of objectives and desired condition statements where habitat can be affected by livestock grazing is as follows, and the reality is there currently just is not any monitoring data on the BTNF that can help answer this question:

> *What constitutes suitable conditions for the habitat elements affected by livestock grazing, and how much suitable habitat needs to be provided to meet Forest Plan Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and higher-level directives with respect to spotted frogs and boreal toads?*

Why Percent Retention is the Subject of Suitable Conditions and not Height, Biomass, and Structural Density

There is a wide range of reasons for using minimum percent retention of herbaceous vegetation — rather than using minimum stubble height or minimum Robel pole measures — including those that follow.

1. The use of percent retention is a simple approach that both provides for a certain proportion of herbaceous attributes meaningful to wildlife to be maintained through the summer into the fall each year and consistently provides forage for livestock every year. Impacts are shared between livestock and wildlife/watershed resources each year, rather than having livestock or wildlife/watershed resources being heavily impacted in a series of years and then having the opposite occur in another series of years, which could happen using a minimum stubble height or Robel pole reading. As an example of the last item, minimum herbaceous needs of wildlife in terms of absolute height, biomass, and structural density — if this could be determined — could very well result in little or no grazing in years of below-average precipitation.
2. Herbaceous height is considerably less of a habitat issue for spotted frogs and boreal toads in most situations in areas grazed by livestock than the amount of canopy cover that remains intact or relatively intact, so long as the height of the bulk of plant material (e.g., tuft height) is sufficiently tall. This is because livestock do not incrementally graze down the height of vegetation, but rather typically take bites at roughly 1-4 inches above the ground, which creates two very different height categories (e.g., 1-4 inches and 12-18 inches). Average height in these cases is not biologically meaningful.
3. Minimum absolute measures (e.g., stubble height, Robel pole readings) would not allow a minimum herbaceous retention level to be used as a proxy for suitable conditions of other habitat and survival elements that are correlated with grazing intensity such as water quality, surface water retention in small pools, survival as affected by trampling, soil looseness, and maintenance of shallow burrows. One

implication is that additional monitoring may be needed to address each of these elements, or livestock grazing use would not be managed to address these crucial elements.

In some cases, negative effects of reductions in vegetation height/density occurred when vegetation height or Robel pole readings remained relatively high. (Only a few studies identified enough information on vegetation height / Robel pole readings to make this comparison.) In Schmutzer et al. (2008), reductions from about 29 inches and 34 inches to about 17 inches and 24 inches, respectively, corresponded with significant reductions in water quality, tadpole diversity, and frog diversity. In Foote and Rice Hornung (2005), reductions in Robel pole readings from about 20 inches and 24 inches to about 7, 8, 9, and 11 inches significantly reduced dragonfly and damselfly species richness and abundance. When Robel pole readings dropped below about 16 inches, species richness and abundance of dragonflies and damsel flies began dropping fairly rapidly. Similar reductions in vegetation in a previous study resulted in significant reductions in water quality (Hornung and Rice 2003).

Similar results were obtained in two sets of studies in which the evidence of grazing activity at each inventoried pond was rated as none, slight, moderate, or extensive. In one study, grazed ponds with slight or greater evidence of grazing activity were significantly less likely to be occupied by spotted frogs than ponds with no grazing (Munger et al. 1994) and a subsequent study found similar patterns without significant effects (Munger et al. 1996). Although statistically significant, 42% more tadpoles successfully metamorphosed in ungrazed ponds than ponds with an average of just over slight evidence of grazing activity (Bull and Hayes (2000). In both cases, slight evidence of grazing activity likely corresponds to roughly 80% retention of total herbaceous vegetation, which translates into a relatively small reduction in vegetation height and Robel pole readings.

4. Variability in herbaceous height and canopy cover is high among plant community types and within individual plant community types from site to site and from year to year, which increases the complexity of formulating meaningful figures that apply across plant community types and even within types.
5. Whether a minimum suitable height meets habitat needs of spotted frogs and boreal toads depends on the structure of the vegetation, post grazing. As an example, an original ungrazed height of, say, 6 inches would perform some canopy functions due to grass leaves forming a canopy, while a grazed height of 6 inches on a site with an ungrazed height of, say, 18 inches may perform few canopy functions since remnant vegetation would primarily be stalks or basal material with less plant material off to the sides of the base. (These figures do not include height of seedheads.)
6. There is less information available to identify biologically meaningful minimum stubble heights or Robel pole readings (i.e., that would provide for the habitat needs of frogs and toads) than is available to identify minimum retention levels, and this would take considerable time to gather and synthesize.
7. A minimum percent retention rather than a minimum stubble height or Robel pole reading would better take into account habitat-selection of individual spotted frogs and boreal toads in individual situations. A minimum retention level would A minimum stubble height could potentially drastically change the vegetation structure whereas a minimum percent retention level would preserve a moderate to moderately large portion of the structural attributes of the community.
8. Objective 4.7(d) requires an adequate amount of suitable forage and cover to be retained for all wildlife, not just sensitive species and management indicator species, and ascertaining minimum heights and/or densities for this range of wildlife species for each plant community would be very difficult, especially given the wide range of natural variability within plant communities, variability in the degree to which communities have been impacted, and differing precipitation levels. Developing minimum thresholds based on absolute measures (e.g., stubble height, Robel pole) for frogs and toads sets the stage for doing the same for other individual species or groups of species. It is more straightforward to identify minimum thresholds for a wide range of wildlife species based on percentages than it is to identify minimum thresholds based on absolute measures, as can be seen in DeLong (2009b).

Percentages are good equalizer among a range of different factors, including between wildlife and livestock (in terms of appropriations), among wildlife species, among different plant communities of varying heights and structural density, and among years of different precipitation levels.

Herbaceous Species Composition

Herbaceous species composition is a central issue for herbaceous retention, mostly because herbaceous species composition drives the height and structure of herbaceous communities and understories. The analysis and resultant statement of suitable conditions in this appendix assumed healthy, functioning plant communities, including a natural composition of herbaceous species or mix of species that closely resembles the height and structural density of the natural plant community. For spotted frogs and boreal toads, the exact plant species composition does not matter nearly as much as plant species compositions that produce the height and structure of the natural community for that site and that represent natural hydrologic conditions.

Herbaceous species composition for wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities is characterized in the "Herbaceous Species Composition for and Rangelands" section on the main report.

Where a substantial proportion of the acreage of wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities (e.g., ≥1/3 of the acreage of any of these types) have either been converted to domination by nonnative bluegrasses, redtop, or smooth brome or have reduced canopy cover (e.g., altered species composition/drying of wet meadows; e.g., see Youngblood et al. 1985, Padgett et al. 1989), it is all the more important to maintain suitable retention levels of herbaceous vegetation in each of the remaining relatively-natural communities. Another implication of herbaceous species compositions to retention is that altered hydrology has in some places converted wet meadow communities to moist meadow communities, many times with high composition of nonnative bluegrasses, redtop, or smooth brome. This many times results in a "triple whamy." First, the vegetation height, density, and diversity typically are greatly reduced. Second, reduced vigor of nonnative bluegrasses, due to heavy utilization, further reduces the height and density of vegetation. Third, grazing in any given season compounds these effects by further reducing vegetation height (many times to a large degree) for the remainder of the season, which effectively reduces or eliminates plant species diversity for the remainder of the season.

Near-100% Herbaceous Retention as a Starting Point of Assessment

A key purpose of this analysis was to identify a lower limit or threshold of suitable herbaceous retention, especially in livestock allotments. The basic approach was to start with near-100%[G] retention and incrementally work down through progressively lower retention levels and determine if there was sufficient information to demonstrate the needs of spotted frogs and boreal toads would be met and that they would be sufficiently protected against harm (e.g., from reduced water quality, accelerated decline in surface water, trampling). Then, at the herbaceous retention level where sufficient information did not demonstrate their needs would be sufficiently met or they would not be sufficiently protected from harm, then the next highest retention category would comprise the lower limit to habitat suitability with respect to retention of herbaceous vegetation and related habitat and survival elements.

No basis was found in law, regulation, or policy for starting assessments with existing conditions and then having to demonstrate with scientific research and scientific information that either (1) existing conditions led to population reductions of spotted frogs and boreal toads before deeming existing conditions not suitable, or (2) existing conditions do not adequately provide for the needs of spotted frogs and boreal toads, with the implication that existing conditions would be identified as suitable if these could not be demonstrated.

All assessments began with near-100% retention for reasons outlined in the next four subsections.

[G] "Near-100%" is used because 100% retention is an impossibility given the numerous invertebrate, small mammal, and larger herbivores. Near-100% is used to reflect conditions largely ungrazed by large herbivores.

1. There is an Affirmative Requirement to Protect Sensitive Species and Provide Suitable Conditions for Them, and there are No Requirements to Manage for Existing Conditions Unless Population Impacts are Proven

Management direction for sensitive species is written in the affirmative, specifically requiring sensitive species to be protected and for suitable habitat to be provided. Forest Plan Objective 3.3(a) calls for sensitive species to be protected and for suitable conditions to be provided for sensitive species, and Objective 4.47(d) requires that an adequate amount of suitable forage and cover be retained for sensitive species and other wildlife. The Sensitive Species Management Standard requires crucial habitats of sensitive species list to be protected and maintained. A responsibility of Forester Supervisors and District Rangers is to "…ensure compliance with procedural and <u>biological requirements</u> for sensitive species" (FSM 2670.45.1, FSM 2670.46.1), emphasis added. "The broad objective of habitat planning and evaluation is <u>to provide habitats to meet</u> goals and objectives for wildlife and fish, including endangered, threatened, and sensitive animal and plant species set forth in land and resource management plans" (FSM 2620.2), emphasis added. Also, one objective of habitat planning on National Forest System lands is to "Provide a sound base of information to support management decision-making affecting wildlife and fish, including endangered, threatened, and sensitive animal and plant species, and their habitats" (FSM 2620.2.2).

Management direction for sensitive species does not, in contrast, call for conditions maintained by current management to be maintained until or unless it can be demonstrated that these conditions have caused or are causing population reductions. Doing so on livestock grazing allotments would place the burden of proof on biologists to demonstrate that populations are being negatively affected before the agency would be able to define suitable conditions or develop objectives that do not encompass existing conditions. Particularly given the current limited amount of data or lack of data on spotted frogs and boreal toads, this would result in the agency erring on the side of current livestock grazing management and at the potential detriment of sensitive species that are affected by livestock grazing use.

An important implication for defining suitable conditions and developing objectives for individual sensitive species is that biologists must be able to affirmatively demonstrate that identified suitable conditions will adequately meet the needs of these species. Where conditions are known to meet their needs (e.g., the conditions under which they existed prior to Euro-American settlement, including absence of artificial mortality factors, absence of artificial habitat fragmentation, absence of introduced diseases, and absence of human-induced climate change and increases in UV-B radiation), biologists must be able to affirmatively demonstrate that movement away these conditions will still provide suitable habitat conditions and adequately protect sensitive species (see the "Where does Burden of Proof Rest?" section of the main report). It is not sufficient to define suitable conditions based on the presumption that, because there is no monitoring data showing that a given sensitive-wildlife population has been negatively affected by current management, existing conditions fall within the range of habitat suitability, particularly when sufficient monitoring data does not exist to address this topic. As Carl Sagan (Astronomer) aptly observed, "the absence of evidence is not the evidence of absence." Therefore, for the conditions produced by current management (including direct mortality factors like crushing by livestock) need to be demonstrated to be within the range of suitability before they can be deemed suitable.

There are no requirements for the agency to have to prove that current management is causing population declines or having some other substantive negative impacts on a species before defining suitable conditions that do not encompass existing conditions. Imposing this type of requirement would conflict with Forest Service management direction for conserving sensitive species and this is not a component of wildlife management planning procedures (Crowe 1992, Adamcik et al. 2004).

2. Impetus for Identifying a Low-End Retention Threshold was to Accommodate Livestock Use

The only reason for identifying a minimum herbaceous retention threshold that is lower than what naturally occurred in is to accommodate livestock grazing. If it were not for livestock grazing, there would be no need to establish a minimum herbaceous retention level in an objective or desired condition statement for spotted frogs and boreal toads. As such, a major focus of the analysis outlined in this appendix was to start with conditions reflective of the conditions under which spotted frog and boreal toad habitat existed on the BTNF prior to Euro-American settlement (see reason no. '2', below), and then progressively assess lower retention levels (that would increasingly accommodate livestock grazing) until it can no longer be demonstrated that Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and higher-level policies can be achieved with respect to spotted frogs and boreal toads.

If we strictly adhered to the coarse-filter / fine-filter approach in setting objectives for spotted frogs and boreal toads (i.e., only making adjustments to the estimated natural conditions to better accommodate the needs of spotted frogs and boreal toads), it would not be possible to provide opportunities for livestock grazing except possibly in a small number of isolated instances. To provide for livestock grazing, estimated natural conditions needed to be adjusted while at the same time ensuring that suitable conditions are still met for these species.

Restated, the lower threshold identified in suitable condition statement for herbaceous retention, later in this report, in no way reflects the lower limit that would be established if it were not for the need to accommodate livestock grazing. The lowering of the threshold below what existed under natural conditions was not driven by the needs of the species, as this lower level will result in diminished habitat conditions and survival rates relative to higher retention levels. This is particularly true given the degraded conditions of a fairly large portion of the moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities on the BTNF.

To be clear, however, livestock grazing is a legitimate use of the BTNF, as it is one of the uses of National Forest System lands identified in the Multiple-Use Sustained Yield Act, and the Forest Plan for the BTNF calls for up to 260,000 AUMs per year (Objective 1.1(h)). Because livestock grazing plays no more than a small role in approximating natural conditions in most of the BTNF's wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities, the step of determining how far down retention levels can be taken

An overriding question in this analysis was "how far down can the retention level be taken to accommodate livestock grazing while still providing suitable habitat conditions?" The following paragraphs summarize several adjustments that were made.

For the purposes of this report, a minimum retention level of 70% constitutes adjusted coarse-filter conditions because the amphibian community in this area appear to have developed with higher retention levels in most wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and willow-meadow communities, and because 70% retention in these habitats results in a reduction in habitat quality and possibly reduced survival for spotted frogs and boreal toads, compared to higher retention levels. Reduced habitat conditions and survival are primarily due to a major reduction in the herbaceous canopy and effects of livestock walking/running at the associated level of use. A minimum of 70% retention, however, was settled upon based on the analysis in this appendix because it would still retain suitable habitat conditions so long as substantive areas have higher retention levels, as discussed previously. Also, 70% herbaceous retention provides for a level of grazing that is within the scope of contemporary range management (Figure A.2; Vallentine 1990, Heady and Child 1994, Holechek et al. 2011), meaning that 70% herbaceous retention should be workable from the livestock grazing standpoint. Roughly speaking, 70% retention translates to approximately 35-45% utilization of key forage species in many plant communities, but less so where key forage species comprise a high proportion of the total herbaceous species composition, for example in sedge communities (Appendix B). Where problems are irreconcilable with herding and other methods, fencing can be used.

Another adjustment was that a minimum of 70% retention only applies to 80% of the area, meaning that retention of total herbaceous vegetation can dip below 70% on as much as 80% of a breeding site (Objective B.1) and within 1/3 mile of a breeding site (Objective B.2). This adjustment was made in recognition that some overuse happens in commercial livestock grazing programs.

However, even with the addition of the 80% criteria, riparian areas and meadows with extensive acreages dominated by nonnative bluegrasses will make it difficult to meet the minimum 70% retention on 80% of each vegetation category. Retention levels as low as 50% (key forage species) may need to be accommodated within 1/3 mile of breeding sites in parts of moist meadow, silver sagebrush, shrubby cinquefoil, and/or willow-meadow communities that are dominated by nonnative bluegrasses and/or smooth brome (i.e., the percent canopy cover of this group of species is ≥50% of the total herbaceous canopy cover) may need to be accommodated for several reasons:

- Cattle are attracted to sites with heavy components of Kentucky bluegrass, bulbous bluegrass, Canada bluegrass, and other bluegrasses and there is a high propensity of cattle to make high use of these areas given the favorability of the forage (Youngblood et al. 1985), and requiring retention of ≥70% could place an unworkable restriction into the objective with respect to meeting requirements for providing for livestock grazing use. Cattle typically graze these sites before grazing other plant communities.
- It is critical, from the standpoint of spotted frogs and boreal toads, that herbaceous layers dominated by nonnative bluegrass and/or smooth brome do not increase in size or distribution, and it is important that the existing distribution and size of herbaceous layers dominated by nonnative bluegrasses or smooth brome declines to the greatest extent possible. The focus of management should be on preventing increases in the acreage and distribution of sites dominated by nonnative bluegrasses and, to the extent possible, increasing the composition of more desirable plant species within areas dominated by nonnative bluegrasses. This requires limiting grazing pressure to a level that allows native and other desirable species within and around these sites to maintain plant vigor and, on sites where vigor is depressed, to restore vigor. Some range experts have identified a maximum 50% as the threshold for allowing adequate plant vigor (Heady and Child 1994). A study by Crider (1955) showed that defoliation of individual Kentucky bluegrass plants at ≤50% allows these plants to remain vigorous, but that defoliation levels of ≥60% result in reductions in root mass, and this study only involved one defoliation event per plant. In some allotments, multiple defoliations currently occur between mid June and mid October. These results have been extrapolated in range management to other grass species. However, because Kentucky bluegrass is more tolerant of grazing than many other graminoid species (e.g., slender wheatgrass, Columbia needlegrass, Nebraska sedge, tufted hairgrass, and Idaho fescue), 50% utilization represents an absolute upper end. As an example, data presented in Heady (1950) shows that vigor and health of bluebunch wheatgrass declined when plants were grazed at utilization levels higher than approximately 40% during the growing season (stubble heights were converted to percent utilization levels based weight and height data presented in his paper). Fifty percent utilization corresponded to an average of about 6 inches in Heady's (1950) study, and he concluded that a minimum stubble height of 6 inches was not sufficient to prevent deterioration of plants.

  Furthermore, research by Crider (1955) was done on individual plants. Applying a maximum 50% utilization to a plant community allows a majority of plants to be grazed at more than 50%. This all means that great care needs to be taken to limit utilization on these sites to 50%, as an absolute maximum.
- In the absence of adequate control over grazing use in areas dominated by nonnative bluegrasses, this can perpetuate low vigor of nonnative bluegrasses and native species, lead to overgrazing of adjoining plant communities, excessive grazing of streambanks, and excessive browsing of willows.

3. Coarse-Filter or Natural Conditions

Natural conditions do not equate to ungrazed conditions, but most wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities across the B TNF received little grazing prior to Euro-American settlement, and these are part of the conditions under which the native amphibian-community formed in this area. Even today with high elk populations, it is difficult to detect grazing activity on a large majority of the acreage of these types prior to the onset of livestock grazing on a year-to-year basis. Elk are at consistently higher numbers today than they were prior to Euro-American settlement, which means there is potentially higher grazing pressure today than under natural conditions. On the other hand, bison are no longer present on most of the lands they once roamed. While grazing pressure was likely high in some low elevation meadows, bison likely only sporadically grazed these areas and not every year.

Natural conditions is addressed under the larger heading of "Near-100% Herbaceous Retention as a Starting Point" because natural conditions in moist and wet meadows, across the BTNF, is much closer to ungrazed conditions than to heavily grazed conditions in these meadows, and because it provides an important reason for starting at ungrazed conditions in the determination of suitable retention levels.

There are several reasons why natural conditions (e.g., natural range of variability) provide a logical and defensible starting point for identifying suitable conditions for spotted frogs and boreal toads. Some of these are outlined below.

Reasons why Natural Conditions are with the Range of Suitable Conditions

The conditions under which the composition of the amphibian community developed are clearly sufficient to maintain populations of spotted frogs and boreal toads. Else, these species would not have existed in the BTNF area when Euro-Americans settled here. The composition of an amphibian community involves two things: the number/identity of species and the relative abundance of each. At a minimum, spotted frogs, boreal toads, chorus frogs, leopard frogs, and tiger salamanders existed within what is now the BTNF (Patla 2001). Habitat conditions (summarized in the main body of the report) were sufficient for spotted frogs, boreal toads, chorus frogs, and tiger salamanders to be well distributed and relatively common, whereas leopard frogs may have been relatively uncommon given the elevations of the BTNF. Because the species composition of the amphibian community of the BTNF area developed or formed under conditions that existed prior to Euro-American settlement and because the Forest Service cannot be expected to manage for population levels of any wildlife species above the natural capacity of the land to support, the onus is on proponents of any approach other than using natural conditions as a starting point for defining suitable habitat conditions.

A fundamental principle of conserving biological diversity is based on the principle that, as stated in the 2012 Planning Rule, "…native species evolved and adapted within the limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Maintaining or restoring the ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area…" (USDA 2012:21212). Haufler (1999:24) stated this very similarly: "…the native species of a region adapted to and occurred within the historical range of ecosystem conditions, and that by maintaining ecosystems within this range, the needs of all species will be met (Risbrudt 1992, Morgan et al. 1994)." Applet and Keeton (1999) made a very similar assessment, and it is supported by principles of conservation biology (Noss and Cooperider 1994, Hunter 1996). The Planning Rule went on to explain the intent of taking a coarse-filter/fine-filter approach "…is to keep common native species common, contribute to the recovery of threatened and endangered species, conserve candidate species, and protect species of conservation concern." The coarse-filter, fine-filter approach was described in more detail by Haufler (1999a) and Haufler (1999b). A coarse-filter approach technically involves the approximation of the height, structural-density, and biomass of herbaceous vegetation under which native wildlife-communities (including amphibian communities) developed or evolved in a given area. The coarse-filter approach is discussed further in the following subsection, "Managing Sensitive Amphibians as Part of the Native Wildlife-Community."

A related principle is that of the historical (or, natural) range of variability and reference conditions. Key premises' of this principle are that ecological conditions change over time as they are affected naturally by various disturbance processes, and that as people alter disturbance patterns (e.g., logging, fire suppression, livestock grazing), ecological conditions change, sometimes outside the range of variability that occurred under natural disturbance processes (Aplet and Keeton 1999, Haufler 1999b). As explained by Aplet and Keeton (1999:73), the historical range of variability "…describes the bounded behavior of ecosystems prior to the dramatic changes in state factors that accompanied the settlement of North America… For several thousand years prior to colonization, topographic relief and parent material remained relatively constant. Climate fluctuated but narrowly, relative to the Quaternary or even the entire Holecene (Johnson et al. 1994; Woolfenden 1996)." They continued by addressing effects of indigenous people which they assessed were relatively consistent across landscapes over several thousand years, and they closed with "…Resulting ecosystems were likewise bounded in their behavior; they maintained characteristic species composition, pattern, and behavior" over the several thousand years prior to Euro-American settlement. The assumption behind the use of historic range of variability, Aplet and Keeton (1999) said, is that restoring and maintaining ecological conditions within ranges that organisms have adapted to over evolutionary time is the management approach most likely to produce sustainable ecosystems. Stoddard et al. (2006) defined four aspects of reference conditions: historical condition, least disturbed condition, minimally disturbed condition, and best attainable condition. For historic conditions, Stoddard et al. (2006:1270) stated that " 'reference condition is a state in the present or in the past corresponding to very low pressure, without the effects of major industrialization, urbanization and intensification of agriculture, and with only very minor modification of physicochemistry, hydromorphology and biology' (Wallin et al. 2003:36)." Pollock et al. (2012) discussed reference conditions similarly.

Managing Sensitive Amphibian Species as Part of the Native Wildlife-Community

Although the development of suitable conditions for sensitive species has taken a species-by-species or single-species approach, management eventually needs to synthesize the suitable conditions for all sensitive and non-sensitive wildlife species, and requirements for other resources and activities in order to manage any given piece of land. From the standpoint of wildlife, the 2012 Planning Rule outlines a process to accomplish through the use of a coarse-filter/fine-filter approach (see the "Approach for Developing Suitable Condition Statements" section of the main report for more information).

Given the large number of wildlife species (and large number of other resources and activities) the Forest Service is responsible for managing and conserving, it is not possible to individually or independently manage for the needs of individual wildlife species, except possibly to make adjustments addressing a small number of specific needs for a very small number of wildlife species. The only realistic way to sustain the full complement of native wildlife species in native wildlife-communities, including amphibian communities, on a given landscape over the long term is to approximate habitat conditions under which native wildlife-communities formed or evolved on that landscape (Diamond 1981, Reid and Miller 1989, Keystone 1991, Noss and Cooperider 1994, Hunter 1996, Hughes et al. 2000, Cooperrider 2002, Samways 2005). This is reinforced by and is a central tenant of the "coarse-filter approach" outlined in Section 43 of WO FSH Amendment 1909.12-2006-5 and as explained in more detail in the 2012 Planning Rule. There are far too many species (many with specific habitat needs) and unknowns to attempt to manage for the needs of each individual species or group of species if the ultimate goal is to maintain populations of all native species. It is well recognized that our understanding of habitat needs and wildlife-habitat relationships is incomplete (Peek 1986, Hunter 1996, Samways 2005). Given the large number of unknowns, combined with our knowledge of the sometimes strong dependencies between specific plant and animal species, symbiotic relationships, food webs, and other ecological relationships (Leopold 1939, Krebs 1978, Ricklefs 1979, National Research Council 2007), the concept of keeping all the parts is sound.

One implication of this is that objectives for one species or small group of species should not be developed in isolation or independent of objectives for the entire compliment of native wildlife species. If a situation dictates that objectives must be developed independently, they need to be developed in the context of the whole.

The coarse-filter approach of the 2012 Planning Rule is described in the *Federal Register* as follows: "…The premise behind the proposed coarse-filter approach [in section 219.9] is that native species evolved and adapted within the limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Maintaining or restoring the ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area…" (USDA 2012:21212).

The majority of wildlife species associated with wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities on the BTNF favor or depend on species-diverse, moderately-tall to tall, dense herbaceous vegetation (e.g., Brown 1967, Wheelwright and Rising 1993, Edge et al. 1995, Fagerstone and Ramey 1996, Batzli et al. 1999, Wyo. Partners in Flight 2003, Foote and Hornung 2005, Samways 2005, Slater 2005, DeLong 2009b, Orabona et al. 2009, DeLong 2012). It is widely accepted that moderate and larger alterations to the structure of forestlands impact wildlife diversity, and it should not be surprising that the same is true of meadow habitat (Appendix C). Only 4 small mammal species on the BTNF are associated with or favor short or sparse herbaceous vegetation in contrast with 13 species of small mammal species that are associated with or favor tall, dense or moderate-height, moderately-dense herbaceous cover (Zeveloff and Collett 1988, Fagerstone and Ramey 1996, Cerovsky et al. 2004). Missing on the BTNF are at least four groups of small mammal species associated with short and/or sparse vegetation that exist within 100 miles of the BTNF.

Microtine voles (meadow, montane, long-tailed, water, and western heather voles on the BTNF) are particularly dependent on tall, dense herbaceous vegetation (Brown 1967, Medin and Clary 1990, Fagerstone and Ramey

1996, Batzli et al. 1999) and they likely are the most important food source for a range of predatory species like long-tailed weasels, short-tailed weasels, Swainson's hawks, long-eared owls, short-eared owls, and great gray owls (Zeveloff 1988, DeGraff et al. 1991, Duncan and Hayward 1994, England et al. 1997, Slater 2005). As pointed out ninety years ago, "More than any group of small mammals, meadow mice [microtine voles] hold the key to balance of natural adjustment for a large portion of our native bird and mammal population…" (Bailey 1924:534, as cited in Johnson and Johnson 1982:34). Microtine voles appear to be good indicators of moist meadow habitat conditions. Eighty percent herbaceous retention appears to be the lower threshold of suitability for microtine voles (DeLong 2012). Other species that depend on or favor relatively-tall, dense herbaceous vegetation in wet meadows, moist meadows, meadow-willow, silver sagebrush, and shrubby cinquefoil communities include, as examples, western jumping mice, masked shrew, water shrew, vagrant shrew, dusky shrew, northern harriers, several waterfowl species, soras, short-eared owls, western meadowlark, savannah sparrow; in willow communities, several species require or favor herbaceous vegetation, including several species of shrews, white-crowned sparrows, and fox sparrows (DeLong 2009b). The diversity of native invertebrate-communities begins declining when retention levels decline below roughly 80% (see the "Forage, Cover, and Substrate for Invertebrate Prey" section for citations).

There is moderate evidence[H] that 70% retention of herbaceous vegetation would be sufficient to minimally provide for the needs of native wildlife-communities associated with wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities, recognizing that species requiring or favoring tall, dense herbaceous vegetation (e.g., microtine voles, northern harriers, soras) may be absent or at relatively low densities at this retention level (DeLong 2009b, DeLong 2012). Available information indicates that forage conditions would be suitable for mule deer and elk at 70% retention of herbaceous vegetation, possibly suitable for elk at 60% retention, but not suitable for mule deer at 60% retention (DeLong 2009b), based on WAFWA (2007), Wisdom and Thomas (1996), and other sources. There is a low amount of evidence that 60% retention of herbaceous vegetation would be sufficient to minimally provide for the needs of native wildlife-communities that need herbaceous vegetation, directly or indirectly, in wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities.

Therefore, the 70-100% retention of herbaceous vegetation as a suitable condition for spotted frogs and boreal toads (including the recognition that areas of ≥80% retention are needed) is consistent with maintaining suitable habitat conditions for the range of wildlife species associated with wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities, recognizing that some species (e.g., microtine voles, a large variety of invertebrates associated with tall, dense herbaceous vegetation conditions) require or favor higher levels of retention than 70%.

This is not to say there are no wildlife species that favor or require short-stature herbaceous vegetation in wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities on the BTNF, as there are several that do (e.g., Richardson's ground squirrel, killdeer) and there are several generalist species that can use a range of height/structural conditions (e.g., deer mouse, mountain bluebird, American robin) with some of these favoring short-stature conditions. However, these species did not, prior to the onset of livestock grazing in the area now encompassed by the BTNF, have substantial amounts of suitable habitat in wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities. Species like deer mice, mountain bluebirds, and robins primarily used and continue to use other vegetation types, and species like mountain bluebirds and robins only used wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities as suitable conditions became available.

What are the Natural Conditions (Conditions Under Which the Amphibian Community Formed)?

There were wetlands, moist meadows, and silver sagebrush communities that likely received fairly high grazing and trampling pressure, at times, by native ungulates prior to Euro-American settlement (e.g., resulting in 40-50% retention or possibly lower). However, there were likely far more acres of wetlands, moist meadows, and silver sagebrush communities on which retention would have visually appeared to be 95-100% through the summer period, with a likely average of ≥90% in most years. Even now in areas inhabited by elk, many moist meadow and

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[H] moderate to high evidence for 70-79% retention.

silver sagebrush communities are in the <5% utilization category of the landscape appearance method (BLM et al. 2008) just prior to the onset of the livestock grazing season. Therefore, even though some spotted frog and boreal toad habitat likely periodically had low retention levels prior to Euro-American settlement, amphibian communities formed under relatively high herbaceous retention levels, on average, across what is now the BTNF.

A snapshot of species associated with meadows reinforces that meadows provided relatively tall, dense herbaceous habitat prior to Euro-American settlement. The majority of wildlife species associated with wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and willow-meadow communities on the BTNF favor or depend on diverse, moderately-tall to tall, dense herbaceous vegetation (e.g., Brown 1967, Wheelwright and Rising 1993, Edge et al. 1995, Fagerstone and Ramey 1996, Batzli et al. 1999, Wyo. Partners in Flight 2003, Foote and Hornung 2005, Samways 2005, Slater 2005, DeLong 2009b, Orabona et al. 2009), and only a small number (e.g., Uinta ground squirrel). Also, in looking at all meadow and rangeland small mammals, only 4 small mammal species on the BTNF are associated with short or sparse herbaceous vegetation in contrast with 13 species of small mammal species associated with or favor tall, dense or moderate-height, moderately-dense herbaceous cover (Zeveloff and Collett 1988, Fagerstone and Ramey 1996, Cerovsky et al. 2004). The Uinta ground squirrel is only of these species, but this group of 4 also includes white-tailed prairie dogs, thirteen-lined ground squirrels, least chipmunks[I], although it is not clear whether white-tailed prairie dogs and thirteen-lined ground squirrels exist on the BTNF. Missing from the BTNF are at least four groups of small mammals species associated with short and/or sparse vegetation that exist within 100 miles of the BTNF.

Grazing by Native Ungulates

Grazing by native ungulates in most breeding wetlands, summering wetlands, riparian areas, and other summer and migration habitat on the BTNF likely is not substantively different now than what it was prior to Euro-American settlement, except in some localized areas. Four differences in native-ungulate grazing intensities are as follows:

- *Parts of the BTNF likely were intermittently or sporadically grazed by bison; e.g., low elevation wide valley bottoms with substantive grass resources.*

  Bison were thought to be scarce to uncommon in the intermountain West when Europeans began exploring the area (Mack and Thompson 1982, Burkhardt 1996).

  There would appear to have been three ways that bison used lands that are now within the BTNF:

  1. As extensions of shrub steppe habitat — There are two different viewpoints on the prevalence of bison in shrub steppe habitat of the intermountain West. Mack and Thompson (1982) argued that bison were rare in most parts of the intermountain West, and Burkhardt (1996) argued that bison were common in shrub steppe landscapes across the intermountain West prior to American Indians acquiring horses and rifles. Both sets of authors cited supporting scientific information, and both addressed occurrence of bison in shrub steppe habitat in the intermountain West.

     Either way, only a minor portion of the BTNF consists of the sagebrush shrub steppe, and the sagebrush shrub steppe that is included in the BTNF is at the very edges of vast shrub steppe landscapes. This occurs along the lower elevations of the Pinedale, Big Piney, and Kemmerer Ranger Districts (upper Green River basin deserts), and some of the low elevation big sagebrush habitat on the Greys River Ranger District is near the Snake River Plain.

  2. Use of valley bottoms — Mack and Thompson (1982) and Burkhardt (1996) provided no more than a small amount of evidence that bison inhabited mountainous areas and valleys. Mack and Thompson (1982:758) pointed out that bison "…were seen repeatedly in the Upper Snake River Plain until mid-nineteenth century (Schroedl 1973; Butler 1978)." Bison were known to inhabit Star Valley, possibly at relatively high numbers at times, as observed by trapper Osborn Russell during the late 1830s (Haines 1965). Star Valley is a large wide valley historically dominated by mountain big sagebrush

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[I] Golden-mantled ground squirrels and Uinta chipmunks were not included even though they favor areas of low amounts of herbaceous vegetation because they are associated with forested/treed areas.

that is very near and connected to the Upper Snake River Plain. Lubinski (2000) concluded that bison were either fairly common in the Green River Basin of Wyoming (covering an area from northern Utah and Colorado north to the upper Green River watershed on what is now the BTNF) or bison remains were transported from other hunting areas. None of the archeological sites covered in Lubinski (2000) appear to have been on the BTNF, and BTNF lands occur only on the edge of the study area. Cannon (2001) concluded that bison may have been prevalent on the Yellowstone Plateau and that they inhabited Jackson Hole.

Therefore, there is little evidence that more than small numbers of bison ventured beyond the shrub steppe and wide valley bottoms into mountainous areas that dominate the BTNF. For the small numbers of bison known to have at least occasionally visited some of the larger valleys of the BTNF, it is not clear whether these were dispersing individuals or small groups, exploratory movements, nomadic movements, or possibly even regular movements. Gates et al. (2005) provides a literature review of different types of movements documented for bison. As one example, while Russell reported seeing bison and other large herbivores in Star Valley when he traveled through the valley, he did not record any observations of bison in the Greys River or Little Greys River valleys on his travels through there (Haines 1965). Several skulls have been found along the Greys River and in other river valleys, indicating that at least some bison moved through these areas. There likely are other valleys on the BTNF that were periodically visited by bison.

3 Other miscellaneous habitat — It is likely that bison used other rangelands on what is now the BTNF, but the use was likely lower than at the edges of the shrub steppe and in the larger river valleys. There is little or no indication that bison visited moderate to high elevation wetland, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, meadow-willow, and meadow-herb communities.

Bison in the intermountain West are thought to have had a sporadic grazing pattern across landscapes and, after they grazed a given area, it is thought they did not return to the same area for one to several years (Haines 1965, Van Vuren 1981, Van Vuren 1987, Miller et al. 1994, Van Vuren 2001). This, combined with differing assessments of the abundance of bison in the intermountain West, indicates that use of the edges shrub steppe landscapes may have been relatively low and infrequent although use could have been higher, but likely sporadic. Use in large river valleys likely was infrequent and likely consisted of low numbers, except possible river valley like the Gros Ventre and Hoback River valleys where use likely was higher than less accessible valleys with lesser amounts of rangeland (e.g., Greys River).

Furthermore, bison spend substantively less time grazing and loafing near water sources than cattle and, of the time they spend at water holes, they probably spend less time in the water than cattle due in part to lower metabolic rates in bison and their ability to better cope with heat than cattle (Van Vuren 1981, Steuter and Hidinger 1999, Van Vuren 2001, Fuhlendorf et al. 2010). Although contemporary bison diets can be high in sedges where and when they inhabit river valley bottoms (Meagher 1973, Campbell and Hinkes 1983, Cannon 2001), sedges are primarily eaten during winter when the ground was presumably frozen. In these situations, bison apparently do not have access to historic winter ranges. Bison probably only summered on the BTNF prior to Euro-American settlement. There does not appear to be any evidence that bison spent more than a minor amount of time in wetlands and wet meadows (while wet) in what is now the BTNF grazing on sedges.

Therefore, there is little evidence that bison made much use (e.g., grazing, drinking) of a large majority of wetland, wet meadow, and willow habitat on the BTNF, and while bison likely sporadically used moist meadow, silver sagebrush, and adjoining rangeland communities at low elevations — accessible to the shrub steppe and in large river valleys — these communities throughout the rest of the BTNF likely were not used by bison. Also, aside from some of the wide valley bottoms with substantive grass production (e.g., in moist meadows, silver sagebrush communities) that adjoin the shrub steppe and large valleys like Star Valley and Jackson Hole — where small herds likely grazed periodically — there is does not appear to be any evidence that bison grazed moist meadow and silver sagebrush communities further into what is now the BTNF (e.g., mountain meadows) more than occasionally.

- *Grazing by elk likely was higher in low elevation valley bottoms prior to Euro-American settlement than what occurs today, due primarily to the existing prevalence of roads and associated human activities and cattle in many of the BTNFs low elevation valley bottoms.*

  Elk numbers today on the BTNF are consistently higher than they were prior to Euro-American settlement due to elk being artificially fed, recognizing that elk numbers likely were relatively high at times prior to Euro-American settlement, but experienced period population declines that at times may have been large (Murie 1951, Boyce 1989, O'Gara and Dundas 2002). Compared to existing populations on the BTNF, elk numbers likely fluctuated substantially more than they do now. "Historically, Wyoming probably was more densely populated with elk than any other state… (Murie 1951)" (O'Gara and Dundas 2002:112). They continued by stating that mountain ranges in northwestern Wyoming "were a center of abundance for elk and have remained so." Elk in these mountains had access to large winter ranges, including the Green River basin and Snake River plain in Idaho (Murie 1951, O'Gara and Dundas 2002).

  The higher use by elk in low elevation valley bottoms likely involved small acreages of moist meadow, silver sagebrush, and shrubby cinquefoil communities relative to the total acreage of these communities across the BTNF. Elk do not use wetland, wet meadow, and willow communities to any large degree (Boyce 1989, Skovlin 2002), which can in part be inferred from elk not foraging on the sedge species prevalent in these habitats and the lack of willows in elk diets except in winter (Cook 2002).

  The establishment and maintenance of elk wallows, primarily by bull elk, greatly reduces habitat quality of springs and small wetlands for spotted frogs and boreal toads, but wallows are natural components of the environment, many times exist in forest interiors which receive no more than minor use by spotted frogs and boreal toads, and elk wallows affect only a small percentage of springs and wetlands.

  Just prior to the onset of livestock grazing, signs of grazing are barely discernable in most wetlands, wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, meadow-willow, and willow-herb communities on the BTNF. There is no reason to believe grazing pressure by elk in these communities was higher prior to Euro-American settlement.

- *Overall grazing pressure by elk in mid to higher elevation communities likely is higher now than it was historically given consistently high elk numbers.*

  This is primarily due to consistently higher elk numbers than occurred historically (see above) and reduced use of lower elevation areas due to roads and associated human activity (see above). However, elk do not use wetland, wet meadow, and willow communities to any large degree.

- *Use of wetlands by moose may be higher now than prior to Euro-American settlement.*

  Grazing and trampling by moose in wetlands currently appears to be low. Nonetheless, Houston (1968) argued that moose were not present in Wyoming prior to the late 1800s when they moved into the area from Montana and Idaho. He said they became established in Jackson Hole, and this timeframe likely applies as well to the Wyoming and Salt River Ranges by the early 1900s. From 1960, numbers in Wyoming appeared to steadily increase from less than 4,000 to an estimated 8,700 in the early 1980s, and then to an estimated 13,500 by 1990 (Karns 1997). Even if moose were present and low in abundance in western Wyoming prior to the late 1800s, it appears that browsing and grazing pressure by moose is currently higher than what it was prior to Euro-American settlement.

Are Adjustments Needed to Better Accommodate Spotted Frogs and Boreal Toads?

No fine-filter adjustments appear to be needed to the coarse-filter approach (approximation of natural conditions) to meet Forest Plan Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and Diversity of Wildlife Habitat Guideline regarding the retention of herbaceous vegetation, with one possible exception in limited situations. While it is recognized that light grazing (e.g., ≤10-20% use of total herbaceous vegetation[J]) in

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[J] 90% retention of total herbaceous vegetation retains an estimated 75-88% % of the weight of the vegetation above 2 inches and equates to an estimated 10-25% use of key forage species; 80% retention of total herbaceous vegetation retains an dense sedge wetlands can benefit spotted frogs and boreal toads (Watson et al. 2003, Bull 2005), there is insufficient need to make a fine-filter adjustment, except possibly on a case-by-case basis where it can be demonstrated this adjustment is warranted.

There is no scientific information demonstrating that an approximation of natural herbaceous conditions or herbaceous communities ungrazed by livestock would not adequately meet the needs of spotted frog and boreal toads or that these conditions would negatively affect these species, with the one possible exception. This further substantiates starting with ungrazed conditions (i.e., near-100% retention) in the process of determining a minimum retention threshold.

There are many things we do not know about specific habitat needs of spotted frogs and boreal toads under different circumstances, and this is another reason why erring on the side of the conditions under which amphibian communities formed in this area — when there is question — would best contribute to meeting Objective 3.3(a) with respect to these species.

The one possible exception is that livestock grazing use can be used in limited situations to create basking areas for spotted frogs in wetlands completely dominated by relatively-tall emergent vegetation (Maxell 2000, Watson et al. 2003, Bull 2005, Shovlain et al. 2006) and to produce and maintain open, sunlit shallow waters to facilitate egg and tadpole development (no literature was found that identified this possible use). The four citations listed in the previous sentence identified this as a possible use based in incidental observations. No scientific studies have addressed this issue. The “Openings Providing Sun Exposure” section, earlier in this appendix, discuss these in more detail. The extent to which livestock are used to this end, the use would need to be prescriptive (i.e., identification of need on specific wetlands, specific objectives and strategies for accomplishing the objectives).

This adjustment, on a case-by-case basis, may help to offset the multiple stressors now acting on spotted frog and boreal toad populations on the BTNF, including chitrid fungus, climate change, increased UV radiation, reduced water quality (e.g., from atmospheric sources), roads and motorized use, livestock grazing use, overrepresentation of late-seral forestlands. If it were not for these stressors, the natural process of wetlands being filled-in by emergent vegetation would not be an issue, but protection and conservation of individual breeding wetlands is becoming increasingly important. However, there are few wetlands where this is or could become an issue. And given the large number and variety of negative effects of livestock grazing use on spotted frogs and boreal toads, as well as a large number of other wildlife species, it is imperative that any use of livestock grazing to create and/or maintain open, shallow-water conditions for egg and tadpole development be carefully prescribed and controlled. Other options exist for creating and maintaining these conditions where issues occur.

4. Conditions within Livestock Exclosures

One of the most common recommendations in the literature dealing with spotted frogs and boreal toads in livestock allotments is the exclusion of livestock from their habitat, especially breeding areas (e.g., to provide protection from trampling), but also other important habitats (Bartelt 2000, Maxell 2000, Engle 2001, Loeffler et al. 2001, Patla 2001, Hogrefe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Schmutzer et al. 2008, Brown et al. 2015:50, Pilliod and Scherer 2015). In a recent study in Idaho, Pilliod and Scherer (2015:579) “found evidence that excluding cattle from ponds and surrounding riparian habitats resulted in higher levels of frog production (more egg masses), higher adult frog recruitment and survival, and higher population growth rate.”And the Fish; Wildlife; Threatened, Endangered, and Sensitive Species Standard requires that “Range improvements… will be coordinated and designed to help meet fish and wildlife habitat needs, especially on key habitat areas… ***Special emphasis will be placed on helping to meet the needs of*** Threatened, Endangered, and ***Sensitive species***” (emphasis added). Even in the range literature, some authors have recommended fencing livestock from water bodies to protect them against such things as elevated nitrogen and phosphorus loading (Hubbard et al. 2004). Together with the large volume of scientific information documenting the wide range of negative effects of livestock grazing use on amphibians, a strong argument can readily be made for excluding

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estimated 50-76% % of the weight of the vegetation above 2 inches and equates to an estimated 20-35% use of key forage species.

livestock from spotted frog and boreal toad breeding sites and surrounding habitat. Livestock exclusion typically results in near-100% retention of herbaceous vegetation except where native herbivores have measurable effects.

Some people have argued that the benefits of livestock exclusion as a basis for starting the assessment at near-100% retention is invalid because, if livestock do not have access to wetlands, emergent vegetation can become overly dense to facilitate tadpole development and to provide basking sites for metamorphs and adults. This is invalid for several reasons. First, this is entails one benefit of prescribed livestock-grazing-use applicable to very limited situations in contrast to a large number and variety of negative impacts that can occur from livestock grazing use across large portions of frog and toad habitat. The negative effects far outweigh the limited possible benefit, and in the narrow set of conditions in which livestock grazing use could be used to maintain openings in otherwise extensive stands of tall, dense emergent vegetation would entail highly prescriptive grazing to accomplish specific objectives while minimizing negative effects. Second, near-100% retention is only a starting point, and information in this subsection is not being used to recommend exclusion of livestock grazing. Third, continued grazing by livestock at most levels under consideration would contribute to maintaining at least some openings, making the assertion somewhat of a mute point.

Recommendations on excluding livestock range from fencing breeding sites to fencing entire ranges of individual populations, including breeding sites, summering habitat, migration corridors, and migration habitat. For amphibians in general, Maxell (2000) recommended fencing livestock from all parts of riparian areas that provide critical breeding, foraging, or overwintering habitats or that serve as important migratory or dispersal corridors in order to protect these critical areas from damage, as well as preventing mass mortality as a result of trampling or disease at the time of metamorphosis. Patla and Keinath (2005:58) recommended, for spotted frogs, fencing critical breeding, foraging, and over-wintering habitat (e.g., ponds, springs, riparian areas) and movement corridors between breeding and wintering sites. Keinath and McGee (2005:44,38) recommended locating and protecting boreal toad movement corridors and protecting them from impacts of livestock grazing and recommended “reducing interactions between livestock and boreal toads during critical periods,” possibly including exclusion. They identified critical periods as the breeding period (mid-May to mid-June, to July at higher elevations), hatching of eggs (late May to late June, to late July at higher elevations), metamorphosis (late July to late August, to late September at higher elevations), toadlet dispersal (highly variable), and overwintering (late September to mid-May). Brown et al. (2015:50), which identified livestock grazing as one of two high priority risk factors of Yosemite toads, assessed that, “To minimize trampling risk, livestock could be actively managed to avoid areas of meadows occupied by the less mobile Yosemite toad life stages (tadpoles and new metamorphs). Maxell (2000:90) recommended excluding livestock “…from boreal toad breeding sites at the time of breeding and at the time of metamorphosis in order to prevent mass mortality of aggregations of adults or metamorphs as a result of trampling.” USFWS (2002:55765) noted that “habitat protection and removal of grazing at Mona Springs has resulted in significant improvements to spotted frog habitat.”

It is acknowledge that some other authors have identified a possible benefit of creating small open patches in extensive stands of dense emergent vegetation (Maxell 2000, Watson et al. 2003, Bull 2005), but only a light level of livestock grazing (e.g., ≤10% utilization of total herbaceous vegetation) would be need to create small open patches, and this potential benefit is only applicable in wetlands that have 100% canopy cover or near 100% canopy cover of relatively tall graminoids with little or no open water.

Except possibly wetlands with 100% or near-100% canopy cover of sedges across the entire wetland, ungrazed conditions (ungrazed by large herbivores) in healthy wetlands, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow represent the upper end of the suitable retention level for spotted frogs and boreal toads.

Information on Key Amphibian-Livestock Grazing Studies Cited in this Report

The purpose of this section is to provide details of studies that are cited frequently in this appendix and that have information particularly relevant to the analysis in this appendix. Where percent herbaceous utilization information was not presented in the published papers, estimates of herbaceous utilization and/or herbaceous retention were calculated using pertinent data presented in individual the papers. There is little consistency in how livestock grazing use was measured or estimated among studies.

Studies on Yosemite Toads (2012, 2013)

The studies in this subsection (Roche et al. 2012b, Roche et al. 2012a, and McIlroy et al. 2013) are examined in some detail because (1) habitat use by cattle in the study areas differs from habitat use on the BTNF, and (2) habitat conditions in the vicinity of breeding sites in the study areas differ from those on the BTNF. It apparently was uncommon or rare for cattle to get close to Yosemite toad breeding sites in the study areas. Meadows with a hydrologic ranking of '6' (i.e., wet) received no more than very light use by cattle (Roche et al. 2012b:Tables 4B, 5A, and 6A). Hydrologic rankings were for each meadow as a whole, and breeding sites were wetter than the any given meadow on average. S. McIlroy (pers. comm., email dated 11-19-2013) was asked whether cattle used breeding wetlands to any large degree, and she responded, no, use by cattle is rare likely given the deep, muddy soils surrounding breeding wetlands. Wetland conditions and conditions surrounding wetlands at many boreal toad breeding sites on the BTNF can readily be accessed by cattle, except to the extent that dense willow prevent extensive use. As summarized by Roche et al. (2012b:1), "Because cattle and toads largely occupied divergent zones along the moisture gradient, the potential for indirect or direct negative effects is likely minimized via a partitioning of the meadow habitat." In parts of the BTNF, boreal toads and cattle do not occupy divergent zones, but rather occupy the same habitats. Even with the sharp contrast in conditions between the Sierra Nevada study areas and the BTNF, results of the three studies provide information that can be used in developing suitable condition statements for boreal toads on the BTNF. Given the differences in conditions, however, results of different parts of the studies needed to be deconstructed.

Yosemite toads are related to boreal toads, and a set of studies conducted on the effects of cattle grazing on Yosemite toads on three national forests in Sierra Nevada (Allen-Diaz et al. 2010, Roche et al. 2012b, Roche et al. 2012a, and McIlroy et al. 2013) provide the most directly applicable information to-date on this taxa of toads. Many results preliminarily presented in Allen-Diaz et al. (2010), which is a final agency report, were published by Roche et al. (2012b), but Allen-Diaz et al. (2010) is referenced in this report because it contains some information not presented in Roche et al. (2012b).

Allen-Diaz et al. (2010), Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) were conducted on the west slope of the central Sierra Nevada in California, at an elevation of about 6,950 to 8,858 feet and average annual precipitation of about 45 inches, with 75-90% of this falling as snow from October to April. Snowmelt typically occurs between May and June. Meadows in the study area, which cover less than 10% of the acreage of allotments, are generally characterized by shallow water tables (i.e., near-surface saturation conditions). Meadow soils were classified as Mollisols and Inceptisols with Histosols found in the wettest areas of meadows. Wet meadow vegetation was dominated by several species of sedges (including beaked sedge, analogue sedge, and Nebraska sedge) and moist meadows were dominated by tufted hairgrass, American bistort, and clover.

Annual production in Roche et al. (2012b) ranged from about 892 to 2,856 pounds/acre and averaged[K] about 1,583 pounds/acre; ranged from about 1,330 to 3,065 pounds/acre and averaged about 2,327 pounds/acre in Roche et al. (2012a); and ranged from 1,412 to 3,673 pounds/acre and averaged about 2,730 pounds/acre in McIlroy et al. (2013). Eighty percent of meadows produced more than 2,000 pounds/acre. Twenty-four individual meadows were included in the study by Allen-Diaz et al. (2010) and Roche et al. (2012b), 9 meadows were included in the study by Roche et al. (2012a), and 5 meadows were included in the study by McIlroy et al. (2013), with some apparent overlap in meadows used.

Meadows were located within active cattle allotments that were each approximately 55,880 to 68,600 acres (in Allen-Diaz et al. 2010, Roche et al. 2012b, Roche et al. 2012a) and 14,500-68,600 acres in size (in McIlory et al. 2013) with 200-250 and 156-235 cow-calf pairs per allotment, respectively. Cattle grazing on the allotments began in late June or early July each year and continued through mid September. The established utilization limit on the allotments is a maximum of 40% utilization. Season-end utilization of total herbaceous vegetation in meadows ranged from 4% to 49% in Roche et al. (2012b); ranged from 9% to 54% in the 3 grazed meadows of Roche et al. (2012a); ranged from 13% to 43% in the 5 grazed meadows of McIlroy et al. (2013). Utilization was not measured in the 3 and 5 meadows, respectively, in which breeding areas were fenced but the rest of each

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[K] A range was not provided for Allen-Diaz et al. (2010) and Roche et al. (2012c) because the range presented in their paper was an average of early, mid, and late growing seasons.

meadow was grazed by cattle. (The other 3 and 5 meadows, respectively, were completely fenced.) Utilization in Roche et al. (2012b) was measured in July, August, and September (after cattle removal); and it was only measured in September after cattle removal in Roche et al. (2012a) and McIlroy et al. (2013). Therefore, existing cattle grazing management in the study-area meadows is characterized as light to moderate (Roche et al. 2012b). Utilization was measured in terms of all herbaceous vegetation, not utilization of key forage species (Roche et al. 2012b:4). Utilization in all studies was measured using the comparative yield method, in which all herbaceous vegetation is clipped and weighed (BLM et al. 1999).

Cattle were grazed season-long, which is different than on the BTNF where many allotments are grazed in pasture systems. One key difference is that grazing utilization levels progressively increase in season-long allotments, as was shown in Roche et al. (2012b), compared to pastures where grazing utilization peaks at the end of each grazing season within pasture.

The research group "…found no evidence that existing USFS grazing management impaired amphibian habitat conditions…" in their respective Sierra Nevada study areas (Roche et al. 2012b:9), but this conclusion cannot be directly applied to the BTNF with respect to cattle grazing and boreal toads for the following reasons:

1. Roche et al. (2012a:63) characterized cattle grazing on their study area as follows "In the system we studied, which is regulated by USFS grazing standards and guidelines, grazing intensities are relatively light to moderate," which is different than grazing levels in many graminoid-dominated meadows on the BTNF where the utilization standard in riparian areas is ≤55-65% of key forage species (USFS 1990b:128). Utilization rates in most meadows and parts of meadows in the studies by Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) were well under the 40% utilization standard of the Stanislaus and Sierra Nevada National Forests, not at or near 40%.

   Roche et al. (2012b) provided the only breakdowns of actual use measurements. The following breakdowns are important because toad response variables were assessed in May-July or June-July. To apply results to the BTNF, toad response variables need to be compared against the grazing levels that occurred prior to and/or during the time the response variables were measured.

   Average retention in 24 meadows in July was as follows (from Figure 5A of Roche et al. 2012b):

   - Retention was ≥75% on 100% of meadows.
   - Retention was ≥80% on 96% of meadows.
   - Retention was ≥90% on 82% of meadows.

   Average retention in 24 meadows in August was as follows (from Figure 6A of Roche et al. 2012b):

   - Retention was ≥50% on 100% of meadows.
   - Retention was ≥60% on 92% of meadows.
   - Retention was ≥70% on 67% of meadows.
   - Retention was ≥80% on 42% of meadows.
   - Retention was ≥90% on 24% of meadows.

   Average retention in 24 meadows in September was as follows (from Figure 4B of Roche et al. 2012b):

   - Retention was ≥45% on 100% of meadows.
   - Retention was ≥50% on 96% of meadows.
   - Retention was ≥60% on 82% of meadows.
   - Retention was ≥70% on 52% of meadows.
   - Retention was ≥80% on 22% of meadows.
   - Retention was ≥90% on 18% of meadows.

Grazing-season-end (September) retention of total herbaceous vegetation in meadows was similar in Roche et al. (2012a) and McIlroy et al. (2013), although for far fewer grazed meadows were evaluated. Retention ranged from 46% to 81% in the 3 grazed meadows of Roche et al. (2012a), but specifics were not given by meadow; and retention was measured at 57%, 59%, 69% 70%, and 87% in the 5 grazed meadows of McIlroy et al. (2013); Retention was ≥50% on 100% of meadows, ≥60% on 60% of the meadows (nearly 80% of the meadows), ≥70% on 40% of meadows (nearly 60% of meadows), and ≥80% on 10% of meadows.

Retention was substantially greater than 60% (and utilization was substantially less than 40%) on 25% to 67% or more of meadows, depending on timing of utilization measurements, meaning study results do not reflect effects of what could happen under a maximum 40% utilization limit where efforts at distributing cattle are successful and most grazing use is at or just under the 40% limit.

2. Herbaceous retention in breeding wetlands and on shorelines of breeding wetlands appears to have been ≥85% if not ≥90% or more in all studies, as measured in September, because few if any cattle ventured into breeding wetlands. Roche et al. (2012b:1) pointed out that "…the potential for indirect or direct negative effects is likely minimized via a partitioning of the meadow habitat" because "cattle and toads largely occupied divergent zones along the moisture gradient." Because Roche et al. (2012b), Roche et al. (2012a), and McIlroy (2013 did not measure utilization in or immediately adjacent to breeding wetlands, estimates of utilization at breeding wetlands needed to be done indirectly. Utilization was measured in other parts of meadows (Figure A.18).

   Figures 4B, 5A, and 6A of Roche et al. (2012b) show comparatively little grazing by cattle in the wettest meadow-scale hydrologic rankings. Utilization in the one meadow with a hydrologic ranking of '6' (wettest on a scale of 1-6) was measured at 9%, 1%, and 5% in July, August, and September, and the trend lines for each of these months crossed the ranking of '6' at about 4-12% utilization (Figures 4B, 5A, and 6A). McIlroy et al. (2013), the only study to present utilization rates within exclosures, measured utilization at 5-17% in 9 separate exclosures around breeding wetlands. Furthermore, the hydrologic rankings in Figures 4B, 5A, and 6A are meadow-wide, and wetlands are even wetter than any meadow on average. Based on this apparent relationship, S. McIlroy (pers. comm., email dated 11-19-2013) was asked whether cattle used breeding wetlands to any large degree, and she responded, no, use by cattle is rare likely given the deep, muddy soils surrounding breeding wetlands. Therefore, the lack of any statistically significant effects of cattle grazing on toad response variables within breeding wetlands and on shorelines of breeding wetlands (response variables in Roche et al. 2012a and McIlroy et al. 2013) may have been strongly influenced by this.

   Because retention across meadows was ≥90% on 82% of meadows in July (Roche et al. 2012b), retention in and immediately adjacent to breeding pools likely was ≥95% in July.

   Although cattle grazing, trampling, defecation, and urination did not directly significantly affect toad response variables within and immediately adjacent to breeding pools, they had the potential to indirectly affect parameters like water quality as a consequence of runoff from grazed portions of meadows. However, because cattle did not graze, walk, defecate, or urinate directly in breeding pools more than a minor degree, there was little or no opportunity to directly impact tadpoles, metamorphs, and adults (e.g., mortality due to crushing), to reduce hiding and escape cover in the water column and on shorelines, to reduce shading or humidity-retention attributes, to reduce tadpole forage, or to reduce insects at breeding sites.

   In contrast to the situation in the Sierra Nevada study areas, wetland conditions and conditions surrounding wetlands at many boreal toad breeding sites on the BTNF are readily accessible by cattle, except to the extent that dense willow prevent extensive use. In parts of the BTNF, boreal toads and cattle do not occupy divergent zones, but rather occupy the same habitats.

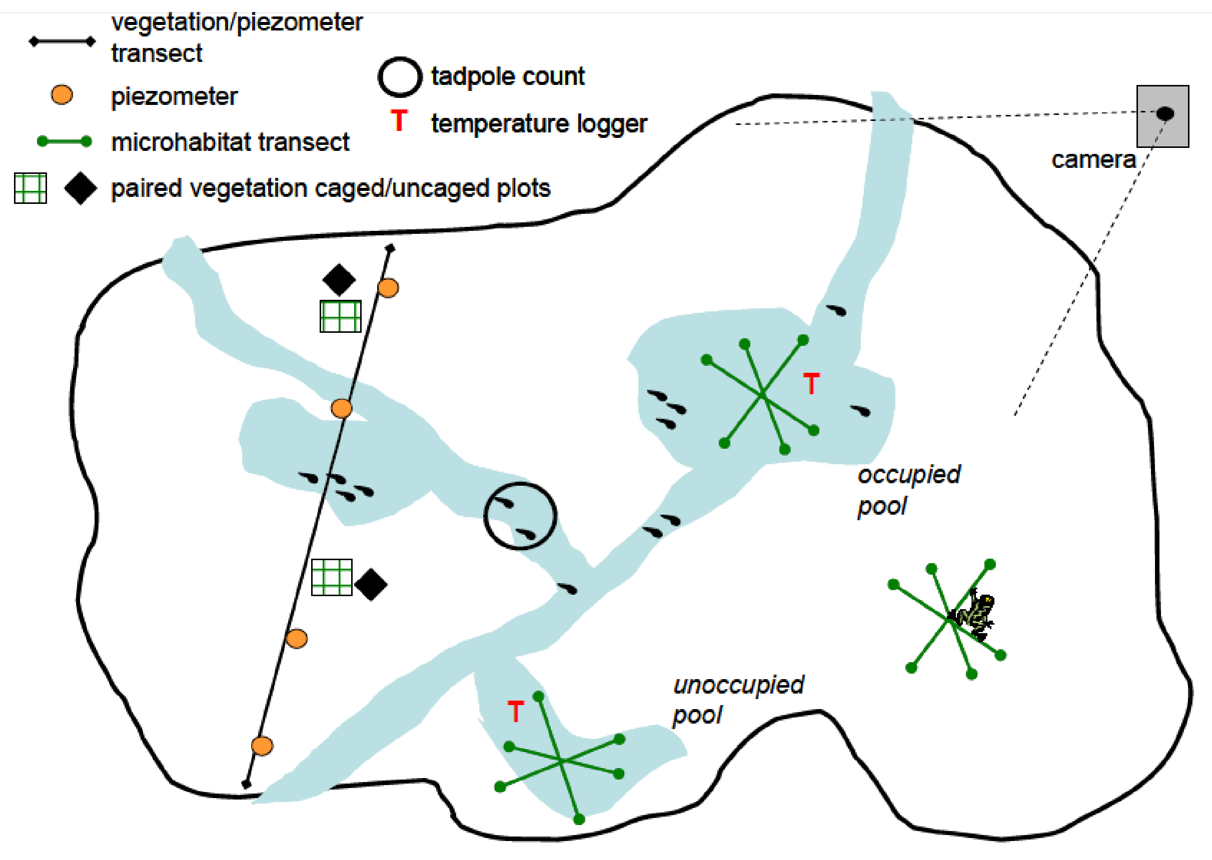

Figure A.18. Illustration of field data collections methods variously identified in Roche et al. (2012a), Roche et al. (2012b), and McIlroy et al. (2013). This is Figure 3 on page 20 of Appendix A ofAllen-Diaz 2010).

3. Data on Yosemite toad response variables were collected during June-July or May-July, compared to the cattle grazing season of late June/early July through mid September, and actual use being measured in September (Roche et al. 2012a, McIlroy et al. 2013) and in July, August, and September (Roche et al. 2012b). More specifically, data on Yosemite toad response variables were collected in June-July in Roche et al. (2012b), 2nd/3rd week of May through Aug 2, 2006, June 18, 2007, and July 10, 2008 in Roche et al. (2012a), and apparently May-July in McIlroy et al. (2013); timing was not identified in the latter study, but response variables dictate that timing of data collection was either May-June or May-July. Specific temporal relationships include the following:

    a. Data on the occupancy of adult toads was collected in June-July and grazing utilization data, for the purposes of assessing effects on toad occupancy, was collected in July in Roche et al. (2012b). They found that toad occupancy in meadows was positively correlated with meadow wetness, but no significant correlation was detected between cattle utilization levels and meadow wetness in July. (There was a slightly negative relationship, and the lack of a significant relationship appears in part to be due to low sample size of meadows with high hydrologic rankings.) Roche et al. (2012b:7) concluded that “Our study results suggest Yosemite toads and cattle largely select for divergent meadow types based on habitat and forage values, respectively,” although this was based on comparing toad occupancy in June-July and grazing utilization levels in August and September (see ‘b’ below).

Results of Roche et al. (2012b), specifically toad occupancy in June-July and cattle utilization levels as measured in July, can be used in assessing relationships between toads and livestock grazing during the early cattle grazing season (e.g., in the first pasture) on the BTNF.

b. Toad occupancy in meadows in relation to grazing utilization patterns after July is unknown because, while utilization data was collected in August and September, toad occupancy data was not collected in these months. Several studies have shown that large proportions of western/boreal toads travel up to 1/3 mile, with some traveling up to 1.5 miles or even as far as 3.9 miles after the breeding season (Bartelt et al. 2004, Muths 2003, Bull 2006, Pierce 2006). Meadows in the study by Roche et al. (2012b) were only 1-20 acres in size, meaning that toads could have moved well beyond the meadows in which they bred. Even if many toads remained in study area meadows through the summer, toads would have been able to readily move from less-favored to more-favored habitat throughout as habitat conditions changed. Data is not available to determine whether toads distributed themselves independently of retention levels or if they selected sites with higher retention levels.

   Therefore, results of this study cannot be used to assess effects of livestock grazing use on toad distribution and habitat use after July on the BTNF. Whereas grazing use remained below 25% up through July in the study area's season-long grazing allotments (with the peak in utilization happening in September), grazing use peaks sometime in July in the first pastures in rotations on the BTNF.

c. Roche et al. (2012a) collected data on toad occupancy at breeding wetlands and on pool habitat variables (water quality, water temperature, pool depth, and flow regime) during the 2nd/3rd week of May through Aug 2 (2006), June 18 (2007), and July 10 (2008), and measured utilization in September. They did not detect any statistically significant effects of livestock grazing use on these variables. However, while this appears to represent effects of current grazing in the Sierra Nevada study area, to apply results to the BTNF, the effects on response variables need to be evaluated relative to the level of grazing that had the chance to affect the variables (i.e., grazing that occurred prior to, not after, measurement of these variables took place).

   Although Roche et al. (2012a) did not measure utilization levels in July, September grazing levels were similar to those measured by Roche et al. (2012b) and July utilization was ≤25% in all 24 meadows in Roche et al. (2012b). An implication to the BTNF, therefore, is that grazing utilization levels of ≤25% in meadows did not result in any statistically significant effects on toad occupancy of breeding pools, water quality, and water temperature where utilization levels appeared to have been ≤10% through July (in recognition that toad breeding and cattle grazing occurred in different places).

d. McIlroy et al. (2013) collected data on toad occupancy of breeding sites, tadpole density, and habitat conditions (e.g., water temperature, water depth, detritus depth) during periods likely similar to Roche et al. (2012a), above; they did not identify the timing of sampling except that utilization was measured in September. They did not detect any statistically significant effects of current grazing. As spelled out above, to apply results to the BTNF, the effects on response variables need to be evaluated relative to the level of grazing that occurred prior to, not after, measurement of these variables took place.

   July utilization levels in McIlroy et at (2013) were likely ≤25% across meadows because September utilization levels were similar to those of Roche et al. (2012b) and all 24 meadows in Roche et al. (2012b) received ≤25% use in July. An implication to the BTNF, therefore, is that grazing utilization levels of ≤25% across meadows did not result in any statistically significant effects on toad occupancy of breeding pools, water quality, and water temperature where utilization appeared to ≤10% through July and possibly up to ≤15% through August (in recognition that toad breeding and cattle grazing occurred in different places).

e. Additionally, data on some response variables (e.g., toad occupancy of breeding wetlands, tadpole occupancy, herbaceous cover, water quality) in Roche et al. (2012a) and McIlroy et al. (2013) apparently were monitored just before turn-out of cattle or soon thereafter. One implication of this is that some results reflect the effects of no cattle grazing use in the season in which data were collected on these variables. Also, for man Thus, toad occupancy, tadpole occupancy, and percent canopy cover of herbaceous vegetation appear to reflect long-term changes and did not reflect changes from any season's grazing use

4. While annual production levels in meadows of the Sierra Nevada project areas would appear to be fairly comparable to that of wet/moist meadows in healthy condition on the BTNF, annual production levels in the Sierra Nevada project areas are higher than that of altered meadows on the BTNF. Annual production of herbaceous vegetation ranged from lows of about 892, 1,330, and 1,412 pounds/acre to highs of about 2,856, 3,065, and 3,673 pounds/acre, and averaged about 1,583, 2,327, and 2,730 pounds/acre among the three studies. Eighty percent of meadows produced more than 2,000 pounds/acre. This probably is generally comparable to annual production on healthy wet/moist meadows of the BTNF because annual production levels of specific plant communities include 1,700-5,500 pounds/acre (beaked sedge communities) and 325-850 pounds/acre (analogue sedge communities), 2,800-3,700 pounds/acre (tufted hairgrass communities),and 1,900-5,900 pounds/acre (small-winged sedge communities) (Youngblood et al. 1985). The figures for Youngblood et al. (1985) are for individual plant communities and figures for the Sierra Nevada study areas are for entire meadows.

   In altered meadows and altered portions of meadows (e.g., communities dominated by species such as nonnative bluegrasses, northwest cinquefoil), annual production levels can 400-800 pounds/acre or less (Youngblood et al. 1985), which can influence the effects of cattle grazing on toad response variables.

5. All meadows in the Sierra Nevada project areas were consisted of herbaceous plant communities, most prominently herbaceous communities dominated by various sedges and tufted hairgrass (i.e., wet and moist meadows), which is different than many boreal toad breeding sites on the BTNF that are located in riparian zones dominated by willows. This difference has the potential to cause differences in the effects of cattle grazing on toad response variables. On the other hand, dense willows that limit access of cattle to breeding sites on the BTNF may mimic the reluctance of cattle to access breeding pools in the Sierra Nevada breeding sites due to deep mud surrounding these breeding pools.

6. It is also possible that differences in characteristics of meadows in different treatments affected results of Roche et al. (2012a) and McIlroy et al. (2013). Breeding pools were significantly deeper in grazed meadows of Roche et al. (2012a), which may have contributed to consistently lower water temperatures and would have had the potential to affect comparisons of water quality (e.g., diluting effects of large volume of water). Water tables were consistently shallower, breeding pools were consistently smaller, and herbaceous production was consistently lower in whole meadow exclosures in McIlroy et al (2013), which had the potential to affect results to some degree, recognizing there appears to have been little difference in conditions within breeding pools between grazed meadows and grazed meadows with breeding areas excluded since very little if any grazing occurred within breeding pools.

Spotted Frogs in Oregon (Adams et al. 2009)

Adams et al. (2009) conducted a study on the effects of cattle grazing on Columbia spotted frogs in Oregon. Twelve spring-fed ponds were used in the study, ranging in size from 0.03 acres (1,200 ft^2) to 1.0 acre, with 9 of the 12 ponds ranging in size from 0.03 acres to 0.15 acres (6,725 ft^2). Ponds were characterized as being <1m to >2m deep, and 9 of the 12 were ≥1m deep, and most had been created in riparian areas by small mining operations. Emergent and shoreline vegetation consisted mainly of spikrush (Eleocharis), mannagrass (glyceria), buttercups (ranunculus), and Utricularia. Of the 12 ponds, 4 did not have an exclosure, 4 were partially excluded, and 4 were fully excluded, with fences 3-16 feet from the edge of the pond. The partial exclusure included a fence across the water.

Egg masses were counted in April through early June, and numbers of metamorphic frogs were estimated using counts started sometime after mid-July and continued through the completion of metamorphosis (August-September). Water quality samples were collected in July and September.

Livestock grazing was season-long and it ran from late June through September. Shoreline vegetation height was measured in August and in September after livestock grazing season. Herbaceous vegetation height was an average of about 12.4 inches tall inside their full exclosure, 11.0 inches tall inside the partial exclosure, and about

3.9 inches tall outside the exclosures. This equates to an estimated 50-60% retention outside exclosures based on changes in average vegetation heights (Figure 2 of Adams et al. 2009) relative to height-weight relationship information in Kinney and Clary (1994).

There were no apparent numeric differences in pH, conductance, acid neutralizing capacity between grazed wetlands and ungrazed wetlands, and Adams et al. (2009) did not detect any statistically significant differences ($P = 0.226$ and higher). They reported that nitrate, nitrite, ammonia, and orthophosphates were at or below detectable limits in most wetlands. If the level of livestock use in wetlands was accurately reflected by average vegetation height, these results are inconsistent with a large number of studies that found livestock grazing use in wetlands to affect conductance, nitrate, nitrite, ammonia, and orthophosphates (see "Water Quality" discussion in the "Roles of Herbaceous Canopy/Retention and Openings" section). Adams et al. (2009) identified dilution of nutrients in the ponds as a consequence of ponds being being fed by springs and groundwater flow as a potential reason for no significant difference in water quality between grazed and ungrazed ponds. Some of the breeding ponds are also relatively large (e.g., one of the grazed ponds was about 1 acre) and deep (e.g., >2m), which can contribute to dilution of compounds.

Adams et al. (2009) stated there were no statistical differences in egg mass counts among treatments, but it is not clear what they actually tested. Average egg mass counts in grazed wetlands were substantially lower in post-treatment years even though no treatment was applied, and the same pattern existed in partial-exclosure wetlands. This effect appeared to be negated in the full exclosure wetlands, since the average post-treatment egg mass count was slightly higher than the pre-treatment count in the full exclosure wetlands. Adams et al. (2009) stated that this pattern was not significant ($F_{2,6} = 0.98$; $P = 0.429$), but it is not clear what this test/comparison to which this refers, and there is no indication they tested for year effect by treatment type. If there was no statistical significance in year effect, this could potentially be due to small sample size or some other study design feature. Additionally, Adams et al. (2009:139) stated that "All of our results should be interpreted cautiously because of low replication and the probability that treatment effects will take longer than two years to fully manifest themselves. In particular, effects of treatment on pond habitats might be cumulative and could only be detected by a change in egg mass numbers which might take several years to emerge. An alternative explanation for the lack of treatment effect on egg mass numbers is that the small riparian buffer provided by the exclosures was inadequate to alter the interaction between cattle and frogs…"

Adams et al. (2009) did not detect any statistical differences in tadpole survival between ungrazed wetlands and grazed wetlands ($P = 0.85$). There are several factors that need to be considered when interpreting this result: (1) there was a large amount of variability in habitat conditions and in egg-mass numbers and tadpole survivorship prior to exclosures being constructed; (2) tadpole survivorship in the full-exclosure wetlands was half that of the grazed wetlands prior to exclosures being constructed, and the variation was low enough that a significant difference is apparent; (3) egg mass counts and tadpole survival in grazed wetlands were substantially lower in post-treatment years even though no treatment was applied, and the same pattern existed in partial-exclosure wetlands; (4) in contrast, this difference appeared to be negated (egg mass counts) and nearly negated (tadpole survival) in the full exclosure wetlands, since average pre- and post-treatment egg mass counts were nearly identical and average pre- and post-treatment tadpole survivorship only declined by slight amount after exclosures were constructed; (5) exclosure fences were close to the water's edge (as close as about 3 feet), which would have allowed some metamorphs originating in exclosures to access shorelines where they could have been trampled by cattle which in turn had the possibility of lowering the count of metamorphs at partial-exclosure and full-exclosure wetlands; and (6) researchers assessed survivorship from egg to completion of metamorphosis and did not assess survivorship until metamorphs dispersed from breeding ponds, which could have affected results because mortality of metamorphs on shorelines occupied by livestock can be high in some situations.

With respect to items 4 and 5, above, the authors did not appear to conduct any statistical analysis of year effect with respect to tadpole survival. Based on information in Figure 2.C of Adams et al. (2009), it appears there may have been a statistically significant year effect in the control wetlands (no exclosures), but not in the full-exclosure wetlands. Even aside from whether a year effect was statistically significant, the pattern in tadpole survival, as well as egg mass counts, indicates (1) fewer eggs laid and lower proportion of tadpoles survived in the latter half of the study period for unknown reasons, and (2) these effects appeared to be offset to some degree by full exclosures.

Studies on Frogs and Toads in Tennessee (Schmutzer et al. 2008 and Burton et al. 2009)

The studies by Schmutzer et al. (2008) and Burton et al. (2009) were conducted at the Plateau Research and Education Center in Tennessee. Although the studies were conducted in an ecosystem that is different than wetland systems in the intermountain West, many aspects of the ways in which livestock grazing affects frogs and toads are similar, for example: effects of changes in water quality (e.g., increases in nitrate, ammonium) on tadpoles, effects of reductions in hiding cover, effects of trampling on tadpole and adult survival. Given the small number of studies that have examined the effects of livestock grazing on frogs and toads, Schmutzer et al. (2008) and Burton et al. (2009) add substantively to the information available to assessing cause-and-effects relationships between livestock grazing and frog/toad breeding and survival, recognizing there are differences in wetland composition and functioning. It is noteworthy that results of these two studies for frogs appear to be consistent with findings of Munger et al. (1994), Munger et al. (1996), and possibly Bull and Hayes (2001) which were conducted on spotted frogs in southeastern Idaho and Oregon.

All study wetlands were typical farm ponds, containing a permanently flooded center with emergent shoreline vegetation composed of cattail, rushes, and sedges. Landscape composition did not differ between land-use types. As such, the authors were confident that the land-use treatment in their studies represented the presence or absence of direct access of cattle to wetlands. Wetlands were stocked with fish, and sampling in another study revealed that composition was similar between cattle-access and cattle-excluded wetlands.

Schmutzer et al. (2008) used 7 farm ponds for the study: 3 with cattle access and 4 where cattle were excluded from wetlands (≥66 ft. buffer) with fencing. In the same study area, Burton et al. (2009) used 8 farm ponds for the study: 4 with cattle access and 4 where cattle were excluded from wetlands (≥66 ft. buffer) with fencing. Average density around cattle-access wetlands was 35 cattle per wetland acre per month (Schmutzer et al. 2008) and 53 cattle per wetland acre per month (Burton et al. 2009), presumably meaning that this many cattle had access to the wetland each month. Wetlands were 0.35-2.57 acres and in proximity to each other (<1.25 miles total separation). Pastures associated with access wetlands were 11.9-21.5 acres. Access by cattle was allowed 12 months per year.

Cattle-excluded wetlands had not been exposed to direct cattle grazing for over 10 years, whereas cattle were present in cattle access wetlands for over 10 years. Average distance from cattle-excluded wetlands to grazing cattle during the study was about 362 feet.

In Schmutzer et al. (2008), amphibian larvae were sampled twice per week in each wetland from 28 March to 26 August 2005 and from 27 March to 25 August 2006 using seine and dip nets. They measured biomass of filamentous algae and detritus once each month, and measured water quality every 2 weeks in each wetland. They sampled water quality about 8.2 ft. from shore, and they used this distance from shore because it was exactly the midpoint distance between the shore and the farthest point where larval sampling occurred. We measured the following water quality variables: dissolved oxygen, turbidity, specific conductivity, pH, temperature, ammonia nitrogen, nitrite, nitrate, and phosphate.

Burton et al. (2009) used pitfall traps to measure relative capture rates of postmetamorphic amphibians. They partially enclosed (50% of the circumference) all study wetlands with a 2-ft. tall continuous drift fence (Figure A.19). They placed the drift fence parallel to and approximately 33 ft. upslope from the shoreline of each wetland, and placed pitfall traps on alternate sides. They placed an electrical fence around the drift fence and pitfall traps at cattle-access wetlands to prevent cattle from destroying the fence or injuring themselves in the pitfalls (Figure A.19). Pitfalls were opened pitfalls twice per week for 24 hours from late March to late August in 2005 and 2006. Burton et al. (2009) divided each wetland into four equal quadrants using two lines that intersected in the middle, and they estimated relative egg mass abundance once per week for each species group at each wetland in opposing quadrants. Near the shoreline of each wetland in two different quadrants than egg mass abundance was estimated, they measured emergent vegetation height and percent vertical structure using a graduated profile board and estimated percent horizontal cover of vegetation and water once per month.

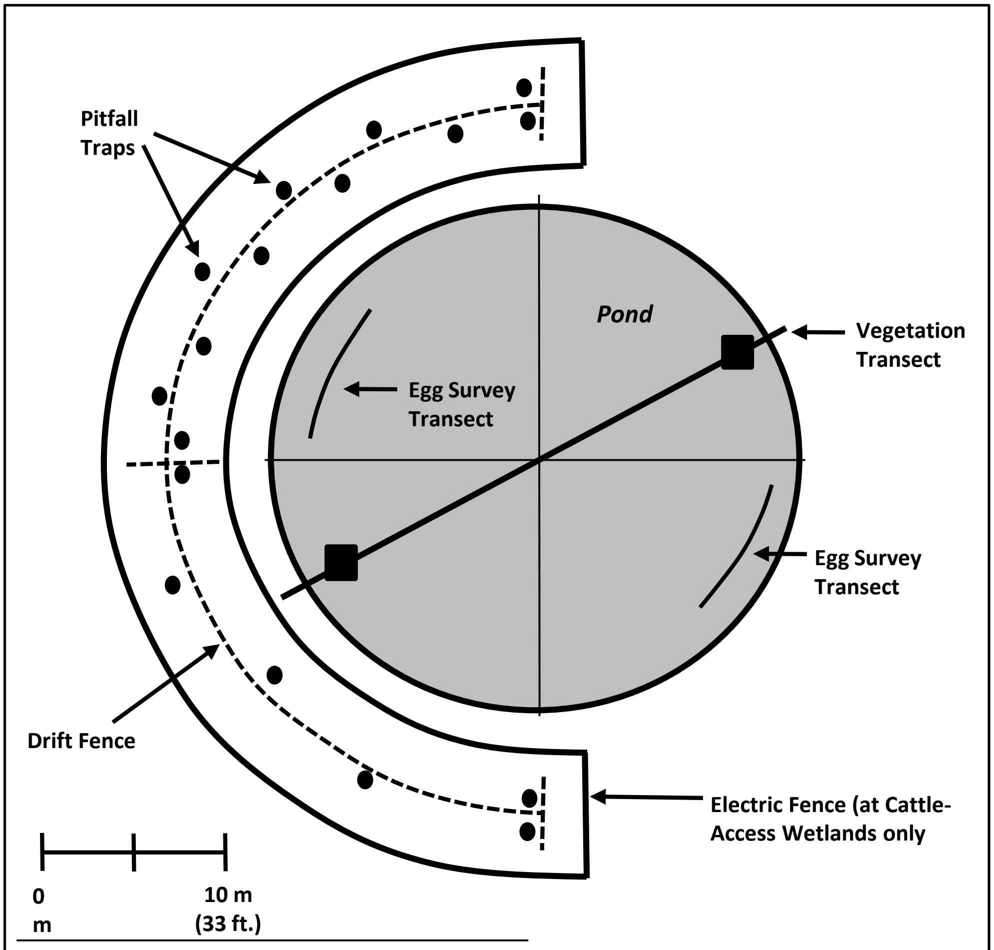

Figure A.19. An illustration of the field data collection methods of Burton (2009). This was re-drawn from Figure 1 of Burton et al. (2009).

In Burton et al. (2009), the average emergent vegetation height, percent horizontal cover, and percent vertical structure were 42%, 20%, and 46% lower in grazed wetlands than in cattle-excluded wetlands. Assuming equal pre-grazed measures in grazed and cattle-excluded wetlands, these percentages translate to 58% of pre-grazed height being retained, 80% of pre-grazed percent horizontal cover being retained, and 54% of pre-grazed percent vertical structure being retained in grazed wetlands, on average. Emergent vegetation height in exclosures averaged 28.8 and 34.0 inches in 2005 and 2006, respectively, and emergent vegetation height in cattle-access wetlands averaged 16.6 and 23.7 inches in 2005 and 2006, respectively. This means that 58% and 70% of the average height was retained in grazed wetlands, which roughly translates into ≥70% and ≥85%, respectively, based on height-weight relationships of sedges and rushes in Kinney and Clary (1994). Burton et al (2007) did not identify pre-grazed vegetation height in the grazed wetlands and did not specify whether they took into account vegetation that was trampled into the mud. If vegetation trampled into the mud was taken into account (e.g., as 0" readings), this may have reduced the estimates of percent retention to some degree. However, percent horizontal cover was only 20% lower in grazed wetlands, meaning that, if trampling of vegetation into the mud occurred, it appears to have been fairly limited.

Schmutzer et al. (2008) did not assess grazing utilization or grazing intensity, but instead referred to heights provided in Burton et al. (2009). In their measures of detritus, Schmutzer et al. (2008) found that biomass of detritus in 2005 was 10.9x greater in cattle-excluded wetlands than in grazed wetlands, and that it was 3-4x greater in 2006. This is a larger difference than Burton et al. (2009) found in emergent vegetation height and percent vertical structure, but effects of grazing on detritus would have been delayed by one year, meaning that the 3-4x greater biomass of detritus in cattle-excluded wetlands in 2006 would have been associated with the 74% greater height and 84% greater vertical structure in cattle-excluded wetlands as measured in 2005. If grazing pressure in grazed wetlands was higher in 2004 and previous years than it was in 2005 and 2006, this would help explain why the biomass in 2005 was 10.9x greater in cattle-excluded wetlands than in grazed wetlands. It is also possible that detritus accumulates for more than one year, meaning that consistently lower amounts of residual vegetation in grazed wetlands would result in a compounding of effects over several years. Furthermore, although not discussed in Schmutzer et al.(2008), trampling of emergent vegetation into the substrate may have contributed to the significantly lower amount of detritus in grazed wetlands than in ungrazed wetlands; e.g., any plant material that is trampled into the mud would not be measured. However, there was only a 20% difference in horizontal cover of vegetation.

Schmutzer et al. (2008) found significant reductions in water quality for the following parameters: specific conductivity was 70% greater in grazed wetlands than in cattle-excluded wetlands, turbidity was about 3.5x greater in grazed wetlands than in cattle-excluded wetlands, and dissolved oxygen was 39% lower in grazed wetlands than in cattle-excluded wetlands. Also, ammonia nitrogen, nitrites, and nitrates were consistently higher (5–216% higher) in grazed wetlands than in cattle excluded wetlands, but results were not statistically significant at the P<0.10 level. They pointed out that ammonia may have reached levels that were biologically significant.

Schumtzer et al. (2008) found markedly higher tadpole diversity and markedly higher abundance of some tadpole species in cattle-excluded wetlands. Average species richness of amphibian tadpoles was 2-4x greater in cattle-excluded wetlands than in cattle-access wetlands in 2005 (P ≥0.13) and 2.7x greater in wetlands cattle-excluded wetlands in 2006 (P = 0.08). Tadpoles of two species of frogs were more abundant in cattle-excluded wetlands than in grazed wetlands.

In the study by Burton et al. (2009), average daily capture of green frog metamorphs at cattle-excluded wetlands was 2.5x greater than at cattle-access wetlands in 2005 (P = 0.18) and average capture of green frog metamorphs at cattle-excluded wetlands was 9.8x greater in 2006 (P = 0.06). Average daily capture of green frogs (total) at cattle-excluded wetlands was 2.3x greater than at cattle-access wetlands in 2005 (P = 0.19) and average capture of green frogs (total) at cattle-excluded wetlands was 8.7x greater in 2006 (P = 0.07).

Average daily capture of American toads at grazed wetlands was 68 times and 76 times greater than at cattle-excluded wetlands in 2005 and 2006, respectively (P < 0.03), and this was driven by large numbers of adult toads in April. The only other months in which capture rates of was high were June and August; average daily capture of toads (primarily adults) was about 3x lower in June than in April and about 14x lower in August. Burton et al. (2009) stated that only the average daily capture of adult female and male American toads at grazed wetlands was significantly greater than at cattle-excluded wetlands in 2005 and 2006, respectively, meaning either there was no significant difference between average daily capture of American toad metamorphs or there were too few toad metamorphs to perform a statistical analysis.

Burton et al. (2009) did not detect any statistically significant difference in abundance of egg masses between cattle-excluded and grazed wetlands, presumably including no differences for any particular species groups (e.g., bullfrog/green frog, American toad/Fowler's toad); egg masses were identified to groups because they could not differentiate between the eggs of some species. It is not clear whether no differences were detected in the number of toad egg masses between cattle-excluded and grazed wetlands or whether the numbers of toad egg masses were too small to perform a statistical analysis. The latter appears to be the case since (1) Burton et al. (2009) appeared to capture few toad metamorphs in pit traps (adult toads appeared to overwhelm the samples), and (2) Schmutzer et al. (2008) did appear to catch enough toad tadpoles to perform statistical analyses. Therefore, while there was a significantly larger number of American toads at grazed wetlands, Schmutzer et al. (2008) and Burton et al. (2009) did provide any evidence of substantive reproduction.

For the 12 other species, combined, that were captured in the study by Burton et al. (2009), they detected no differences in mean daily capture rates between grazed and cattle-excluded wetlands (P > 0.12). Based on their discussion and based on results of Schmutzer et al. (2008) on tadpole response variables for some of these other species, average daily captures were greater for these other amphibian species (primarily frogs) and the P-value is low enough for the results to be of consideration.

While Burton et al. (2009) provides some indication that American toads may require less herbaceous vegetation than frog species at project area wetlands, aspects of the study design bring into question some of the implications they describe in their discussion. In their study, the average daily capture rate of American toads at grazed wetlands was 68-76 times greater than at ungrazed wetlands. This contrasted with the average daily capture rate of green frogs, which was as much as 16-21 times greater (in May and June) at ungrazed wetlands than at grazed wetlands. Possible explanations for the large differences in capture rates for frogs and American toads in Burton et al. (2009) included the lower need for shading and humid microsites by American toads, lower palatability of toads to predators with an implication of less need for hiding cover. However, there are several reasons the higher capture rates of American toads at grazed wetlands may not have indicated a lesser need or little need for herbaceous vegetation:

- No pre-treatment sampling was reported (e.g., as was done in Adams et al. 2009), so it was not possible to determine whether toads had been, prior to treatment, highly abundant at only a small number of wetlands and only at grazed wetlands.
- No data or results of analyses were presented to provide any indication of capture rates per pond, so it was not possible to determine whether, for example, the majority of toad captures were at one pond.
- Vegetation height was measured in a different hydric/vegetation zone than where toads and frogs were captured, and no narrative characterizations of vegetation height or grazing intensity was provided for the zone where frogs and toads were actually captured. Vegetation height was measured halfway into the emergent vegetation zone of wetlands and pitfall traps were located about 33 feet above the high water mark. Vegetation within wetlands performs different functions, with respect to amphibian ecology, than vegetation on shorelines.
- Cattle were excluded from the immediate vicinity of the drift fence and pitfall traps, which appears to have resulted in an ungrazed corridor as wide as about 20-25 feet, according to their Figure 1 (Figure A.19), but may have been as wide as 10 feet or more. Because shoreline vegetation many times is grazed at higher utilization rates than emergent vegetation, the fenced exclosure (around the drift fence and pitfall traps) — if herbaceous cover were an important factor — may have provided a refugia for toads at the grazed wetlands, which would have had the potential of attracting high concentrations of toads (and frogs) compared to the remainder of the shoreline vegetation that was grazed to a shorter height.

The extent to which this information applies to boreal toads is unclear. From the standpoint of toad metamorphs, major reductions in herbaceous vegetation on a shoreline where they congregated appeared to have resulted in desiccation that lead to a high mortality rate (Bartelt 1998, as cited by Maxell 2000:15). If, on the shoreline where the hundreds of toads died as a consequence of desiccation after herbaceous vegetation was eliminated by sheep (as described by Bartelt), there had remained a long narrow strip of herbaceous vegetation similar to what appears to have been provided with the electric fence in the study by Burton et al. (2009), it is possible that many of the toad metamorphs would have moved to this strip of vegetation and possibly not succumbed to desiccation.

Spotted Frogs in Oregon (Shovlain et al. 2006)

Shovlain et al. (2006) conducted a study on the effects of cattle grazing on Columbia spotted frogs in the Fremont-Winema National Forest in southcentral Oregon. The study area consisted of Jack Creek, which ranges from about 3 to 16 ft. wide, runs at a low gradient (<2%), and is at an elevation of about 5,200–5,400 ft. Water sedge dominates riparian communities adjacent to the creek and several other sedge species also occur (e.g., blister sedge, analogue sedge, Nebraska sedge). They did not report on plant species in moist meadow and dry meadow portions of the riparian zone. Old, “depauperate” willow plants were present in places, and beaver have not been documented for the last 30 years, although old sign of beaver activity was found. Cattle grazing is permitted from July 1 through October 1, and consists of 365 cow/calf pairs. The allotment contains about 1,571 acres of riparian habitat and an additional 2,035 areas of wet soil that are also grazed.

They fit 24 frogs with transmitters in 2002 and 36 in 2003, and 13 paired plots consisting of a 15 x 15m exclosure and 15 x 15 m control were established at previously determined high frog-density areas along Jack Creek. Shovlain et al. (2006) used 10-point intercept frames inside and outside exclosures as an index to grazing pressure on a monthly basis from July through September, but they also measured vegetation height on a monthly basis.

Shovlain et al. (2006) found that (1) as pin differences increased by one unit, the odds of finding a frog in the exclosure increased by a factor of 1.62 (p = 0.05) with an approximate 95% confidence interval of 1.00 to 2.74, providing evidence that as grazing pressure increased, frogs increasingly favored habitat within exclosures; (2) with lower grazing pressure, as measured by pin-counts of vegetation that indicated the amount of vegetation removed, Oregon spotted frogs did not show a preference for cattle exclosures or areas grazed by cattle; and (3) with heavier grazing pressure, a large majority of frogs spent most of their time in exclosures. They did not identify a crosswalk between pin-counts and percent utilization or stubble height, and it is possible this transition happened at a relatively high retention level.

Spotted Frogs in Oregon (Bull and Hayes 2000)

Bull and Hayes (2000) conducted a study on the effects of cattle grazing on Columbia spotted frogs in five major river systems of northeastern Oregon. A total of 127 ponds were used in the study, with pond depth averaging about 5 feet deep (ungrazed) and 3.9 feet deed (grazed) and averaged 0.35 acres (ungrazed) and 0.27 acres (grazed). No ranges were provided and prominent emergent and shoreline plant species were identified.

Searches for egg masses were conducted between March 22 and May 20 1997. Water quality was measured at this time and in August. The authors selected 54 of the 127 breeding sites "based on accessibility and grazing activity to assess frog recruitment" (Bull and Hayes 2000:292).

Aside from stating that livestock grazing "occurred some of each watershed sometime between June and October," the authors did not provide any background information on livestock grazing. Evidence of grazing activity at each of the 54 breeding sites was recorded in three ways: degree of utilization, number of dung pats, and trampling (hoof-print density), and all three characteristics were given a rating at each site from 0 to 3 (0 = none, 1 = slight evidence, 2 = moderate evidence, and 3 = extensive evidence). The authors did not provide any additional information on this rating system, but categories of BLM et al. (2008:27) would appear to fit their rating system:

	Comparable BLM et al. (2008:27) Grazing-Use Categories for Herbaceous Veg.		
Bull and Hayes (2000) Rating	Description	% Use Herb Veg.	*% Use of Key Forage Species*
0 (none)	No sign of grazing.	0-5%	*<15%*
1 (slight)	The rangeland has the appearance of very light grazing. The herbaceous forage plants may be topped or slightly used.	6-20%	*6-35%*
2 (moderate)	The rangeland may be topped, skimmed, or grazed in patches.	21-40%	*21-55%*
3 (extensive)	The rangeland appears entirely covered as uniformly as natural features and facilities allow.	41-60%	*41-75%*
	The rangeland has the appearance of complete search. Herbaceous species are almost completely utilized.	61-80%	*61-90%*

The three variables indicating intensity of grazing were all statistically different between grazed and ungrazed breeding sites, as sites were separated into two groups based on grazing intensity: grazed and ungrazed. Measures of livestock activity (utilization, number of dung pats, and trampling) at ungrazed breeding sites ranged from 0 to 1 for each variable and averaged 0, 0.1, and 0.2, respectively. The three measures of livestock activity ranged from 0 to 3 and averaged 1.3, 1.3, and 0.9, respectively. This appears to translate to an average herbaceous retention level in the vicinity of 80% at grazed wetlands. Note that the mid-point for slight (6-20%) use is 13%; thus, although a rating of 1.3 is above a rating 1, 20% use is somewhat above the midpoint of 13%. It is unlikely that the average rating of 1.3 equates to grazing use in the vicinity of 30% because reducing the canopy cover of relatively-intact vegetation by 35-50% and reducing the biomass above 2 inches by 45-75% (two characteristics of 70% retention) indicates more use than what most people would consider "slight evidence" of livestock utilization.

Bull and Hayes (2000) did not detect any statistically significant difference in water quality variables (pH, conductivity, nitrates, dissolved oxygen), the number of egg masses, egg mass volume, or number of tadpoles that completed metamorphosis at the $p < 0.05$ level. The number of egg masses and egg mass volume was equivalent between ungrazed and grazed breeding sites or was 17% higher at grazed breeding sites, but the difference was not statistically significant. The number of tadpoles that completed metamorphosis was 32% lower at grazed sites (ave. = 39) than at grazed sites (ave. = 57). The study did not separate out the potential effects of cattle grazing on egg mass volume and the number of metamorphosed frogs. When the number of eggs are made equivalent between ungrazed and grazed breeding wetlands, as was done in Adams et al. (2009), this translates into 41% fewer tadpoles that successfully metamorphosed into frogs in grazed wetlands compared to ungrazed wetlands. Adams et al. (2009) calculated an *index of survival* from egg mass through metamorphosis for each pond by dividing their estimate of the number of metamorphs by the number of egg masses.) Also, Bull and Hayes (2000) did not assess the number of metamorphs that left the breeding site; the potential exists for substantial mortality between the emergence of metamorphs (which indicated the number of tadpoles that completed metamorphosis in the study) and departure from breeding sites. Figure A.16 provides information that trampling of metamorphs has the potential to be substantive even at relatively high retention levels; the graphs show that trampling could very well have comprised some percentage (anywhere from a small to large percentage) of the 41% fewer metamorphs in grazed ponds.

Although the difference between the number of metamorphs was not statistically different at an alpha level of < 0.05, it is possible they would have been statistically different at an alpha level of $p < 0.10$, 0.15, or 0.20, especially if an "index of survival from egg mass through metamorphosis" were to be incorporated as was done in Adams et al. (2009). This is a reasonable inquiry given the sensitive-species status of spotted frogs (see discussion in Finney 1972:30-35 and Parkhurst 1984, as cited by Howard and Munger 2003; and additional discussion in the "Dealing with Limited Definitive Scientific Information" section in the main report).

Also, although the difference between the number of metamorphs was not statistically different at an alpha level of <0.05, it is reasonable to assume that the number of metamorphs was substantively lower in breeding wetlands with moderate evidence of grazing (rating of 2, or 50% use + or – 10-20%) and extensive evidence of grazing (rating of 3, or ≥60% use), as compared to wetlands that received ratings of 0 or 1, for the following reasons:

- The average number of metamorphed frogs at all grazed breeding wetlands (ratings of 0 to 3, average of 1.3) was 32% lower than the number at ungrazed breeding wetlands, and the percent difference is greater when accounting for the larger egg mass volume in grazed wetlands. The difference would likely be even larger if wetlands with no or slight evidence of grazing were eliminated from consideration.
- Effects of grazing at breeding wetlands with ratings of 2 and 3 appear to have been diluted by effects at the far larger number of breeding wetlands with ratings of 0 and 1. Most grazed breeding sites were given a rating of 1 and several appear to have received a rating of 0 (otherwise the average would not have been so close to a rating of 1). It is unclear why breeding wetlands with no evidence of livestock grazing were placed in the "grazed" category.
- Using $p < 0.05$ as a threshold between significant and non-significant effects, especially without a power analysis, made the possibility of rejecting the null hypothesis of "no effect" (of livestock grazing) very difficult. The analysis used in the study, including the p-value set at 0.05, was set up to make it difficult to make a type I error (i.e., concluding there was an effect when there actually was not). The downside, from the standpoint of applying results to the conservation of sensitive wildlife species, is that this approach makes it more likely to make an error of not detecting a negative effect when one actually occurred.
- The chance of not detecting negative effects when negative effects actually occurred is compounded by the large degree of variability in the study, especially in the level of grazing utilization.

A conclusion of above assessment is that Bull and Hayes (2000) do not provide evidence that moderate or heavy levels of grazing have no negative effects on spotted frogs.

Also, using a significance threshold of $p < 0.5$ without identifying the actual p-values of statistical tests (1) does not allow for interpretation of the results in light of actual p-values, and (2) it is possible that statistical significance existing, with or without adjustments based on an index, at $p < 0.1$, < 0.15, or < 0.2 thresholds. Because of the concern for spotted frogs and boreal toads as sensitive species, a higher p-value would be warranted.

Spotted Frogs in Eastern Idaho (Munger et al. 1994, 1996)

Munger et al. (1994) and Munger et al. (1996) conducted an inventory of amphibians and reptiles in southwest Idaho, with an emphasis on spotted frogs, and they reported on habitat associations, including associations between the presence of adult and tadpole spotted frogs and different intensities of cattle grazing. Inventory was conducted between May 18 and July 9. They inventoried a total of 204 wetland/stream sites and observed adults or tadpole spotted frogs at 44 of these sites. They rated the intensity of grazing in the same way as was described above in the "Spotted frogs in Oregon (Bull and Hayes 2000)" subsection, except that instead of "extensive" for a rating of 3, they characterized it as "heavy" and "substantial." Heavy grazing was characterized by Holechek et al. (2011:141) as 51-60% use of key forage species, which translates to an estimated (31-60% use of total herbaceous vegetation; Appendix B); this corroborates the characterization of "extensive" evidence of grazing in the crosswalk in the "Spotted frogs in Oregon (Bull and Hayes 2000)" subsection, above.

Substantive negative effects of livestock grazing use appear to have begun in the vicinity of 20% utilization of herbaceous vegetation based on the following:

- Munger et al. (1994:6) concluded that "This study found that sites with adult spotted frogs had ratings for grazing pressure that were significantly lower than sites without adult spotted frogs." "Sites with adult spotted frogs had a significantly lower rating for evidence of grazing (an average of 0.769 on a scale of 3) than did sites without adults (average rating 1.262)" (Munger et al. 1994:4). They did not identify the p-value threshold, but it is presumed to be either 0.05 or 0.10.

  The average rating of 1.262 appears to translate to an average herbaceous retention level in the vicinity of 80%. Note that the mid-point for slight (6-20%) use is 13%; thus, although a rating of 1.262 is above a rating 1, 20% use is somewhat above the midpoint of 13%. It is unlikely that the average rating of 1.262 equates to grazing use in the vicinity of 30% because reducing the canopy cover of relatively-intact vegetation by 35-50% and reducing the biomass above 2 inches by 45-75% (two characteristics of 70% retention) indicates more use than what most people would consider "slight evidence" of livestock utilization.

- While there was an equal number of ungrazed wetlands with and without spotted frogs, there were about 3.5x more wetlands-grazed-at-a-rating-of-1 without spotted frogs than there were with spotted frogs (Figure 20.b). This indicates that, if wetlands with a grazing-rating of 1 provided suitable habitat, there was substantial opportunity for greater occupancy by spotted frogs.

  A rating of 1 ("slight evidence" of grazing) appears to translate to a retention level in the vicinity of 80%, based on the chart in the "Spotted Frogs in Oregon Bull and Hayes 2000)," above. The rating actually corresponds to 6-20% use (80-94% retention), but the low end of this range probably is lower than grazing that was identified as slight in Munger et al. (1994).

- While the distribution of non-occupied wetlands across grazing ratings (row B, below) was similar to the total availability of wetlands across grazing ratings (row A), the distribution of occupied wetlands across grazing ratings (row C) was substantially different than the total availability of wetlands across grazing ratings (row A). In particular, ungrazed wetlands were used more than their availability and wetlands grazed at ratings 2 and 3 were used less than their availability, indicating that ungrazed wetlands were more favorable than grazed wetlands. Wetlands grazed at rating of 1 were used approximately equal to their availability. This provides some indication that grazing at 20% use of herbaceous vegetation may not be as detrimental as information in the previous two bullets suggest. Figure A.20.a provides a visual display of this. No information was provided in Munger et al. (1994) indicating the success of reproductive efforts at each level of grazing.

	Grazing Rating			
	0	1	2	3
A. Availability of Wetlands (n = 172)	31 (18%)	87 (51%)	44 (26%)	10 (6%)
B. Non-use by Spotted Frogs (n = 132)	16 (12%)	67 (51%)	40 (30%)	9 (7%)
C. Occupied by Spotted Frogs (n = 40)	16 (40%)	20 (50%)	4 (10%)	<1 (2%)

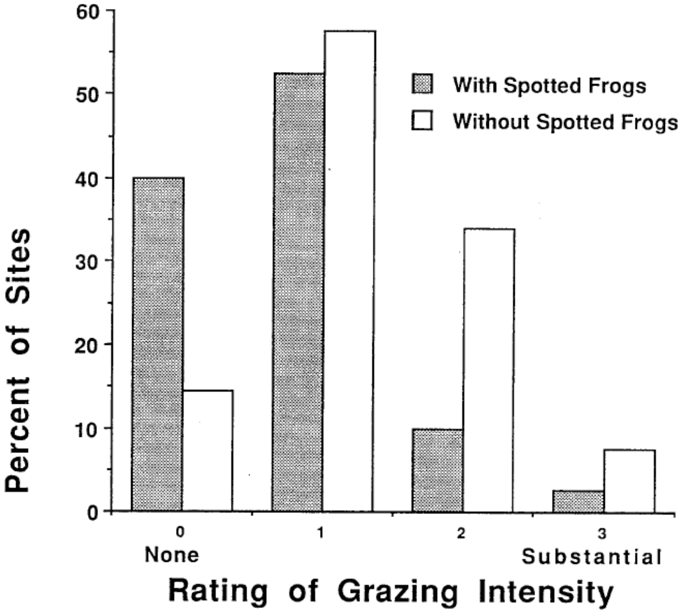

Figure A-20.a. This is Figure 1 of Munger et al. (1994:7): Relative grazing intensity at 40 sites at which spotted frog tadpoles and/or adults were found and at 132 sites at which neither spotted frog adults nor spotted frog tadpoles were found. Each set of bars (gray and white) adds to 100%.

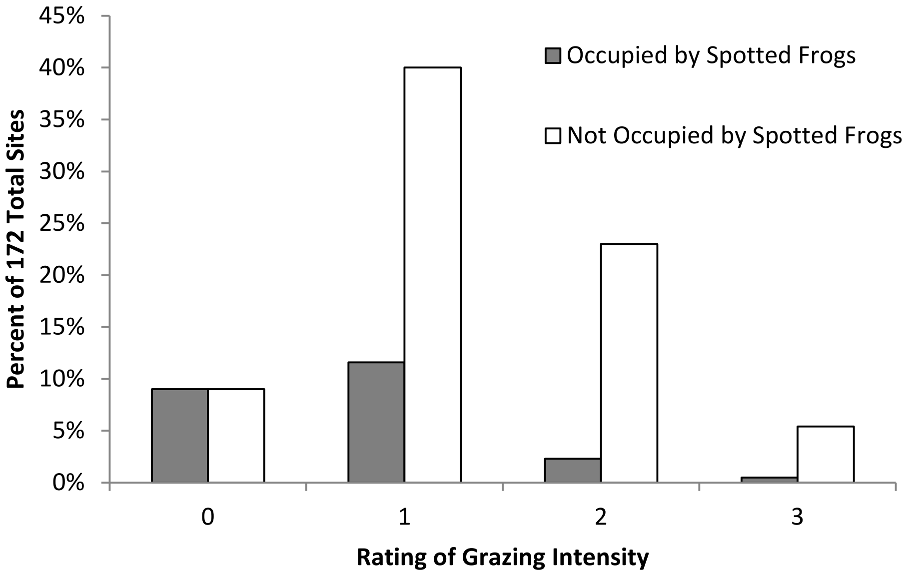

Figure A-20.b. Percent of sites (172 total) at which spotted frog tadpoles and/or adults were found and at which neither spotted frog adults nor spotted frog tadpoles were found, based on information in Figure 1 of Munger et al. (1994). All bars combined add to 100%.

Munger et al. (1994) shows that (1) ungrazed wetlands are more favorable than ungrazed wetlands, (2) herbaceous retention in the neighborhood of 80% was a threshold between suitable and unsuitable conditions for spotted frogs, and (3) grazing at >20% was sufficient to substantively reduce the occurrence of spotted frogs at wetlands. Grazing use at higher levels (ratings of 2 and 3, or 21-40% use and 41-60% use or greater) had considerably more impact on spotted frog occupancy. At ratings of 2 and 3, there were 10x more wetlands unoccupied by spotted frogs than there were wetlands occupied by spotted frogs (Figure A.20.b).

In 1996, the authors found no statistically significant effects of livestock grazing on spotted frog occurrence, although (1) they observed more evidence of grazing at sites without spotted frogs than at sites with spotted frogs, and (2) breeding sites tended to have lower overall grazing intensity than did non-breeding sites. The authors unfortunately did not provide any information on results of this part of their study or the statistical analysis. While they did not find any statistically significant effects of livestock grazing on spotted frogs, they did not document any analysis demonstrating that livestock grazing did not have any statistically significant effects on spotted frog occurrence. It is possible that livestock grazing had some effect on the occurrence of spotted frogs given ‘1’ and ‘2,’ above.

Dragonflies and Damselflies (Hornung and Rice 2003, and Foote and Rice Hornung 2005)

The only example found of the effects of different retention levels of vegetation on wetland invertebrates was a study by Hornung and Rice (2003) and Foote and Rice Hornung (2005). Dragonflies and damselflies are among the invertebrates commonly eaten by spotted frogs (Patla and Keinath 2005). Based on observations of Pearl et al. (2005), it is possible that damselflies and dragonflies comprise an important food source for some populations at some times of the year.

The studies by were conducted in 27 emergent marsh wetlands in southeastern Alberta. Each wetland had a ≥5 year history of either ungrazed by livestock, deferred grazing, or season-long grazing, and each was continued through the study. Deferred grazing occurred during mid-July through mid-August and season-long grazing occurred May through August.

There were 6 sample periods of odonates (dragonflies and damselflies) and water quality, 1 every 2 weeks. Vegetation was measured near peak standing crop at the end of the summer. It was measured using a Robel pole to integrate vegetation height and density.

Robel pole readings in sedge plots averaged about 19.7 inches in ungrazed wetlands, 7.3 inches in wetlands with deferred grazing (37% of ungrazed wetland measure), and 9.1 inches in wetlands grazed season long (46% of ungrazed wetland measure). Robel pole readings in hardstem bulrush plots averaged about 23.6 inches in ungrazed wetlands, 8.3 inches in wetlands with deferred grazing (35% of ungrazed wetland measure), and 11.2 inches in wetlands grazed season long (47% of ungrazed wetland measure). This information was obtained from Figures 3 and 5 in Foote and Rice Hornung (2005). The “percent of ungrazed measure” in each case represents the percent of Robel pole readings retained through the grazing season.

About 37% and 35% of ungrazed Robel pole measures were retained in carex-dominated and hardstem bulrush-dominated sites, respectively, that received deferred grazing (Foote and Rice Hornung 2005); using information in Table A.2 of this report, these percentages translate into an estimated 60% and possibly as high as 70% retention of total herbaceous vegetation, on average. About 46% and 47% of ungrazed Robel pole measures were retained in carex-dominated and hardstem bulrush-dominated sites, respectively, that were grazed season long; using information in Table A.2 of this report, these percentages translate into an estimated 70% and possibly as low as 60% retention of total herbaceous vegetation, on average. A similar, but weaker pattern was found in silver sagebrush communities adjoining marshes.

Foote and Rice Hornung (2005) determined that dragonfly and damselfly species diversity declined with the decreasing Robel pole readings in sedge and hardstem bulrush communities, and found there to be statistically significant correlations. Below a sedge height of about 16 inches (40 cm) — compared to ungrazed heights of about 18-28 inches — species richness and abundance quickly declined to half or less and possibly as much as an 80-90% reduction on some sites (Figures 4 and 6 of Foote and Rice Hornung 2005). Compared to ungrazed heights of about 18 to 28 inches, the apparent 16-inch threshold appears to occur in the neighborhood of 80% or possibly as low as 70% retention of total herbaceous vegetation because the 16-inch threshold represents a retention of 57-89% of Robel pole readings (Table A.2). In a previous study that involved fewer wetlands, the diversity of dragonflies and damselflies declined as grazing intensity increased ($p = 0.06$, $r^2 = 0.23$) according to the Shannon-Weiner Diversity Index (Hornung and Rice 2003), but a threshold was not apparent.

Foote and Rice Hornung (2005) did not detect any significant differences (at the $p = 0.10$ level) in water quality (e.g., total dissolved solid (TDS) urine indicators) between grazed and ungrazed wetlands. However, they did not present any data or results of specific tests, so there is no way to ascertain the potential of livestock grazing use affecting water quality despite effects not being detected at the $p = 0.10$ level. Therefore, it is possible that differences between grazed and ungrazed wetlands occurred, but there is no way to ascertain this.

Additionally, in an earlier study in the same study area, Hornung and Rice (2003) found ammonium levels to be significantly higher in mid-July ($p = 0.062$) and possibly in late August ($p = 0.156$) in grazed wetlands than in ungrazed wetlands, and orthophosphates were found to be significantly higher ($p = 0.085$ in mid July and $p = 0.066$ in late August) in grazed wetlands than in ungrazed wetlands. (They did not measure nitrate and nitrite levels.) Grazing intensity in their study was ascertained by estimating percent of plant stems that were grazed, and this provides a rough indication of the percent canopy cover of relatively-intact vegetation that remains after grazing. Ten of 16 wetlands were grazed, with percent of stems grazed ranging from about 10% to 58% (average = 26%), with 7 of the 10 wetlands having 10-22% of stems grazed. To the extent that percent of plant stems grazed indicates percent canopy cover of relatively-intact vegetation, the average percent of stems grazed (26%) most closely align with 80% (possibly as low as 70%) retention of total herbaceous vegetation (Table A.2), which is comparable to the estimate of retention for Foote and Rice Hornung (2005) using a different cross-walk. The range of stems grazed (10-58%) most closely aligns with a 60-90% retention of total herbaceous vegetation, with 7 of 10 of the grazed wetlands (10-22% of stems grazed) possibly having retention levels of 80-90%.

Criteria for Identifying Level of Support for Assessments

This section outlines the considerations used in identifying the level of support for conclusions made on individual habitat elements with respect to progressively lower herbaceous-retention levels.

An important point is that — in the process of delineating suitable conditions for spotted frogs and boreal toads — we are mainly talking about the degree of scientific support for deviations away from near-100% retention of herbaceous vegetation and associated intensity of livestock grazing use (the basis for this is outlined in the “Near-100% Herbaceous Retention as a Starting Point of Assessment” subsection, above). To be clear, we are not talking about the degree of support for conditions that deviate from existing conditions; there is no legal, regulatory, or policy basis for taking this approach with respect to defining suitable conditions and habitat objectives for sensitive species on National Forest System lands.

Therefore, if support for a given herbaceous retention level (and associated intensity of livestock grazing use) is identified as being inadequate, then incrementally higher retention levels would need to be examined until an adequate level of support is reached.

Strong Support or Large Amount of Evidence

For a conclusion of “strong support” or “large amount of evidence” to be made, either 1 or 2 would need to apply, and 3, 4, and 5 would need to apply:

1. Several scientific studies provide direct evidence (i.e., statistically-significant beneficial effects) supporting an assessment that the retained biomass above 2 inches, canopy cover of relatively-intact vegetation, and vegetation height are high enough (or low enough) to meet the species’ needs associated with these attributes, and that the associated livestock grazing-use intensity is low enough to avoid or minimize reductions in water quality, water levels, and survival due to trampling. (For studies that appear to support the assessment because they failed to reject a null hypothesis, it would take several studies in different areas to begin providing support.)
2. A large amount of scientific information on individual aspects of the habitat element shows that retained biomass above 2 inches, relatively-intact canopy cover, and height are sufficient to meet the particular

needs typically provided by these structural attributes and that associated livestock grazing-use intensity is low enough to avoid or greatly minimize reductions in physiological condition or survival of tadpoles, metamorphs, and/or adults.

3. There is little if any information showing that the retained biomass above 2 inches, relatively-intact canopy cover, and/or height are too high to meet the species' needs associated with the particular habitat element.
4. There is little or no scientific information demonstrating that (a) the retained biomass above 2 inches, relatively-intact canopy cover, and/or height are otherwise insufficient to meet the species' needs associated with the particular habitat element or (b) the associated livestock grazing-use intensity is not low enough for impacts to remain at low levels with respect to water quality, declines in water levels, and mortality due to trampling.
5. There are no studies and there is no more than a negligible amount of scientific information on individual aspects of the habitat element showing that (a) reducing the biomass above 2 inches, relatively-intact canopy cover, and height to the identified level would have substantive negative effects on spotted frogs and/or boreal toads; and (b) associated livestock grazing-use intensity is high enough to contribute to reductions in water quality, water levels, and survival due to trampling that have substantive potential to reduce physiological condition or survival of tadpoles, metamorphs, and/or adults.

Moderate Support or Moderate Amount of Evidence

Support or evidence is lower than outlined for "Strong Support or Large Amount of Evidence," above, but it is higher than support or evidence outlined for "Low Amount of Evidence or Weak Support," above.

More specifically, for a conclusion of "moderate support" or "moderate amount of evidence" to be made, either 1 or 2 would need to apply, and 3 and 4 would both need to apply:

1. One or two scientific studies (or more if the number of studies under 'a' is similar) provide direct evidence (i.e., statistically-significant beneficial effects) supporting an assessment that the retained biomass above 2 inches, canopy cover of relatively-intact vegetation, and vegetation height are high enough (or low enough) to meet the species' needs associated with these attributes, and that the associated livestock grazing-use intensity is low enough to avoid or minimize reductions in water quality, water levels, and survival due to trampling, and/or adults, <u>and</u> either:
   a. One or two other studies (or more, as explained above) do not support the assessment; or
   b. Results of the supporting studies conflict somewhat with scientific information on individual aspects of the habitat element relative to retained biomass above 2 inches, relatively-intact canopy cover, and height, or to the associated intensity of livestock grazing use.

   On balance, this information shows that the retained biomass above 2 inches, relatively-intact canopy cover, and height are sufficient to meet the particular needs typically provided by these structural attributes and that associated livestock grazing-use intensity is low enough to avoid or greatly minimize reductions in water quality, water levels, and survival due to trampling.
2. Several sources of scientific information on individual aspects of the habitat element show (both a and b):
   a. Retained biomass above 2 inches, relatively-intact canopy cover, and height are sufficient to meet the particular needs typically provided by these structural attributes, and either:
      i. other sources of scientific information provide some evidence that habitat needs associated with these structural attributes would not be met, or
      ii. the conditions would be near the edge of what the scientific information shows as being suitable.
   b. The associated intensity of livestock grazing-use is low enough to avoid or minimize reductions in water quality, water levels, and survival due to trampling, and either:
      i. other sources of scientific information provide some evidence reductions would not be minimal, or

    ii. scientific information, as a whole, shows variability in effects from situation to situation depending on a range of variables, but this body of information shows that reductions would be minimal in most situations.

3. The retained biomass above 2 inches, relatively-intact canopy cover, and/or height at the specified retention level overlap with the published qualitative descriptions of vegetation structural requirements/preferences of spotted frogs and/or boreal toads.
4. There are one or two studies and/or there is at least some scientific information on individual aspects of the habitat element showing that (a) reducing the biomass above 2 inches, relatively-intact canopy cover, and height to the identified level would have substantive negative effects on spotted frogs and/or boreal toads; and (b) associated livestock grazing-use intensity is high enough under some situations to contribute to reductions in water quality, water levels, and survival due to trampling that in turn would have substantive potential to reduce physiological condition or survival of tadpoles, metamorphs, and/or adults in these situations.

Weak Support or Low Amount of Evidence

For a conclusion of "weak support" or "low amount of evidence" to be made, 1 and 2 would need to apply, and 3, 4, and 5 may apply (they would strengthen the conclusion):

1. There are no scientific studies that provide direct evidence (i.e., statistically-significant beneficial effects) supporting an assessment that the retention level is high enough (or low enough) to meet the particular needs provided by the vegetation structure and composition at this retention level, and that the associated livestock grazing-use intensity is low enough to avoid or minimize reductions in water quality, water levels, and survival due to trampling. Or, if one or two scientific studies provide direct evidence, it is outweighed by scientific information that either does not support such an assessment or provides evidence to the contrary.
2. Only 1 or 2 sources of scientific information on individual aspects of the habitat element show that (a) the retained biomass above 2 inches, relatively-intact canopy cover, and height are sufficient to meet the habitat needs of spotted frogs and boreal toads associated with these attributes, <u>but</u> most sources of scientific information on the subject do not show that habitat needs would be met and some of this information provides evidence that needs would not be met; and (b) the associated intensity of livestock grazing-use is low enough to avoid or greatly minimize reductions in water quality, water levels, and survival due to trampling, <u>but</u> most sources of scientific information on the subject do not show that impacts would remain minimal and some of this information provides evidence that reductions would be substantive.
3. The retained biomass above 2 inches, relatively-intact canopy cover, and/or height at the specified retention level generally does not overlap with the published qualitative descriptions of vegetation structural requirements/preferences of spotted frogs and/or boreal toads, or is marginal.
4. The preponderance of scientific information demonstrates that the retention level is insufficient to meet the species' needs associated with the particular habitat element or that the associated livestock grazing-use intensity is high enough to substantively reduce water quality, water levels, and survival due to trampling which in turn would reduce physiological condition or survival of tadpoles, metamorphs, and/or adults.
5. There are several studies and/or there is a moderate to large amount of scientific information on individual aspects of the habitat element showing that (a) reducing the biomass above 2 inches, relatively-intact canopy cover, and height to the identified level would have substantive negative effects on spotted frogs and/or boreal toads; and (b) associated livestock grazing-use intensity is high enough to reduce water quality, water levels, and survival due to trampling that have substantive potential to reduce physiological condition or survival of tadpoles, metamorphs, and/or adults.

No Support

For a conclusion of "no support," 1 and 2 would need to apply, and 3, 4, and 5 may apply (they would strengthen the conclusion of no support):

1. No scientific studies provide direct evidence (i.e., statistically-significant beneficial effects) supporting an assessment that the retention level is high enough (or low enough) to meet the particular needs provided by the vegetation structure and composition at this retention level, and that the associated livestock grazing-use intensity is low enough to avoid or minimize reductions in physiological condition or survival of tadpoles, metamorphs, and/or adults.
2. No sources of scientific information on individual aspects of the habitat element show that (a) the retained biomass above 2 inches, relatively-intact canopy cover, and height are sufficient to meet the species' needs associated with these attributes; and (b) the associated intensity of livestock grazing-use is low enough to avoid or greatly minimize reductions in physiological condition or survival of tadpoles, metamorphs, and/or adults.
3. The retained biomass above 2 inches, relatively-intact canopy cover, and/or height at the specified retention level does not overlap with the published qualitative descriptions of vegetation structural requirements/preferences of spotted frogs and/or boreal toads.
4. The preponderance of scientific information demonstrates that the retention level is insufficient to meet the species' needs associated with the particular habitat element or that the associated livestock grazing-use intensity is high enough to substantively reduce water quality, water levels, and survival due to trampling which in turn would reduce physiological condition or survival of tadpoles, metamorphs, and/or adults.
5. There are several studies and/or there is a moderate to large amount of scientific information on individual aspects of the habitat element showing that (a) reducing the biomass above 2 inches, relatively-intact canopy cover, and height to the identified level would have substantive negative effects on spotted frogs and/or boreal toads; and (b) associated livestock grazing-use intensity is high enough to reduce water quality, water levels, and survival due to trampling that have substantive potential to reduce physiological condition or survival of tadpoles, metamorphs, and/or adults.

≥90% RETENTION OF TOTAL HERBACEOUS VEGETATION

There is strong evidence that 90% to near-100% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, especially where herbaceous species composition is somewhat altered (i.e., a species composition that provides lower than natural height and/or canopy cover). A retention level of ≥90% would satisfactorily "…minimize impacts to species whose viability has been identified as a concern," as required by FSM 2670.32 (WO Amendment 2600-2005-1). All assessments in this section assume that plant communities have are relatively natural structure[L] (e.g., height and vegetation density) are in healthy functioning condition. To the extent a plant community is not, higher retention levels may be needed to adjusted upward to get the same effect. A minimum of 90% retention roughly translates to a maximum 10-40% utilization of key forage species (Appendix B).

The strong support for the above assessment is based on ≥90% retention of herbaceous vegetation providing highly suitable: (1) hiding cover for tadpole, juvenile, and adult frogs and toads in breeding and summer-long habitat; (2) protection from the sun and ground-level humidity for juvenile and adult frogs and toads on breeding-pool shorelines and in summer-long habitat; (3) hiding cover and structure within wetlands for tadpoles; (4) hiding cover and protection from the sun for metamorphosed and adult frogs and toads on shorelines; (5) forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat; and (6) contributions to the following year's residual thatch and litter which in turn contributes to hiding

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[L] For spotted frogs and boreal toads, this can include non-native species so long as they contribute to, and do not detract from, relatively natural vegetation structure. Kentucky bluegrass and smooth brome, when they are abundance, do not.

cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities; as well as indicating suitable (7) water quality (as related to urination, defecation, and trampling); survival as related to trampling of tadpole, juvenile, and adult frogs and toads in and adjacent to breeding and summer wetlands pools and in migration habitat; (8) water retention in small breeding pools; (9) soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (10) integrity of near-surface burrows used by frogs and toads; and (11) retention of overhanging streambanks used by frogs or toads for hibernation. This basis for this is outlined in the following eight pages.

Some of the subsections in this section are relatively short because ≥90% is fairly close to 100% retention (see the "Near-100% Herbaceous Retention as a Starting Point"), there is moderate to moderately-strong evidence that ≥70% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, and because ≥70% retention is covered in detail. In other words, because ≥70% retention is deemed to retain suitable habitat conditions for spotted frogs and boreal toads, albeit at the very edge of suitability, this would mean that ≥90% retention would also retain suitable habitat conditions. The structural attributes of herbaceous vegetation when retention of herbaceous vegetation is near-100% and 90% appears to be sufficiently close to pre-livestock-grazing characteristics and natural conditions to not need a detailed assessment of each of the habitat elements.

Summary of Key Amphibian–Livestock Grazing Studies

Support for ≥90% Retention as a Threshold

Results of Bull and Hayes (2000), Shovlain et al. (2006), Adams et al. (2009), Roche et al. (2012b), Roche e t al. (2012b), and McIlroy et al. (2013) lend at least support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, recognizing that failure to detect effects of a treatment does not provide strong support for a conclusion of "no treatment effect:"

- No effects in tadpole survival and water quality were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009), meaning that no effects would have been expected in their study at a retention level of 90%.
- Roche et al. (2012b) did not statistically detect effects of ≤25% utilization of herbaceous vegetation on toad occupancy of meadows.
- Roche et al. (2012a) and McIlroy et al. (2013) did not statistically detect effects of an estimated ≤15% utilization of herbaceous vegetation on toad occupancy, tadpole density, water quality, or water temperature in breeding wetlands.
- Shovlain et al. (2006) found that spotted frogs did not preferentially use habitat inside exclosures when livestock grazing was fairly light; utilization or retention were not quantified in a way that percent retention could be determined, but 90% retention certainly would have qualified as less than light grazing pressure in the study.
- Bull and Hayes (2000) did not detect a significant difference ($p < 0.05$) in tadpole survival between ungrazed wetlands and grazed wetlands, which are estimated to have had 80% of herbaceous vegetation retained.

Results Not Pertinent to Assessment of ≥90% Retention as a Threshold

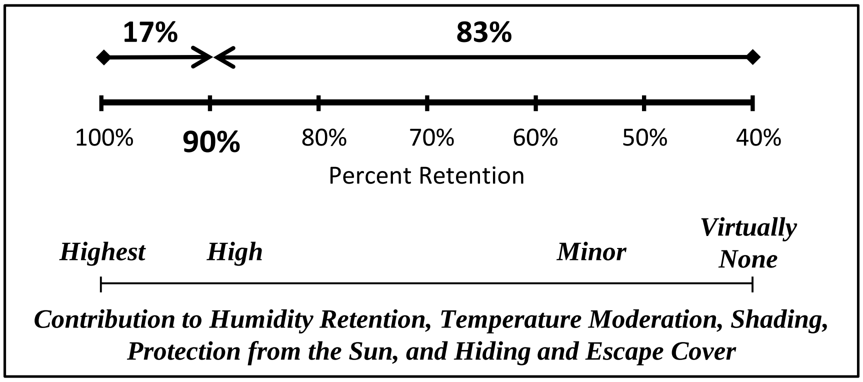
Results of Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) do not support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, but they also do not provide any indication that ≥90% retention of total herbaceous vegetation is insufficient. This is because, although negative effects were detected in each of these studies, it was at a grazing use rate that was higher than 10%.

Examination of Herbaceous Structural Attributes at 90% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Humidity Retention, Temperature Moderation, and Protection from the Sun;” “Hiding and Escape Cover;” “Forage for Tadpoles;” and “Forage, Cover, and Substrate” sections). These sections should be consulted for desired conditions. Material in the “Roles of Herbaceous Canopy/Retention and Openings” section is not repeated below and should be consulted as background information.

The following information sets the stage for this section by numerically characterizing 90% retention of total herbaceous vegetation:

- In herbaceous communities and understories that are in healthy condition, 90% retention of total herbaceous vegetation would retain a large majority of the plant material that contributes to amphibian cover and insect forage and cover (Table A.2, Figure A.14), which puts it at the high end of suitability for nearly all habitat and survival elements. More specifically, 90% retention of total herbaceous vegetation would retain:
    - An estimated 85-100% of the canopy cover of relatively intact herbaceous vegetation, based on DeLong (2009b:Table 11) (Table A.2, Figure A.14, Figure A.8).
    - An estimated 75-88% of the biomass of herbaceous vegetation above a 2-inch height, based on height-weight relationships in Kinney and Clary (1994) and BLM et al. (1999:118) including the exclusion of the weight of the bottom 2 inches of plants based on their information.
    - 70-100% of starting Robel pole readings compared to pre-grazing readings, based on DeLong (2009a) and additional data collected in 2011. These direct measures of visual obstruction, which substantiate the information in the above two bullets, provide a good indication of the degree to which hiding cover qualities are retained.
    - 45-80% of plant height if vegetation is grazed at an even height (e.g., sedge communities), based on height-weight relationship information in Kinney and Clary (1994) and BLM et al. (1999:118) (Table A.2, Figure A.14, Figure A.9).
- This numeric characterization of herbaceous communities having 90% retention generally fits within and is generally consistent with the narrative characterization of the 6-20% utilization class of the landscape appearance method in BLM (2008:27): “The rangeland has the appearance of very light grazing. The herbaceous forage plants may be topped or slightly used.”



Retaining an estimated 85% to as much as nearly 100% of the canopy cover of herbaceous vegetation would retain a large portion to nearly all of the attributes of the vegetation that provides hiding cover, retains humidity near the ground, moderates temperatures, provides shade, and provides habitat for a range of invertebrate prey species. This assessment is primarily for communities with naturally moderate-height to tall, dense herbaceous vegetation, and they assume plant communities are at near fully functioning conditions. Support for assessments made in the following pages progressively declines with progressively lower ecological conditions (i.e., as factors such as overall canopy cover and plant species richness decline). The assessment in the first sentence of this paragraph is based on information provided for each of six habitat elements in the following subheadings (see the “Role of Herbaceous Retention” section for background information on each element). Potentially as little as 45% of the biomass of vegetation above a 2-inch height being retained indicates that retention of these habitat elements (e.g., hiding cover, shading, humidity retention) may be lower than “large” in the shorter herbaceous communities and understories, and possibly in dry years. This caveat is also discussed in the following subheadings as pertinent.

Humidity Retention and Temperature Moderation

There is strong support for the assessment that (1) retaining a minimum of approximately 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 75-88% of the herbaceous biomass above 2 inches in moist-meadow type communities, and (2) retaining 65-80% of sedge height above 2 inches (68-82% of total height) in sedge communities would maintain enough humidity retention and temperature moderation attributes to contribute to suitable habitat for spotted frogs and boreal toads. Retaining ≥85% of the canopy cover of relatively-intact herbaceous vegetation would maintain most of the humidity-retaining and temperature-moderating qualities of pre-grazed meadow vegetation (see next paragraph). Even though a moderate to large amount of the “drooping” plant material forming a canopy in sedge communities would be removed at this level of grazing use (assuming even grazing), retaining roughly 70-85% of the height of sedges would retain a large portion of the humidity retention and temperature moderation attributes in sedge communities.

Marlatt (1961) found evidence of an apparent cooling effect and humidity-retention effect within 1 inch of the ground surface when herbaceous canopy cover was ≥70%, but did not find this in the 50%, 30%, and 0%-canopy-cover plots (as illustrated in Figure A.12.d). As a general principle, higher percentages of canopy cover of relatively-tall herbaceous vegetation retain higher levels of near-ground humidity and moderate near-ground temperatures more than lower percentages (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000).

A major amount of intact and relatively-intact canopy cover would remain, which would effectively hold in humidity and moderate temperatures. Even where starting canopy cover is lower than near-100%, a small reduction in relatively-intact canopy cover would likely have limited effect on humidity retention and temperature moderation.

Wind and solar radiation are important factors influencing near-ground humidity levels and temperatures. Greatly reduced wind speed near the ground surface is central to retaining near-ground humidity and moderating near-ground temperatures (Marlatt 1961, Cionco 1972, Oke 1978:118-119, Baldocchi et al. 1983), and retaining ≥85% of the canopy cover of relatively-intact herbaceous vegetation would prevent any measurable increases in near-ground wind that would otherwise reduce humidity and move near-ground air temperature toward ambient (above-canopy) temperatures (see “Humidity Retention, Temperature Moderation, and Protection from the Sun” section of this appendix for supporting literature). Minimizing the amount of solar radiation reaching the soil surface and basal plant material also helps retain near-ground humidity and moderate near-ground temperatures because radiant energy reaching the soil surface heats the soil surface and basal plant material, which increases day-time temperatures immediately above the soil surface and, subsequently, contributes to reductions in near-ground humidity levels. Marlatt (1961) found that net radiant energy over the 70%-canopy-cover plots was virtually equal to that measured over full grass cover, meaning that ≥85% of the canopy cover of relatively-intact herbaceous vegetation would do the same.

Results of Roche et al. (2012b) lend support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable humidity retention and temperature moderation attributes for toads in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The study does not provide direct evidence of this since humidity and temperature were not monitored, but no effects of ≤25% utilization of herbaceous vegetation were statistically detected on toad occupancy of meadows, and 82% of these meadows had <10% utilization (≥90% retention). Also, 96% of these meadows had <20% utilization (≥80% retention).

Shade and Protection from the Sun

There is strong support for the assessment that retaining a minimum of approximately 85-100% of the canopy cover of relatively-intact herbaceous vegetation in moderate height to tall, dense herbaceous communities would retain enough of the vegetation qualities to provide suitable shading and protection from the sun on shorelines, in movement corridors, and in summering habitat. Retaining this proportion of relatively-intact herbaceous canopy in moderate-height and tall herbaceous communities having relatively high canopy cover would maintain nearly all of the pre-grazing opportunities for frogs and toads to find shade and protection from the sun. Even in less dense and in short-statured herbaceous communities, a large majority of pre-grazing opportunities for them to find shade and protection from the sun would be maintained.

Shading and protection from the sun was separated out from the discussion of humidity retention because, while shading contributes to the retention of humidity and moderation of temperatures near ground level, it can conceivably be provided in patches even if the vegetation does not retain near-ground humidity and does not moderate temperatures.

Roche et al. (2012b) lends at least some support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable shading and protection from the sun in meadow habitat. The study does not provide direct evidence of this since shading and protection from the sun were not monitored, but no effects of ≤25% utilization of herbaceous vegetation as measured in July were statistically detected on toad occupancy of meadows in June and July, and 82% of these meadows had <10% utilization (≥90% retention). Also, 96% of these meadows had <20% utilization (≥80% retention).

Roche et al. (2012a) and McIlroy et al. (2013) also may lend some support for this assessment on shorelines, but shading and protection from the sun were not measured and retention levels on shorelines were somewhat higher (≥85% or possibly even ≥90%). The authors did not detect any significant differences in toad occupancy or the number of young-of-the-year at breeding pools among treatments (ungrazed meadows and grazed meadows). Retention levels were likely ≥85% at breeding sites.

Hiding and Escape Cover

There is strong support for the assessment that (1) retaining a minimum of approximately 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 75-88% of the herbaceous biomass above 2 inches in moist-meadow type communities, and (2) retaining 65-80% of sedge height above 2 inches (68-82% of total height) in sedge communities would maintain enough of the vegetation qualities to provide suitable hiding and escape cover in wetlands, on shorelines, in movement corridors, and in summering habitat. The “retained” Robel pole readings provide a good indication of the cover qualities that are retained at different retention levels. In moderate to tall herbaceous communities (e.g., those with the predominant leaf tuft height exceeding 12 inches), post-grazing readings would be expected to be in the upper half of the 70-100% range identified previously, meaning that 90% retention in these plant communities retains a large proportion of hiding-cover qualities. Even in short-statured herbaceous communities, a large majority of pre-grazing hiding and escape cover, what little exist, would be maintained at 90% retention of herbaceous vegetation.

As the potential for predation increases (e.g., predation of tadpoles by fish and tiger salamander larva, predation of adult frogs by ravens), the need for hiding and escape cover for tadpoles, metamorphs, and adults correspondingly increases. Enough hiding and escape cover would remain available for adults while they are in breeding and summering pools, tadpoles in breeding pools, metamorphs on shorelines, and juveniles and adults while they are moving from wetland to wetland or otherwise using non-wetland habitat. Retaining 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 70-100% of pre-grazing Robel pole readings means that trampling effects on vegetation in wetlands would be at a level that livestock only push a negligible or minor amount of vegetation down into the mud where it becomes unavailable for use by tadpoles and adults as hiding cover.

Roche et al. (2012b) lends at least some support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable hiding and escape cover in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The study does not provide direct evidence of this since hiding-cover qualities of vegetation were not monitored, but no effects of ≤25% utilization of herbaceous vegetation as measured in July were statistically detected on toad occupancy of meadows, and 82% of these meadows in June and July had <10% utilization (≥90% retention).

Roche et al. (2012a) and McIlroy et al. (2013) also may lend some support for the assessment that ≥90% retention of total herbaceous vegetation retains suitable hiding and escape cover in breeding wetlands (both in the water column and at the water surface), on shorelines, and in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The authors did not detect any significant differences in tadpole densities, toad occupancy, or the number of young-of-the-year at breeding pools among treatments (ungrazed meadows and grazed meadows), and grazing levels appears to have been ≤10-15% in wetlands.

Tadpole Forage

There is strong support for the assessment that retaining a minimum of an estimated 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 75-88% of herbaceous biomass above 2 inches would retain enough of the vegetation qualities in large enough patches in breeding wetlands to provide suitable forage and forage substrate for tadpoles in the current year and future years, assuming that pre-grazed canopy cover of sedges and other herbaceous vegetation is moderate to relatively high. This includes only a negligible or minor amount of vegetation being pushed down into the mud where it becomes unavailable for direct use by tadpoles either as standing vegetation or as decaying vegetation, or for indirect use by tadpoles (e.g., as substrate for algae).

Results of Roche et al. (2012a) lend some support for sufficient tadpole forage being provided in breeding wetlands where ≥85% of total herbaceous vegetation is retained within breeding wetlands. Herbaceous production in meadows was high in their study (ranged of about 1,330-3,065 pounds/acre and average of about 2,327 pounds/acre) and canopy cover in Roche et al. (2012b) — which is likely representative of breeding wetlands in Roche et al. (2012a) — ranged from 56% to 80% within breeding wetlands, indicating a relatively large amount of herbaceous material being added to the detritus layer each year, even with as much as 10-15% of the biomass being removed on a yearly basis.

The data for the Greater Yellowstone area, identified above in the “Hiding Cover” subsection applies here as well.

Invertebrate Forage, Cover, and Substrate

There is strong support for the assessment that (1) retaining a minimum of approximately 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 75-88% of the herbaceous biomass above 2 inches in moist-meadow type communities, and (2) retaining 65-80% of sedge height above 2 inches (68-82% of total height) in sedge communities would maintain enough of the vegetation qualities to provide suitable habitat for all or nearly all invertebrate species dependent on natural or relatively-natural meadow conditions. There is strong support for this retention level providing for the prey needs of spotted frogs and boreal toads primarily since conditions reflective of ≥90% retention are close to the conditions under which amphibian communities formed in this part of Wyoming. Where 85-100% of the canopy cover and 75-88% of herbaceous biomass above 2 inches are retained, this would maintain a large majority or nearly all of the pre-grazing meadow characteristics, meaning there is a high likelihood that invertebrate communities would not change substantially post-grazing.

As a general principle, invertebrate communities that developed in mountain meadows that typically received no more than light grazing, formed under the influences of relatively tall herbaceous vegetation, a high percent canopy cover, relatively high species composition in moist meadows, and the microclimatic conditions associated with this vegetation structure (see the “Forage, Cover, and Substrate for Invertebrate Prey” section in the “Roles” portion of this appendix for supporting references). Retaining 85-100% of the canopy cover of relatively-intact herbaceous vegetation and 75-88% of the biomass of herbaceous vegetation above 2 inches would retain a large majority of the characteristics of mountain meadows and, therefore, should satisfactorily provide for the needs of most invertebrate species. This is supported by a large volume of literature, mostly by virtue of the characteristics of the plant community changing by such a small degree. Some of this literature is cited in the “Forage, Cover, and Substrate for Invertebrate Prey” section earlier in the appendix (e.g., Morris 1983, Welch et al. 1991, Morris 2000, Kruess and Tscharntke 2002, Ringwood et al. 2004, Foote and Rice Hornung 2005, Samways 2005, Baur et al. 2007, Black et al. 2007, Yamamoto et al. 2007, Littlewood 2008, Kimoto 2010, Black et al. 2011).

Results of Roche et al. (2012b) lend at least some support to the assessment that ≥90% retention of total herbaceous vegetation retains suitable invertebrate habitat for toads in meadow habitat. The study does not provide direct evidence of this, since data was not collected on invertebrates. However, because all measured retention levels were ≥75% (range of 75% to 100% retention) when toad occupancy was sampled in meadows, it may indicate that toads were finding sufficient invertebrate prey in meadows at the time of sampling.

Shallow Waters Exposed to the Sun

There is no evidence that 10% utilization of emergent vegetation would create open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, or to maintain such areas.

Small Open Patches

There is moderate or lower support for the assessment that 10% utilization of herbaceous vegetation would create small openings in large, extensive stands of herbaceous vegetation. This is because 10% use of herbaceous vegetation may not create very many small openings.

Extensive dense stands of sedges without any small pockets of open water may reduce suitability of wetlands for spotted frogs and boreal toads, and low intensity livestock grazing may be beneficial to the frogs and toads in these areas by creating small openings for basking (Maxell 2000, Watson et al. 2003, Bull 2005, Shovlain et al. 2006). Ten percent utilization of herbaceous vegetation in an otherwise dense emergent marsh without any openings would in some situations provide scattered small openings, which would have the potential to benefit spotted frogs and boreal toads, but in other situations may not provide any openings (BLM et al. 2008:27). Creation of small openings would be inconsistent and probably not highly likely in many wetland situations at 90% retention.

However, overly-dense sedge communities in breeding pools on the BTNF appear to be of relatively limited occurrence, and while scattered small openings produced by livestock may be beneficial to spotted frogs and boreal toads in otherwise monotypic stands of emergent vegetation, there is no information indicating this is needed as part of a conservation strategy.

Also, while spotted frogs and boreal toads appear to benefit from small openings in otherwise large areas of consistently tall, dense herbaceous vegetation, no studies have demonstrated they are needed. Many wetlands in mountain meadows did not receive enough use by native ungulates to produce these conditions on a regular basis. Results of Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) provide evidence that Yosemite toads are able to persist in wetlands having highly productive, tall, dense sedge communities with ≥90-95% retention in early to mid summer and ≥85-90% retention in late summer. Very few if any openings were created in the dense sedge cover within breeding wetlands and in the immediate vicinity of these wetlands during their study. Roche et al. (2012b) did not find any indication that toads avoided meadows or parts of meadows with tall, dense herbaceous vegetation and, conversely, there was a general trend toward toads occupying wetter sites which tend to have high productivity of sedges and lower levels of grazing.

Examination of Other Factors Influenced by 90% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Water Quality,” “Surface Water Duration in Small Pools,” “Survival as Influenced by Trampling,” and “Soil Looseness and Porosity, and Overhanging Banks” sections). These sections should be consulted for desired conditions.

On sites where 90% of the annual production of total herbaceous vegetation is retained, effects on water quality, and soil looseness and porosity would remain well within acceptable levels, and effects on the retention of surface-water in small pools and survival of tadpoles, metamorphs, and adults as affected by trampling would likely remain within acceptable levels. This assessment is based on information in the following subsections.

Water Quality

There is strong support for the assessments that 90% retention of herbaceous vegetation would (1) protect against negative impacts to water quality for spotted frogs and boreal toads in all breeding wetlands grazed to this level of retention, and (2) protect against negative impacts to water quality for these species in a majority of breeding wetlands grazed to this level of retention. Only a portion of the 10% use would be from livestock grazing. Given the very light grazing intensity that 90% retention represents, there is low potential for water quality to be negatively impacted.

Retention of 90% of total herbaceous vegetation in and immediately around breeding wetlands would in nearly all cases or all cases indicate that use is low enough that water quality would remain within an acceptable range for spotted frogs and boreal toads. However, potential exists for livestock to use a wetland for drinking while having comparatively lesser effects on vegetation due to livestock drinking and not foraging (especially sheep), and using paths already created by animals that reached the water before them (i.e., factors that can contribute to higher use than percent retention of herbaceous vegetation may indicate).

Findings of several studies lend moderately-high support the assessment that 80% retention of total herbaceous vegetation in and around wetlands would sufficiently limit grazing intensity to maintain suitable water quality for spotted frogs, boreal toads, and their insect prey. Roche et al. (2012a) and McIlroy et al. (2013) lend some support for the assessment that ≥90% retention of total herbaceous vegetation would maintain grazing use of wetlands at low enough levels to allow suitable water quality to be maintained. They did not detect any treatment effects of cattle grazing on concentrations of nitrates, nitrites, phosphorous, or dissolved oxygen, or on turbidity in breeding wetlands, and retention levels in these wetlands during the tadpole phase was likely ≥90% and possibly as low as ≥85% by the end of the tadpole phase.

Bull and Hayes (2000) did not detect any statistically significant difference in water quality variables (pH, conductivity, nitrates, dissolved oxygen) between grazed and ungrazed wetlands. Measures of livestock activity in their study averaged 1.3, 1.3, and 0.9, respectively, in grazed wetlands (i.e., just over slight evidence of grazing activity), which appears to translate to an average herbaceous retention level in the vicinity of 80%, meaning that no statistically significant differences would have occurred in their study if grazing intensity was somewhat less (i.e., less than slight, or 90% retention).

Foote and Rice Hornung (2005) also did not detect any statistically significant effects of cattle grazing on total dissolved solid (TDS) urine indicators in their study of the effects of livestock grazing on dragonfly and damselfly diversity. It is estimated that 60-70% of sedge biomass was retained in grazed wetlands their study area, meaning they would not have detected any statistically significant results at this higher retention level of 90%.

Surface-Water Retention in Small Pools

There likely is a high probability that drinking by livestock would have no discernible effect on water level declines in wetlands when retention of herbaceous vegetation is ≥90% in and immediately around the wetland. There are no known scientific studies or data to support this, but for small breeding wetlands (e.g., <1,000 ft^2), limiting livestock grazing use such that ≥90% of total herbaceous vegetation is retained in and immediately around wetlands would substantively minimize the rate at which water-level declines are accelerated due to livestock drinking. The main support for this is that use of the wetland by livestock for foraging and drinking would be very limited when utilization of total herbaceous vegetation is 10% or less, especially in recognizing that 10% use includes utilization from other grazers. While a light grazing intensity that results in 90% retention of herbaceous vegetation in and immediately around breeding wetlands could hasten water-level declines in mid to late summer in some breeding wetlands, this likely would not be an issue in most situations given the low level of use.

Survival as Affected by Trampling

There is moderately-strong support for the assessment that limiting utilization of herbaceous vegetation to no more than 10% in summering and migration habitat would limit trampling-caused mortality of adult and juvenile spotted frogs and boreal toads to low levels, and there is moderately-high to high support for the assessment that limiting utilization of herbaceous vegetation to no more than 10% at breeding wetlands would adequately limit trampling-caused mortality of tadpoles and metamorphs to relatively low levels.

Summer and Migration Habitat

The potential for livestock to step on juvenile and adult frogs and toads is low in summering habitat and in migration corridors when and where there is overlap between livestock use and use by frogs or toads. Figure A.16 shows that an estimated <10% of small stationary objects are estimated to be trampled in meadows producing 500 pounds/acre, and that an estimated 20-45% of small stationary objects would be trampled in meadows producing 3,000 pounds/acre, assuming cattle are in any given meadow for 2-4 weeks. While the trampling rates for 90% retention are shown to be <10% to as high as 45%, there are several reasons Figure A.16 overestimates trampling of frogs and toads by livestock at this retention level: (1) only a portion of the 10% utilization would be from livestock, possibly a minority; 2) frogs and toads would move out of the way of livestock compared to the stationary objects in Figure A.16; (3) frogs and toads use the wetter sites in riparian areas, meadows, and silver sagebrush communities than are used by livestock; and (4) spotted frogs primarily summer in ponds, their shorelines, and along streams where they are able to jump out of the way of livestock. As such, while it is recognized there is some potential for livestock to crush frogs and toads in summering and migration habitats, trampling by livestock would be substantially less than what is shown in the graphs.

An estimated <10% to 30% of small stationary objects are estimated to be trampled within 2-4 weeks at 10% use (90% retention) of herbaceous vegetation in meadows producing 1,000 to 2,000 pounds/acre.

Breeding Wetlands – Adults and Eggs

The potential for livestock to step on tadpoles and adult frogs and toads at breeding sites would be low because most eggs should be hatched prior to the onset of livestock grazing each year and most adults have left breeding wetlands by the time livestock arrive onto allotments. This does not include adults that remain at breeding wetlands; adults that summer at breeding wetlands are addressed above in the discussion of summering habitat.

Breeding Wetlands – Tadpoles and Metamorphs

At 10% utilization of herbaceous vegetation at breeding sites, there would be a (1) low to moderate potential of trampling tadpoles every year when and where livestock access wetlands containing tadpoles, and while the level of impact in any given year could vary somewhat, there likely would be no more than a small percentage of tadpoles trampled in most years in most wetlands; and (2) low to moderate potential of trampling metamorphs in any given year when and where livestock access wetlands during the metamorphosis period, and the level of impact when incidences occur (i.e., when livestock use of wetland shorelines overlaps in time and space with concentrations of metamorphs) would typically be low.

There likely is a low to moderate potential of trampling metamorphs when and where livestock have access to breeding wetlands during the tail end of the breeding season, and there likely would be a low percent of metamorphs trampled (when incidences occur) for the following reasons. Metamorph emergence and concentration on shorelines would only occur for several days and concentrations occur in small areas, compared to livestock which graze the area for a longer period of time and they range over substantially larger areas. Graphs in Figure A.16 likely overestimate trampling rates of tadpoles and metamorphs because the graphs present trampling rates of small stationary objects by cattle at given densities over the course of 1-4 weeks, but high concentrations of metamorphs only occur for several days. At cattle densities required to reach 10% use of a wetland in 3-4 weeks (0.1-0.5 cows/acre, assuming 2,000-3,000 pound/acre of herbaceous production; Tables A.4 and A.5), an estimated <5% of small stationary objects would be trampled in a 3-4 day period (Table A.3). This may be comparable to trampling rates of metamorphs. However, trampling would only occur when amd where there is overlap between livestock and metamorphs, and there likely are many years when use of any given wetland by livestock does not occur when metamorphs are emerging. If 10% use at a given wetland is attained in about 1 week, this equates to densities of 0.8-1.50 cows/acre, which in turn results in an estimated <10% to an estimated 20% being trampled in a 3-4 day period. The chances of high percentages of metamorphs being trampled would be low when and where livestock and metamorphs overlap.

Results of the study by McIlroy et al. (2013) lend some support for trampling by cattle being at a low enough level to not reduce tadpole densities where herbaceous retention levels at breeding wetlands are ≥85%. However, trampling effects on tadpoles were not assessed in their study and results can only be applied indirectly (because there were no statistical differences in tadpole densities, their likely was not a trampling effect on tadpoles).

Soil Looseness and Porosity

There is strong support for the assessment that limiting use of herbaceous vegetation to 10% would maintain suitable soil looseness and porosity. Ninety percent retention of total herbaceous vegetation would limit soil compaction to levels that are well within acceptable levels. Thurow (1991:149) presented data showing that water infiltration rates (one indicator of the extent to which soils are compacted) in pastures with moderate stocking rates were approximately 15% lower than in a livestock exclosure. Assuming “moderate” equates to 31-50% utilization of key forage species (Holechek et al. 2011:141; their conservative and moderate grazing intensities were combined for the purposes of this assessment), this roughly translates to 55-80% retention of total herbaceous vegetation, and 90% retention of herbaceous vegetation is above this range.

Integrity of Near-Surface Burrows and Streambanks

There is moderate to moderately-strong support for the assessment that limiting utilization of herbaceous vegetation where shallow burrows occur to no more than 10% would limit crushing of these burrows. Because shallow burrows are stationary, clay pigeons provides an approximation of the level of potential impact. An estimated 5-15% of clay pigeons would be expected to be stepped upon when livestock are in meadows (1,000 pounds/acre production) long enough to result in 10% utilization of total herbaceous vegetation (Figure A.16). In meadows with 2,000 and 3,000 pounds/acre, an estimated 10-30% and 20-40%, respectively,of clay pigeons would be expected to be stepped upon. This provides a relatively low potential for shallow burrows being crushed and with it, a potential for occupants to be crushed in them.

There is high support for the assessment that limiting utilization of herbaceous vegetation in riparian habitats to no more than 10% would limit the crushing of streambanks. This is mainly because use of streambank vegetation would be limited when utilization of total herbaceous vegetation in riparian areas remains below 10%. Livestock use of streambanks typically does not increase substantially until vegetation in moist meadows, silver sagebrush, and shrubby cinquefoil is well utilized.

Implications of Livestock Grazing Use to Multiple Stressors

Long-term Reductions in Vegetation Height and Canopy Cover

If starting herbaceous canopy cover (prior to the onset of livestock grazing) is less than near-100% but high enough to effectively retain humidity, moderate temperatures, provide shade, provide hiding and escape cover, and provide invertebrate habitat to some degree, reducing canopy cover by an estimated 0-15% would have limited potential to reduce canopy cover to the point that herbaceous vegetation is no longer providing these functions (bottom of Table A.2). If starting herbaceous canopy cover is too low to retain humidity, moderate temperatures, provide shade, provide high-quality hiding and escape cover, and provide high quality invertebrate habitat, reducing canopy cover by an estimated 0-15% would have little meaningful additional impacts. Similar situations would occur if starting vegetation height is too short to provide an effective canopy and to provide invertebrate habitat, for example where non-native bluegrasses dominate a plant community and where plant vigor is depressed. Starting herbaceous canopy cover and heights as described above can occur naturally, but most moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow sites are productive and typically have high percent canopy cover (e.g., in the neighborhood of 80-100%; (Norton et al. 1981:57, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). Reductions in height and percent canopy cover can result from plant mortality and reduced plant vigor caused by livestock over-use and increases in nonnative species like Kentucky bluegrass and smooth brome.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 90% retention of herbaceous retention would result in only limited greater impacts than described in the “Examination of Herbaceous Structural Attributes at 90% Retention” section, above.

On the other hand, where percent canopy cover and/or height is naturally low or where it is lower due to reduced plant vigor and/or conversion to nonnative species like Kentucky bluegrass, smooth brome, or tarweed, 10% use of herbaceous vegetation would result in somewhat fewer impacts to water quality, wetland water levels, and survival as affected by trampling compared to effects in healthy, naturally-functioning plant communities. This is because utilization is based on weight, and if annual production is, for example, 500 pounds/acre instead of 2,000 pounds/acre, livestock would spend considerably less time in the meadow that produced 500 pounds/acre. In this example, the potential of being trampled could be roughly 3x lower in the meadow supporting 500 pounds/acre than if it produced 2,000 pounds/acre (Figure A.16). Furthermore, fewer spotted frogs and boreal toads would be found in the meadow producing 500 pounds/acre (both in the vegetation and in burrows), which would further reduce the potential of frogs and toads being trampled.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 90% retention of herbaceous retention would result in fewer impacts than described in the "Examination of Other Factors Influenced by 90% Retention" section, above.

If serious attempts are made to retain ≥90% of herbaceous vegetation at each monitored breeding wetland and if monitored breeding wetlands are fairly representative of other breeding wetlands (including grazing levels), herbaceous vegetation would remain at higher levels (>90%) at some monitored and unmonitored breeding wetlands and it is possible for herbaceous vegetation to decline to ≤80% at some unmonitored breeding wetlands. First, under the best of circumstances, retention would only be monitored at a small proportion of known breeding wetlands any given year and not all allotments would be monitored every year. Second, there is a reasonable chance that grazing use will push the limits of whatever retention threshold is identified and action may not be taken until retention levels are several percentage points or more below what is identified as the minimum threshold (i.e., grazing at some monitored breeding wetlands undoubtedly would be <90%). Third, only a portion of breeding sites are known and the location of breeding sites can change from year to year. Fourth, retention levels at different breeding sites would continue to be variable.

Other Multiple Stressors: Chitrid Fungus, Climate Change, UV Radiation, & Local Human-Related Impacts

The assessments made in the preceding 11 pages relative the capability of 90% retention to provide suitable habitat for spotted frogs and boreal toads and to protect them from direct livestock impacts were completed independent of effects of livestock grazing use in the context of multiple stressors.

In combination with all multiple stressors **—** *i.e., altered vegetation conditions (previous subsection), chitrid fungus, ranavirus, climate change, UV radiation, loss of habitat and habitat fragmentation due to roads, elevated mortality due to crushing by motor vehicles, elevated mortality due to introduced fish, poisoning from rotenone, reduced spring flows due to late-seral conditions, reduced beaver-pond distribution and abundance, increases in nitrate and ammonia in wetlands from the atmosphere, loss of wetlands and other habitat due to reservoirs, loss of meadow and willow habitat due to expanding forestland, and other effects on spotted frogs and boreal toads on the BTNF* **—** the addition of effects associated with 10% utilization of herbaceous vegetation in breeding wetlands and other habitats of spotted frogs and boreal toads would contribute no more than a negligible or minor degree toward greater negative impacts and would have no more than negligible negative effects due to the possibility of emergent vegetation expanding into egg and tadpole development sites. This is primarily because nearly all of the habitat attributes of ungrazed vegetation would be retained and livestock use would be low enough to only minimally increase the potential for mortality due to crushing.

≥80% RETENTION OF TOTAL HERBACEOUS VEGETATION

There is moderately-strong evidence that ≥80% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads. A retention level of ≥80% would satisfactorily "…minimize impacts to species whose viability has been identified as a concern," as required by FSM 2670.32 (WO Amendment 2600-2005-1). All assessments in this section assume that plant communities have are relatively natural structure (e.g., height and vegetation density) are in healthy functioning condition. To the extent a plant community is not, higher retention levels may be needed to adjusted upward to get the same effect. A minimum of 80% retention roughly translates to a maximum 20-50% utilization of key forage species, possibly as high as 70% utilization of key forage species if no restrictions are imposed on the use of key forage species (Appendix B). Maximum use of key forage species of 30-40% is consistent with recommendations in some range management textbooks (e.g., Vallentine 1990, Holechek et al. 2011) and a maximum 50% use of key forage species is at the take-half, leave-half level developed in the 1940s (Heady and Child 1994). An herbaceous retention level of 80% translates to 20% use of key forage species where key forage species (e.g., sedges) comprise 100% or near 100% of the plant community, and it translates to 50% use of key forage species where composition of key forage species is relatively low (e.g., 25% by weight) and use of non-key species is relatively high compared to 20% overall use (e.g., 10%). Where the composition of key forage species is low (e.g., <25%) and use of non-key forage species is low (e.g., <10%), 70% retention of herbaceous vegetation can translate to heavy use of key forage species (e.g., as much as 70% use) (Appendix B).

The moderately-strong support for the above assessment is based on ≥80% retention of herbaceous vegetation providing suitable: (1) hiding cover for tadpole, juvenile, and adult frogs and toads in breeding and summer-long habitat; (2) protection from the sun and ground-level humidity for juvenile and adult frogs and toads on breeding-pool shorelines and in summer-long habitat; (3) hiding cover and structure within wetlands for tadpoles; (4) hiding cover and protection from the sun for metamorphosed and adult frogs and toads on shorelines; (5) forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat; and (6) contributions to the following year's residual thatch and litter which in turn contributes to hiding cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities; as well as to indicate suitable (7) water quality (as related to urination, defecation, and trampling); survival as related to trampling of tadpole, juvenile, and adult frogs and toads in and adjacent to breeding and summer wetlands pools and in migration habitat; (8) water retention in small breeding pools; (9) soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (10) integrity of near-surface burrows used by frogs and toads; and (11) retention of overhanging streambanks used by frogs or toads for hibernation. This basis for this is outlined in the following 17 pages.

Because there is moderate to moderately-strong evidence that ≥70% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, and because ≥70% retention was covered in detail, below, some of the subsections in this section ("≥80% Retention of Total Herbaceous Vegetation") are relatively short. In other words because ≥70% retention is deemed to retain suitable habitat conditions for spotted frogs and boreal toads, this would mean that ≥80% retention would also retain suitable habitat conditions.

Summary of Key Amphibian–Livestock Grazing Studies

Support for ≥80% Retention as a Threshold

Results of Bull and Hayes (2000), Shovlain et al. (2006), Adams et al. (2009), Roche et al. (2012b), Roche e t al. (2012b), and McIlroy et al. (2013) lend at least support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, recognizing that failure to detect effects of a treatment does not provide strong support for a conclusion of "no treatment effect:"

- No effects in tadpole survival and water quality were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009), meaning that no effects would have been expected in their study at a retention level of 80%. However, there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands, although this difference was not detected statistically.
- Roche et al. (2012b) did not statistically detect effects of ≤25% utilization of herbaceous vegetation on toad occupancy of meadows and 96% of these meadows had ≤20% utilization (≥80% retention) when toads were surveyed.
- Roche et al. (2012a) and McIlroy et al. (2013) did not statistically detect effects of an estimated ≤15% utilization of herbaceous vegetation on toad occupancy, tadpole density, water quality, or water

temperature in breeding wetlands; it is likely that similar results would be obtained at 20% utilization of herbaceous vegetation.

- Shovlain et al. (2006) found that spotted frogs did not preferentially use habitat inside exclosures when livestock grazing was fairly light; utilization or retention were not quantified in a way that percent retention could be determined, but it is speculated that 80% retention would have qualified as light grazing pressure in the study.
- Bull and Hayes (2000) did not detect a significant difference ($p < 0.05$) in tadpole survival between ungrazed wetlands and grazed wetlands, which are estimated to have had 80% of herbaceous vegetation retained. However, see below for additional assessment.
- Munger et al. (1994) may provide some indication that the threshold between suitable and unsuitable conditions for spotted frogs is in the vicinity of 80% retention. Wetlands grazed at rating of 1 (roughly equivalent to 80% retention) were occupied by spotted frogs approximately equal to their availability, but ungrazed wetlands were occupied at a substantially higher rate than their availability and wetland grazed at >20% use were occupied substantially less than their availability.

Studies that Identify Negative Effects of ~20% Use of Herbaceous Vegetation

On the other hand, results of Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) indicate, for at least some wetland situations, that ≥70% retention of total herbaceous vegetation does not retain suitable herbaceous habitat and/or water quality, and/or does not adequately protect against trampling by livestock, at least in some situations:

- Munger et al. (1994) found that sites with Columbia spotted frogs had significantly lower evidence of livestock grazing use than sites unoccupied by spotted frogs. Even though wetlands grazed at rating of 1 (roughly equivalent to 80% retention) were occupied by spotted frogs approximately equal to their availability, there is some indication that wetlands grazed at a rating of 1 provided less than suitable conditions: (1) sites with adult spotted frogs had a significantly lower rating for evidence of grazing (an average of 0.769 on a scale of 3) than did sites without adults (average rating 1.262), with a rating of 1.62 being roughly equivalent to 80% retention; and (2) there were about 3.5x more wetlands unoccupied by spotted frogs than occupied by spotted frogs where grazing pressure was rated as 1. While results were not statistically significant in Munger et al. (1996), patterns were similar.
- Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetlands than in grazed wetlands (an estimated 70-85% retention), and that water quality was significantly lower in grazed wetlands compared to ungrazed wetlands.
- Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.
- Although results were not statistically significant at the $p < 0.05$ level, spotted frog tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible the effect would have been significant at a higher significance threshold, but this cannot be confirmed.

These studies indicate that livestock grazing use levels as low as about 20% of total herbaceous vegetation (80% retention) negatively affect spotted frogs in at least some situations. While Schmutzer et al. (2008) and Burton (2009) were not conducted in the intermountain West, results are consistent and some of the potential mechanisms of effects are applicable.

Where statistically-significant effects of livestock grazing on response variables (e.g., frog/toad occupancy, tadpole abundance) were detected, it is likely that changes in one or more of the habitat and survival elements — due to livestock grazing use — were responsible, but in most cases the mechanism(s) by which response variables were affected (e.g., habitat and survival elements) were not directly studied. Water quality is an exception to this because it is a response variable measured in several studies, but there are many other possible reasons for effects of livestock grazing on tadpole and adult occupancy, abundance, and species richness. (Changes in vegetation height/structure/biomass was used to estimate percent retention and affects the degree to which several habitat elements are altered, but vegetation height/structure/biomass does not directly address *why* occupancy, abundance, and species richness were reduced.)

Each of these studies are examined below, relative to different levels of livestock grazing use, on each of several (e.g., humidity retention, shading, hiding cover, invertebrate habitat, water quality, survival as affected by trampling). Although the studies did not specifically measure or assess most of these habitat and survival elements, results of the studies provide additional information that can be used to assess whether given habitat and survival elements remain suitable at different herbaceous retention levels.

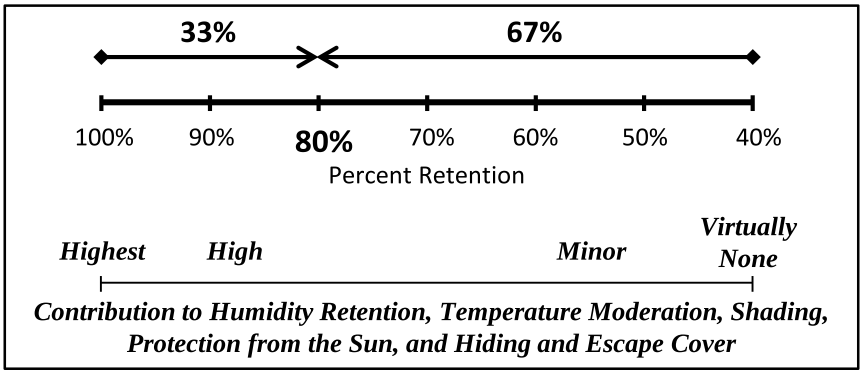
Examination of Herbaceous Structural Attributes at 80% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Humidity Retention, Temperature Moderation, and Protection from the Sun;” “Hiding and Escape Cover;” “Forage for Tadpoles;” and “Forage, Cover, and Substrate” sections). These sections should be consulted for desired conditions. Material in the “Roles of Herbaceous Canopy/Retention and Openings” section is not repeated below and should be consulted as background information.

The following information sets the stage for this section by numerically characterizing 80% retention of total herbaceous vegetation:

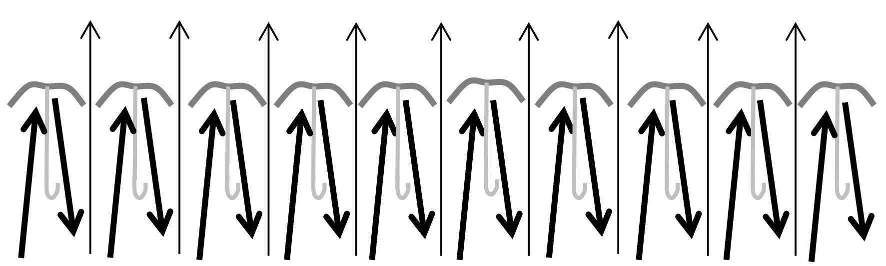
- In herbaceous communities and understories that are in healthy condition, 80% retention of total herbaceous vegetation would a majority of the plant material that contributes to amphibian cover and insect forage and cover (Table A.2, Figure A.14). More specifically, 80% retention of total herbaceous vegetation would retain:
    - An estimated 70-95% of the canopy cover of relatively intact herbaceous vegetation, based on DeLong (2009b:Table 11) (Table A.2, Figure A.14, Figure A.8).
    - An estimated 50-76% of the biomass of herbaceous vegetation above a 2-inch height, based on height-weight relationships in Kinney and Clary (1994) and BLM et al. (1999:118) including the exclusion of the weight of the bottom 2 inches of plants based on their information.
    - 50-85% of starting Robel pole readings compared to pre-grazing readings, based on DeLong (2009a) and additional data collected in 2011. These direct measures of visual obstruction, which substantiate the information in the above two bullets, provide a good indication of the degree to which hiding cover qualities are retained.
    - 25-65% of plant height if vegetation is grazed at an even height (e.g., sedge communities), based on height-weight relationship information in Kinney and Clary (1994) and BLM et al. (1999:118) (Table A.2, Figure A.14, Figure A.9).
- This numeric characterization of herbaceous communities having 80% retention fits between the narrative characterizations of the 6-20% and 21-40% utilization classes of the landscape appearance method in BLM (2008:27): “The rangeland has the appearance of very light grazing; the herbaceous forage plants may be topped or slightly used” and “The rangeland may be topped, skimmed, or grazed in patches,” respectively. A key characteristic is that small patches are starting to form at about 20% utilization.

Retaining an estimated 70% to as much as 95% of the canopy cover of herbaceous vegetation would retain a moderate to moderately-large portion of the attributes of the vegetation that provides hiding and escape cover, retains humidity near the ground, moderate temperatures, provides shade, and provides habitat for a range of invertebrate prey species. This assessment is primarily for communities with naturally moderate-height to tall, dense herbaceous vegetation, and they assume plant communities are at or near fully functioning conditions. Support for assessments made progressively declines with progressively lower ecological conditions (i.e., as factors such as overall canopy cover and plant species richness decline). The assessment in the first sentence of this paragraph is based on information provided for each of six habitat elements in the following subheadings (see the “Role of Herbaceous Retention” section for background information on each element). Potentially as little as 50% of the biomass of vegetation above a 2-inch height being retained indicates that retention of these habitat elements (e.g., hiding cover, shading, humidity retention) may be lower than “moderate to moderately-large” in the shorter herbaceous communities and understories, and possibly in dry years. This caveat is also discussed in the following subheadings as pertinent.

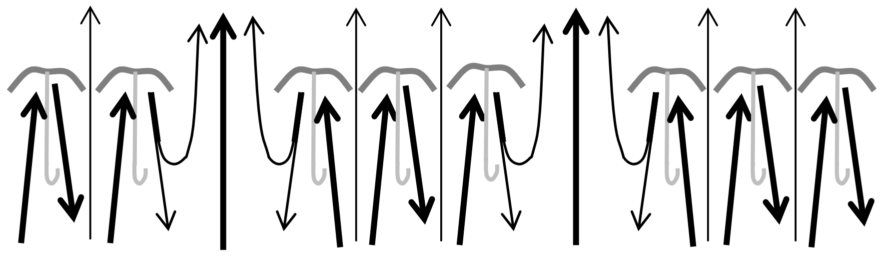


Humidity Retention and Temperature Moderation

There is moderate to moderately-strong support for the assessment that (1) retaining an estimated 70-95% of the canopy cover of relatively-intact herbaceous vegetation and 50-76% herbaceous biomass above 2 inches in moist-meadow type communities, and (2) retaining 53-65% of sedge height above 2 inches (57-70% of total height) in sedge communities would maintain enough humidity retention and temperature moderation attributes to contribute to suitable habitat for spotted frogs (Figure A.21, for sedges). Support is higher (e.g., moderately-strong to strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Willow canopy cover would remain largely intact. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to retaining near-ground humidity and moderating temperatures, but in these cases percent herbaceous retention would not be a factor for these elements and willow canopy cover may be too dense to be used by boreal toads.



Humidity retention and escape — 100% Canopy Cover (umbrellas), for reference.



Humidity retention and escape — 80% Canopy Cover (umbrellas).

Since boreal toads can occupy habitat that is somewhat less humid/moist than what can be inhabited by spotted frogs, support may be as high as strong given the large amount of herbaceous canopy that would remain and the relatively large patches of intact and relatively-intact herbaceous vegetation (or combinations of herbaceous vegetation and short-stature willows) that would remain (Figure A.8, and see ‘umbrella’ diagram this page), the likelihood of sufficient herbaceous-based microsites being retained is high for boreal toads.

Retention of moisture holding and temperature moderation qualities of herbaceous vegetation would be less in herbaceous communities that produce relatively short vegetation (e.g., the lower end of the range in the 50-76% and 50-85% ranges for biomass and Robel pole readings, respectively). Retaining ≥70% of the canopy cover of relatively-intact herbaceous vegetation would maintain much of the humidity-retaining and temperature-moderating qualities of pre-grazed moist-meadow type vegetation (see next paragraph). Even though a large portion or all of the "drooping" plant material forming a canopy in sedge communities would be removed at this level of grazing use (assuming even grazing), retaining an estimated 58-70% of the height of sedges would retain sufficiently tall stubble to maintain some of the humidity retention and temperature moderation attributes in sedge communities.

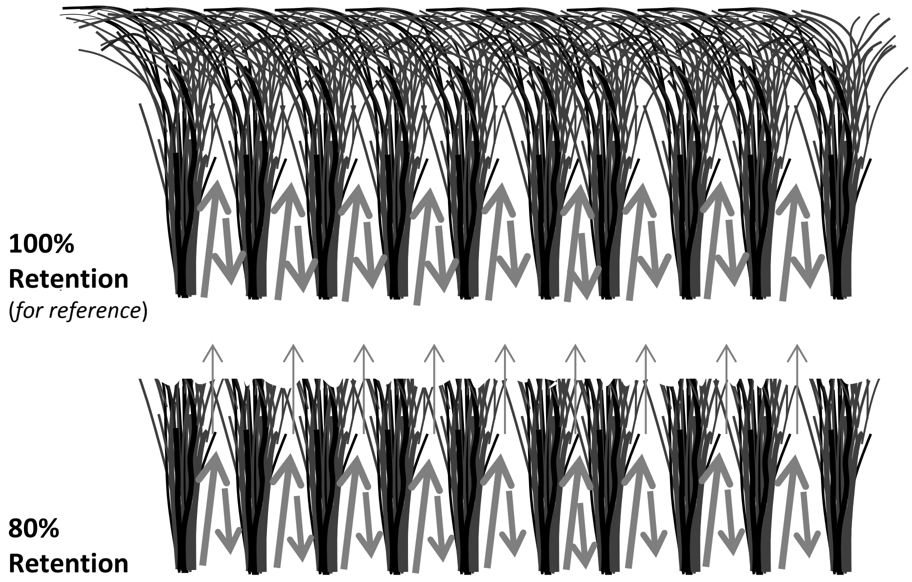


Figure A.21. Humidity retention and escape at 100% and 80% retention. Arrows indicate movement of humidity.

Although no scientific studies were found on ground-level humidity readings at specific levels of percent canopy cover or specific herbaceous retention levels, the two basic principles of (1) a vegetation canopy being needed to retain humidity and moderate temperatures and (2) the positive relationship between percent canopy cover and humidity-retention/temperature-moderation levels (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000) dictate that maintaining an estimated 70-95% of the canopy cover of intact and relatively-intact vegetation would maintain most of the capabilities of vegetation to trap humidity and to moderate temperatures below the canopy layer. On the other hand, the basic principle of a vegetation canopy being needed to retain humidity and moderate temperatures dictates that eliminating the uppermost portion of sedge plants (which contribute most to a greenhouse effect) and reducing plant height by an estimated 30-43% would substantively reduce the ability of the canopy to trap humidity and to moderate temperatures below the canopy layer in sedge communities; except that many times sedge communities have higher soil-moisture contents or are have standing water.

Marlatt (1961) found evidence of an apparent cooling effect and humidity-retention effect within 1 inch of the ground surface when herbaceous canopy cover was ≥70%, but did not find this in the 50%, 30%, and 0%-canopy-cover plots (as illustrated in Figure A.12.d). As a general principle, higher percentages of canopy cover of relatively-tall herbaceous vegetation retain higher levels of near-ground humidity and moderate near-ground temperatures more than lower percentages (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000).

Starting with 100% canopy cover, 80% retention of herbaceous vegetation represents 33% (moderately small) movement toward 40% retention of herbaceous vegetation, with herbaceous vegetation associated with 40% retention contributing nothing or virtually nothing to humidity retention and temperature moderation. A moderately large amount of intact and relatively-intact canopy cover would remain, which would continue to contribute to holding in humidity and moderating temperatures, albeit at reduced levels. If starting canopy cover was lower, a moderately-small reduction in relatively-intact canopy cover would likely have limited effect on humidity retention and temperature moderation, based on available science (e.g., Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000).

Wind and solar radiation are important factors influencing near-ground humidity levels and temperatures. Greatly reduced wind speed near the ground surface is central to retaining near-ground humidity and moderating near-ground temperatures (Marlatt 1961, Cionco 1972, Oke 1978:118-119, Baldocchi et al. 1983). Although the influence of wind immediately above the soil surface may increase when the percent canopy cover of relatively-intact herbaceous vegetation declines to 70%, it would not increase appreciably (Marlatt 1961). This would limit the degree to which wind would reduce near-ground humidity levels and move near-ground temperature toward ambient (above-canopy) temperatures. Also, Marlatt (1961) found that net radiant energy over the 70%-canopy-cover plots was virtually equal to that measured over full grass cover, and 70% canopy cover is the estimated minimum that would be maintained by implementing a ≥80% retention level for herbaceous vegetation where pre-grazed canopy cover is at or near 100%. Minimizing the amount of solar radiation reaching the soil surface and basal plant material helps retain near-ground humidity and moderate near-ground temperatures because radiant energy reaching the soil surface heats the soil surface and basal plant material, which increases day-time temperatures immediately above the soil surface and, subsequently, contributes to reductions in near-ground humidity levels (Marlatt 1961).

Assessments in the previous two paragraphs assume that pre-grazed canopy cover is high (e.g., ≥90%). If it is less than this, allowing percent retention of total herbaceous vegetation to decline to 80% would result in measurably less than 70% canopy cover being maintained, which would allow the influence of air movement and radiant energy to be higher near the ground surface.

Results of Roche et al. (2012b) lend at least some support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable humidity retention and temperature moderation attributes for toads in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The study does not provide direct evidence of this since humidity and temperature were not monitored, but no effects of ≤25% utilization of herbaceous vegetation were statistically detected on toad occupancy of meadows and 96% of these meadows had ≤20% utilization (≥80% retention) when toads were surveyed.

Also, Shovlain et al. (2006) found that spotted frogs did not preferentially use habitat inside exclosures when livestock grazing was fairly light; utilization or retention were not quantified in a way that percent retention could be determined, but it is speculated that 80% retention would have qualified as light grazing pressure in the study.

Munger et al. (1994), Munger et al. (1996), and Burton et al. (2009) do no lend support to the assessment that 80% retention of total herbaceous vegetation retains humidity, but they do not appear to provide any evidence that humidity retention attributes of herbaceous vegetation are less-than-suitable at 80% retention. Despite significantly lower abundance and/or occupancy of frogs at grazed wetlands (estimated 80% and 70-85% herbaceous retention in the two sets of studies), the studies were conducted in wetlands and immediately around wetlands where humidity retention is not an issue.

Shade and Protection from the Sun

There is strong support for the assessment that retaining a minimum of approximately 70-95% of the canopy cover of relatively-intact herbaceous vegetation in moderate height to tall, dense herbaceous communities (and in willow-herb communities) would retain enough of the vegetation qualities in large enough patches to provide suitable shading and protection from the sun on shorelines, in movement corridors, and in summering habitat. This is based on the same line of reasoning in the “Humidity Retention and Temperature Moderation” subsection, above, and the “Hiding Cover” subsection, below. Some canopies may be somewhat more diffuse due to the reduction in biomass. The retained shading qualities of vegetation would continue to provide protection from the sun on the shorelines of breeding pools for metamorphosed frogs and toads, which can achieve high densities at times (Keinath and McGee 2005, Patla and Keinath 2000). If the pre-grazing herbaceous canopy cover on a particular shoreline is high (e.g., >75%), 80% retention of herbaceous vegetation would likely provide a sufficient amount of shading on shorelines for large concentrations of metamorphs. Support would be somewhat lower in short-stature plant communities.

Shading and protection from the sun was separated out from the discussion of humidity retention because, while it contributes to the retention of humidity and moderation of temperatures near ground level, shading can conceivably be provided in patches even if the vegetation does not retain near-ground humidity and does not moderate temperatures.

Roche et al. (2012b) lend at least some support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable shading and protection from the sun for boreal toads in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The study does not provide direct evidence of this since shading and protection from the sun were not monitored, but no effects of ≤25% utilization of herbaceous vegetation as measured in July were statistically detected on toad occupancy of meadows in June and July, and 96% of these meadows had ≤20% utilization (≥80% retention).

Munger et al. (1994), Roche et al. (2012a), and McIlroy et al. (2013) may lend some support to this assessment on shorelines, but shading and protection from the sun were not measured and retention levels on shorelines were somewhat higher (≥85% or possibly even ≥90%) in the latter two studies. At a retention level roughly equivalent to 80%, spotted frogs occupied wetlands equivalent to their availability in Munger et al. (1994), but occupied wetlands substantially lower than their availability where retention levels were lower. Roche et al. (2012a) and McIlroy et al. (2013) did not detect any significant differences in toad occupancy or the number of young-of-the-year at breeding pools among treatments (ungrazed meadows and grazed meadows). Although retention levels were likely ≥85% at breeding sites, similar effects would likely occur at 80% retention with respect to shading and protection from the sun.

Also, Shovlain et al. (2006) found that spotted frogs did not preferentially use habitat inside exclosures when livestock grazing was fairly light (utilization or retention were not quantified in a way that percent retention could be determined).

On the other hand, Burton et al. (2009) does no lend support to the assessment that 80% retention of total herbaceous vegetation retains suitable shading and protection from the sun for spotted frogs in and around wetlands, and reduced shading and protection from the sun may be one reason frog abundance and/or occurrence were lower in grazed wetlands of Munger et al. (1994), Munger et al. (1996), and Burton et al. (2009), which had an estimated 80% and 70-85% herbaceous retention in the two sets of studies. The studies do not provide direct evidence for or against this since shading and protection from the sun were not monitored, and it would appear unlikely that reduced shading would have been a major factor where 80% of the biomass of herbaceous vegetation remained.

Hiding and Escape Cover

There is moderate to moderately-strong support for the assessment that (1) retaining a minimum of approximately 70% of the canopy cover of relatively-intact herbaceous vegetation and 50% herbaceous biomass above 2 inches in moderate height to tall, dense moist-meadow type communities, and (2) retaining 53-65% of sedge height above 2 inches (57-70% of total height) in sedge communities would retain enough of the vegetation qualities in large enough patches to provide suitable hiding and escape cover in wetlands that have a relatively high starting canopy cover of sedges and other herbaceous vegetation. Support is higher (e.g., moderately-strong to strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Canopies of short-stature willows would likely not be affected at this level of grazing. (See "Humidity Retention and Temperature Moderation" subsection for discussion of dense willow canopies.)

The "retained" Robel pole readings provide a good indication of the cover qualities that are retained at different retention levels in herbaceous communities. In moderate to tall herbaceous communities (e.g., those with the predominant leaf tuft height exceeding 12 inches), post-grazing readings would be expected to be in the upper half of the 50-85% range identified previously, meaning that 80% retention in these plant communities retains a moderately-large to large amount of hiding-cover qualities. In comparison, relatively short or sparse herbaceous plant communities tend to lose cover qualities quicker (e.g., the lower half of the 50-85% range).

As the potential for predation increases (e.g., predation of tadpoles by fish, tiger salamander larva), the need for hiding and escape cover for tadpoles, metamorphs, and adults correspondingly increases. Enough hiding and escape cover would remain available for adults while they are in breeding and summering pools, tadpoles in breeding pools, metamorphs on shorelines, and juveniles and adults while they are moving from wetland to wetland or otherwise using non-wetland habitat. Retaining 70-95% of the canopy cover of relatively-intact herbaceous vegetation and 50-85% of pre-grazing Robel pole readings means that trampling effects on vegetation in wetlands would be at a level that only pushes a small amount of vegetation down into the mud where it becomes unavailable for use by tadpoles and adults as hiding cover.

Roche et al. (2012b) lends at least some support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable hiding and escape cover in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. The study does not provide direct evidence of this since hiding-cover qualities of vegetation were not monitored, but no effects of ≤25% utilization of herbaceous vegetation as measured in July were statistically detected on toad occupancy of meadows in June and July, and 96% of these meadows had ≤20% utilization (≥80% retention).

Munger et al. (1994), Roche et al. (2012a), and McIlroy et al. (2013) also may lend some support for the assessment that ≥80% retention of total herbaceous vegetation retains suitable hiding and escape cover in breeding wetlands (both in the water column and at the water surface), on shorelines, and in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. However, hiding-cover qualities of vegetation were not measured and retention levels on shorelines were somewhat higher (≥85% or possibly even ≥90%) in Roche et al. (2012a) and McIlroy et al. (2013). At a retention level roughly equivalent to 80%, spotted frogs occupied wetlands equivalent to their availability in Munger et al. (1994), but occupied wetlands substantially lower than their availability where retention levels were lower. Roche et al. (2012a) and McIlroy et al. (2013) did not detect any significant differences in tadpole densities, toad occupancy, or the number of young-of-the-year at breeding pools among treatments (ungrazed meadows and grazed meadows). Although retention levels were likely ≥85% at breeding sites, similar effects would likely occur at 80% retention with respect to hiding and escape cover.

Also, even though they did not specifically examine hiding cover, Bull and Hayes (2000) may also provide at least some indirect indication that hiding cover for tadpoles is sufficient at 80% herbaceous retention. This is because they did not detect a significant difference in tadpole survival between ungrazed wetlands and grazed wetlands, which are estimated to have had 80% of herbaceous vegetation retained. (While results were not significant, tadpole survival in grazed wetlands was 32-41% lower than in ungrazed wetlands.)

Data for the Greater Yellowstone area supports the retention of a minimum of 50% canopy cover of emergent vegetation in wetlands. Patla and Peterson (unpublished data, as cited by Patla and Keinath 2005:28) found that two thirds of wetland sites had greater than 50% cover of emergent vegetation, mostly sedges. Starting canopy cover can be as low as 70% and possibly even 60% and still have ≥50% canopy cover post-grazing where retention of herbaceous vegetation remains ≥80% (Table A.2).

On the other hand, Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) do no lend support to the assessment that 80% retention of total herbaceous vegetation retains suitable hiding and escape cover for spotted frogs in and around wetlands, and may provide some evidence that hiding cover was reduced sufficiently to affect the abundance and occupancy of frog adults and tadpoles. The studies do not provide direct evidence for or against this since hiding and escape cover were not directly examined, but Munger et al. (1994) found that sites with spotted frogs had significantly lower evidence of livestock grazing use than sites with livestock grazing use (an estimated retention in the neighborhood of 80%). While results were not statistically significant in Munger et al. (1996), patterns were similar. Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetlands than in grazed wetlands (an estimated 70-85% retention). Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%. Although results were not statistically significant at the $p < 0.05$ level, tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible this would have been significant at a higher significance threshold, and it is possible that reductions in hiding and escape cover were factors, but this cannot be confirmed.

Tadpole Forage

There is moderate to strong support for the assessment that retaining a minimum of an estimated 70-95% of the canopy cover of relatively-intact herbaceous vegetation and 50-76% of herbaceous biomass above 2 inches would retain enough of the vegetation qualities in large enough patches in breeding wetlands to provide suitable forage and forage substrate for tadpoles in the current year and future years, assuming that pre-grazed canopy cover of sedges and other herbaceous vegetation is moderate to relatively high. This includes only a small to moderate amount of vegetation being pushed down into the mud where it becomes unavailable for direct use by tadpoles either as standing vegetation or as decaying vegetation, or for indirect use by tadpoles (e.g., as substrate for algae).

Results of Munger et al. (1994), Bull and Hayes (2000), Adams et al. (2009), and Roche et al. (2012a) may lend some support for sufficient tadpole forage being provided in breeding wetlands where ≥80% of total herbaceous vegetation is retained within breeding wetlands. No effects in tadpole survival were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 80% retention in Bull and Hayes (2000); however, see next paragraph. Similarly, no effects in tadpole survival were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009), but there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands. Roche et al. (2012a) lends some support, but herbaceous retention in breeding wetlands was ≥85%. Herbaceous production in meadows/wetlands was high in their study (range of about 1,330-3,065 pounds/acre and average of about 2,327 pounds/acre) and canopy cover in Roche et al. (2012b) — which is likely representative of breeding wetlands in Roche et al. (2012a) — ranged from 56% to 80% within breeding wetlands, indicating a relatively large amount of herbaceous material being added to the detritus layer each year, even with as much as 10-15% of the biomass being removed on a yearly basis. While utilization in their study was lower than 20%, results likely would have been somewhat comparable at ≤20% utilization.

The data for the Greater Yellowstone area, identified above in the “Hiding Cover” subsection applies here as well.

On the other hand, results of Schmutzer et al. (2008) may indicate that it is possible for retention levels as high as 80% to still have at least some negative effects on tadpoles, possibly in part as a result of lower amounts of detritus, and Munger et al. (1994) and Bull and Hayes (2000) may also provide some indication of this. In part, Schmuzter et al. (2008) attributed markedly higher tadpole diversity and markedly higher abundance of some tadpole species in ungrazed wetlands to a 10.9x greater biomass of detritus in ungrazed wetlands in 2005 and a 3-4x greater biomass of detritus in 2006, compared to grazed wetlands. Detritus contributes to hiding and escape cover, as well as feeding sites and forage. Lower biomass of detritus likely resulted from cattle grazing (42% and 30% lower heights of emergent vegetation in grazed wetlands than in ungrazed wetlands in 2005 and 2006, respectively). Also, although not discussed in Schmutzer et al.(2008), trampling of emergent vegetation into the substrate also likely contributed to the significantly lower amount of detritus in grazed wetlands than in ungrazed wetlands, and it was not identified whether trampling of vegetation into the mud was taken into account (in Burton et al. 2009). If vegetation trampled into the mud was taken into account (e.g., as 0” readings), this may have reduced the estimates of percent retention to some degree.

Although results were not statistically significant at the $p < 0.05$ level, tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible this would have been significant at a higher significance threshold, and it is possible that reductions in tadpole forage was a factor, but this cannot be confirmed.

Invertebrate Forage, Cover, and Substrate

While there is only moderate support for the assessment that 80% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads as part of the larger insectivore community, there is moderately-strong to strong support for the assessment that invertebrate species richness and abundance of individual species would be sufficient to meet the dietary needs of spotted frogs and boreal toads.

Invertebrates as Part of Wetland, Meadow, Silver Sagebrush, Meadow-Willow, and Willow-Herb Communities

There is moderate support for the assessment that (1) retaining a minimum of an estimated 70-95% of the canopy cover of relatively-intact herbaceous vegetation and 50-76% of herbaceous biomass above 2 inches in moist-meadow type communities, and (2) retaining 53-65% of sedge height above 2 inches (57-70% of total height) in sedge communities would retain enough of the vegetation qualities in large enough patches to provide for the habitat needs of native invertebrate-communities of moist and wet meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities. (Canopy cover and biomass would be in the middle to upper end of these ranges in moderate height to tall, dense herbaceous communities.) Support is higher (possibly moderately-strong support) for the above assessment where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Live willow shrubs, dead stems, and fallen willow plant material contributes to invertebrate habitat. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to providing invertebrate habitat, but in these cases cattle likely would not graze these site and willow canopy cover may be too dense to be used by boreal toads.

Retaining a large majority of the canopy cover and majority of the biomass in herbaceous and herb-shrub communities would appear to provide more than moderate support, but several studies on the effects of livestock grazing on invertebrates showed negative effects of livestock grazing on invertebrate communities at relatively low utilization rates, estimated to be in the neighborhood of 80% retention, with fairly substantive impacts occurring by the time retention had dropped to this level (Kruess and Tscharntke 2002, Foote and Rice Hornung 2005, Samways 2005, Kimoto et al. 2012). As an example, Foote and Rice Hornung (2005) found that, below a sedge height of about 16 inches (40 cm) — compared to ungrazed heights of about 18-24 inches — diversity quickly declined to half or less and possibly as much as an 80-90% reduction on some sites. Converting 16 inches to percent retention, the threshold at which diversity began to decline was approximately 75-85% retention of herbaceous vegetation, based on height-weight relationships worked out by Kinney and Clary (1994). Therefore, ≥80% retention levels would appear to not negatively affect dragonflies and damselflies under similar circumstances. A similar, but weaker pattern was found in silver sagebrush communities adjoining marshes. (Additional details can be found in the "Information on Key Amphibian-Livestock Grazing Studies Cited in this Report" section of this appendix.) Kruess and Tscharntke (2002) found similar general patterns for grassland specialist invertebrate species, and even other invertebrate species found in grasslands. It is likely that other invertebrate species dependent on dense wet and moist meadow vegetation follow similar patterns.

On the other hand, Howard and Munger (2003) did not detect any significant difference in invertebrate biomass between grazed portions of sites areas and ungrazed portions of sites, as part of a study on Columbia spotted frogs. Although they did not provide any indication of the level of grazing, estimated average retention may have been in the neighborhood of 80% as it appears to have been in studies by Munger (1994) and Munger (1996). The study by Howard and Munger (2003) was less rigorous than the studies cited in the previous paragraph, but it appears to provide at least weak support for the assessment that sites with 80% retention of herbaceous vegetation would maintain some aspects of the invertebrate community. It is possible that retention levels were lower in their study, but they did not provide any information characterizing the intensity of grazing.

As a general principle, invertebrate communities that developed in mountain meadows showing little sign of ungulate grazing once plant community height was attained, and formed under the influences of relatively tall herbaceous vegetation, a high percent canopy cover, relatively high species composition in moist meadows, and the microclimatic conditions associated with this vegetation structure (see the "Near-100% Herbaceous Retention as a Starting Point of Assessment" section). Retaining 70-95% of the canopy cover of the effective canopy cover and 50-76% of the biomass of herbaceous vegetation above 2 inches would retain more than half of the characteristics of mountain meadows and, therefore, should satisfactorily provide for the needs of many invertebrate species representative of native moist and wet meadows, silver sagebrush and shrubby cinquefoil, and meadow-willow communities. However, invertebrate species dependent on or associated with tall, dense herbaceous vegetation would not fare as well. This is generally supported by information summarized in the "Forage, Cover, and Substrate for Invertebrate Prey" section of this appendix given the moderately-high degree to which vegetation characteristics would be retained.

Invertebrate Communities Resulting from Increased Structural Diversity and Eutrophicaton

There is moderately-strong to strong support for the assessment that 80% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads without consideration of any larger insectivore community. There is stronger support for this assessment than for the previous assessment because, at 80% retention, available information summarized in the “Forage, Cover, and Substrate for Invertebrate Prey” section near the beginning of this appendix indicates that invertebrate species richness and abundance in wet and moist meadows, silver sagebrush and shrubby cinquefoil, and meadow-willow vegetation types would remain relatively high.

Some invertebrate taxa initially respond favorably to grazing (East and Pottinger 1983) and this probably occurs through 20% utilization of herbaceous vegetation for many of these taxa.

Results of Roche et al. (2012b) lend at least some support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable invertebrate habitat for toads in meadow habitat. The study does not provide direct evidence of this, since data was not collected on invertebrates. However, because all measured retention levels were ≥75% (range of 75% to 100% retention) when toad occupancy was sampled in meadows, it may indicate that toads were finding sufficient invertebrate prey in meadows at the time of sampling.

Shallow Waters Exposed to the Sun

There is no more than weak evidence that 20% utilization of emergent vegetation would create open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, or to maintain such areas. Any patches that would be opened up to exposure to the sun would likely be small.

The addition of a qualifier allowing up to 20% of the breeding-wetland area to be grazed more than 20% use of herbaceous vegetation — in wetlands with a large proportion of the area dominated by emergent vegetation — would allow for grazing and trampling pressure to be high enough in a small proportion of the wetland to create and maintain openings in the emergent vegetation cover.

Open Patches

There is strong support for the assessment that 20% utilization of herbaceous vegetation would create small openings in large, extensive stands of herbaceous vegetation. This is because openings in extensive stands of dense herbaceous vegetation would increase from near 0% to an estimated 5-30% of the stands, which encompasses “small” openings.

Extensive dense stands of herbaceous without any small pockets of open water may reduce suitability of wetlands for spotted frogs and boreal toads, and low intensity livestock grazing may be neutral or beneficial to the frogs and toads in these areas by creating small openings for basking and by facilitating eutrophication which can benefit larva. Twenty percent utilization of herbaceous vegetation in an otherwise dense emergent marsh without any other openings would provide numerous small openings or a smaller number of larger openings (Table A.2; BLM et al. 2008:27) which would have the potential to benefit spotted frogs and boreal toads.

Shovlain et al. (2006) suggested that one reason for Oregon spotted frogs not selecting against low levels of grazing in their study may be because it created open patches of water in emergent vegetation. Watson et al. (2003) found that grazing by cattle created openings in reed canary-grass (which can become very tall and dense, and was mostly unused by Oregon spotted frogs when stands were consistently tall and dense without any open patches). Bull (2005) similarly assessed that some level of livestock grazing may benefit Columbia spotted frogs by creating openings in otherwise continuously dense marsh habitat, thereby providing basking sites and increasing solar radiation of water. Maxell (2000) identified two amphibian experts supporting the assessment that “In certain areas one possible positive impact may be that mechanical clearing of vegetation opens up basking areas that amphibians require. Although these are only observations, and not results of research, they make sense biologically since spotted frogs and boreal toads have frequently been observed using basking sites.

However, overly-dense sedge communities in breeding pools on the BTNF appear to be of relatively limited occurrence, and while scattered small openings produced by livestock may be beneficial to spotted frogs and boreal toads in otherwise monotypic stands of emergent vegetation, there is no scientific information indicating this is needed as part of a conservation strategy. Many wetlands in mountain meadows did not receive enough use by native ungulates to produce these conditions on a regular basis. Also, while spotted frogs and boreal toads appear to benefit from small openings in otherwise large areas of consistently tall, dense herbaceous vegetation, no studies have demonstrated they are needed. Results of Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) provide evidence that Yosemite toads are able to persist in wetlands having highly productive, tall, dense sedge communities with ≥90-95% retention in early to mid summer and ≥85-90% retention in late summer. Very few if any openings likely were created in the dense sedge cover within breeding wetlands and in the immediate vicinity of these wetlands during their study. Roche et al. (2012b) did not find any indication that toads avoided meadows or parts of meadows with tall, dense herbaceous vegetation and, conversely, there was a general trend toward toads occupying wetter sites which tend to have high productivity of sedges and lower levels of grazing.

Examination of Other Factors Influenced by 80% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., "Water Quality," "Surface Water Duration in Small Pools," "Survival as Influenced by Trampling," and "Soil Looseness and Porosity, and Overhanging Banks" sections). These sections should be consulted for desired conditions. Material in the "Roles of Herbaceous Canopy/Retention and Openings" section is not repeated below and should be consulted as background information.

On sites where 80% of the annual production of total herbaceous vegetation is retained — including in herb-shrub and shrub-herb communities with substantive herbaceous production — effects on water quality, and soil looseness and porosity would likely remain within acceptable limits, and effects on the retention of surface-water in small pools and survival of tadpoles, metamorphs, and adults as affected by trampling should remain within acceptable levels in most situations, with an exception that mortality due to trampling may be high in some situations. This assessment is based on information in the following subsections.

Water Quality

There is moderate support for the assessment that 80% retention of herbaceous vegetation would protect against negative impacts to water quality for spotted frogs and boreal toads in all breeding wetlands grazed to this level of retention, and there is moderately-strong support for the assessment that 80% retention of herbaceous vegetation would protect against negative impacts to water quality for these species in a majority of breeding wetlands grazed to this level of retention. Support is somewhat higher (e.g., strong support) where willows comprise a relatively large proportion of the vegetation canopy cover and herbaceous production is relatively low, but support would still be moderate-strong where herbaceous production is relatively high in willow-herb communities (e.g., 2,000-3,000 pounds/acre). The scientific information summarized below and in the "Water Quality" section shows three important things: (1) water quality likely would be affected by no more than a minor degree in some wetlands; (2) water quality likely would be reduced in some wetlands; and (3) at 20% utilization of herbaceous vegetation within and immediately adjacent to wetlands, water quality in a large majority of wetlands would likely be reduced by no more than a minor degree.

Retention of 80% of total herbaceous vegetation in and immediately around breeding wetlands would in most cases indicate that use is low enough that water quality remains within an acceptable range for spotted frogs and boreal toads. However, potential exists for livestock to use a wetland for drinking while having comparatively lesser effects on vegetation due to livestock drinking and not foraging (especially sheep), and using paths already created by animals that reached the water before them (i.e., factors that can contribute to higher use than percent retention of herbaceous vegetation may indicate).

Findings of several studies lend moderately-high support for the assessment that 80% retention of total herbaceous vegetation in and around wetlands would sufficiently limit grazing intensity to maintain suitable water quality for spotted frogs, boreal toads, and their insect prey. Roche et al. (2012a) and McIlroy et al. (2013) lend some support for the assessment that ≥80% retention of total herbaceous vegetation would maintain grazing use of wetlands at low enough levels to allow suitable water quality to be maintained. They did not detect any treatment effects of cattle grazing on concentrations of nitrates, nitrites, phosphorous, or dissolved oxygen, or on turbidity in breeding wetlands, but retention levels in these wetlands during the tadpole phase was likely ≥90% and possibly as low as ≥85% by the end of the tadpole phase. Because there did not appear to be any patterns of reduced water quality at these retention levels, it is likely that similar results would have been obtained at a lower retention level of 80%.

Bull and Hayes (2000) lend support to the above assessment because they did not detect any statistically significant reductions in water quality variables (pH, conductivity, nitrates, dissolved oxygen), at the $p < 0.05$ level, as a consequence of livestock grazing use. Livestock grazing was light on average (an average rating of just above "slight evidence" of livestock use), which appears to roughly translate to 80% retention of herbaceous vegetation.

Foote and Rice Hornung (2005) also did not detect any statistically significant effects of cattle grazing on total dissolved solid (TDS) urine indicators in their study of the effects of livestock grazing on dragonfly and damselfly diversity. It is estimated that 60-70% of sedge biomass was retained in grazed wetlands their study area, meaning they would not have detected any statistically significant results at this higher retention level of 80%.

While the above studies indicate that retaining ≥80% of total herbaceous vegetation would help prevent water quality from being negatively impacted by livestock, at least two studies shows that negative effects on water quality can occur in some situations at this herbaceous retention level. Schmutzer et al. (2008) found significant reductions in water quality (specific conductance, turbidity, and dissolved oxygen) in wetlands averaging 70-85% retention of herbaceous vegetation compared to cattle-excluded wetlands. Ammonia nitrogen, nitrites, and nitrates were consistently higher (5–216% higher) in grazed wetlands than in cattle-excluded wetlands; although results were not statistically significant at the $P<0.10$ level, results indicate that grazing at this level can elevate concentrations of these contaminants. Ammonia nitrogen may have reached levels that were biologically significant. Hornung and Rice (2003) found ammonium levels to be significantly higher in mid-July and possibly in late August in grazed wetlands than in ungrazed wetlands, and orthophosphates were found to be significantly higher in mid July and late August in grazed wetlands than in ungrazed wetlands. It is estimated that 70-80% of sedge biomass was retained in grazed wetlands their study area. Because naturally occurring nitrate, nitrate, ammonium, and phosphates can be near levels that negatively affect spotted frogs and boreal toads, these studies indicate that inputs from livestock can result in thresholds being exceeded.

Surface-Water Retention in Small Pools

For medium-size and large breeding wetlands on the BTNF, there likely is a relatively high probability of drinking by livestock having no discernible effect on water level declines when retention of herbaceous vegetation is ≥80% in and immediately around the wetland. This is because water volumes of wetlands are far in excess of the volume removed by livestock. For small breeding wetlands (e.g., <2,000 ft^2), limiting livestock grazing use such that ≥80% of total herbaceous vegetation is retained in and immediately around wetlands would help substantively to minimize the rate at which water-level declines are accelerated due to livestock drinking. There are no known scientific studies or data to support these assessments, but 20% use includes some use by wild grazers and it represents a low level of livestock use. However, this level of livestock use would still have potential of causing some wetlands to dry before completion of metamorphosis in situations where tadpoles would otherwise have completed their metamorphosis. This could occur (1) in the smallest of breeding wetlands, and (2) in other small and moderately-small wetlands in which water levels naturally declined to near-dry conditions but in which tadpoles were able to complete metamorphosis.

Even at a relatively light grazing intensity that results in 80% retention of herbaceous vegetation at breeding wetlands, the rate at which water levels decline in mid to late summer could potentially be hastened to some degree by livestock water consumption in some of the BTNF's small breeding pools, depending on a variety of factors such as recharge and evapotranspiration rates. As described in the "Surface Water Duration in Small Pools" section of this appendix, it does not take many cattle to fairly quickly deplete water volumes in small pools. If water is plentiful in the general area and only small numbers of cattle typically use susceptible small breeding pools (and if cattle are routinely eating herbaceous vegetation whenever they are at the pool), a retention of 80% of total herbaceous vegetation would likely suffice to allow use of the pool by livestock while limiting the rate at which water-level declines are accelerated due to livestock drinking. If livestock use a given wetland primarily for water with only limited use and trampling of vegetation, a measure or estimate of 80% retention at the wetland may very well provide an underestimate of the extent to which surface-water levels are declining due to drinking by livestock.

This element warrants further investigation, including assessments of the types of situations in which livestock accelerate declining water levels and the extent to which 80% retention is sufficient to retain sufficient water levels in these situations.

Survival as Affected by Trampling

There is at moderate or moderately-high support for the assessment that limiting utilization of herbaceous vegetation in summering and migration habitat to no more than 20% would limit trampling-caused mortality of adult and juvenile spotted frogs and boreal toads to relatively low levels, and there is moderate support for the assessment that limiting utilization of herbaceous vegetation at breeding wetlands to no more than 20% would adequately limit trampling-caused mortality of tadpoles and metamorphs to relatively low levels in most situations.

Summer and Migration Habitat

The potential for livestock to step on juvenile and adult frogs and toads is probably relatively low in summering habitat and in migration corridors when and where there is overlap between livestock use and use by frogs or toads. Figure A.16 shows that an estimated 5-150% of small stationary objects are estimated to be trampled in meadows producing 500 pounds/acre, and that an estimated 30-75% of small stationary objects would be trampled in meadows producing 3,000 pounds/acre, assuming cattle are in any given meadow for 2-4 weeks. An estimated 10-55% of small stationary objects are estimated to be trampled within 2-4 weeks at 20% use (80% retention) of herbaceous vegetation in meadows producing 1,000 to 2,000 pounds/acre. As an example of actual data, Jensen et al. (1990) found that 53% of clay pigeons were trampled at a cattle density of 3.2 cows/acre for 7 days, and this density for plant communities producing 2,000-3,000 pounds/acre of forage converts to about 80% retention (Tables A.4 and A.5).

There are several reasons estimates from Figure A.16 overestimate trampling of frogs and toads in summer and migration habitat by livestock: (1) of 20% utilization, a portion is not attributable to livestock in any given situation; (2) frogs and toads would move out of the way of livestock compared to the stationary objects in Figure A.16, which means actual trampling rates of frogs and toads likely are lower than what is shown in the graphs; (3) frogs and toads typically use wetter sites in riparian areas, meadows, and silver sagebrush communities than livestock; (4) spotted frogs primarily summer in ponds and other wetlands and are able to jump out of the way of livestock in these situations; and (5) the migration period of spotted frogs — when then are in meadow, silver sagebrush, and even big sagebrush and forestland — is relatively short compared to the amount of time it takes to reach 20% utilization if this were the utilization limit for a given pasture. As such, trampling of frogs and toads by livestock in summering and migration habitat would be less than what is shown in the graphs, likely with percentages in the single digits or possibly in the teens.

On the other hand, it is possible for trampling rates to be elevated on a periodic basis when metamorphs move away from wetlands, given the large number of individuals moving through fairly narrow corridors (Bull 2009) which can result in elevated concentrations in places being used by cattle. Where high concentrations of metamorphs overlap with habitat that is being grazed by cattle, there is a reasonable chance of metamorphs being trampled (Figure A.16, Bartelt 1998).

Breeding Wetlands – Adults and Eggs

The potential for livestock to step on tadpoles and adult frogs and toads at breeding sites would be low because most eggs should be hatched prior to the onset of livestock grazing each year and most adults have left breeding wetlands by the time livestock arrive onto allotments. This does not include adults that remain at breeding wetlands; adults that summer at breeding wetlands are addressed above in the discussion of summering habitat.

Breeding Wetlands – Tadpoles and Metamorphs

At 20% utilization of herbaceous vegetation at breeding sites, there would be a (1) moderate to moderately high potential of trampling tadpoles every year when and where livestock access wetlands containing tadpoles, and while the level of impact in any given year could vary somewhat, there likely would be no more than a small percentage of tadpoles trampled in most years in most wetlands; and (2) moderate potential of trampling metamorphs in any given year when and where livestock access wetlands during the metamorphosis period, but the level of impact when incidences occur (i.e., when livestock use of wetland shorelines overlaps in time and space with concentrations of metamorphs) could range from low to moderate depending on the situation. Where livestock use overlaps in time and space with tadpoles, there would be a high likelihood for at least some tadpoles being trampled, and the potential for this would increase as the summer progresses and pools of water shrink.

There likely is a moderate potential of trampling metamorphs when and where livestock have access to breeding wetlands during the tail end of the breeding season, and there likely would be a low to moderate percent of metamorphs trampled (when incidences occur) for the following reasons. Metamorph emergence and concentration on shorelines would only occur for several days and concentrations occur in small areas, compared to livestock which graze the area for a longer period of time and they range over substantially larger areas. Graphs in Figure A.16 likely overestimate trampling rates of tadpoles and metamorphs because the graphs present trampling rates of small stationary objects by cattle at given densities over the course of 1-4 weeks, but high concentrations of metamorphs only occur for several days. At cattle densities required to reach 20% use of a wetland in 3-4 weeks (0.5-1.5 cows/acre, assuming 2,000-3,000 pound/acre of herbaceous production; Tables A.4 and A.5), an estimated <5% to 15% of small stationary objects would be trampled in a 3-4 day period (Table A.3). This may be comparable to trampling rates of metamorphs. However, trampling would only occur when amd where there is overlap between livestock and metamorphs, and there likely are many years when use of any given wetland by livestock does not occur when metamorphs are emerging. If 20% use at a given wetland is attained in about 1 week, this equates to densities of 1.6-6.0 cows/acre, which in turn results in an estimated 20-70% being trampled in a 3-4 day period. The chances of high percentages of metamorphs being trampled would be relatively low when and where livestock and metamorphs overlap, although the chance of a moderate percentage of metamorphs being trampled would be relatively high when and where livestock and metamorphs overlap. It needs to be recognized that cattle use wetlands for more than just grazing (e.g., some to many may use a wetland for watering and not grazing), and some cattle may remain at a wetland for periods of time without grazing or drinking. To the extent this occurs, the above estimates may underestimated effects.

Results of the study by McIlroy et al. (2013) lend some support for trampling by cattle being at a low enough level to not reduce tadpole densities where herbaceous retention levels at breeding wetlands are ≥85% and likely as low as ≥80%. However, trampling effects on tadpoles were not assessed in their study and results can only be applied indirectly (because there were no statistical differences in tadpole densities, their likely was not a trampling effect on tadpoles).

Munger et al. (1994) and Bull and Hayes (2000) may lend some support to the assessment that 80% retention would sufficiently limit trampling of tadpoles and metamorphs (i.e., so mortality of tadpoles and metamorphs is not measurably increased). At a retention level roughly equivalent to 80%, spotted frogs occupied wetlands equivalent to their availability in Munger et al. (1994), but occupied wetlands substantially lower than their availability where retention levels were lower. This could potentially indicate that trampling was at a low enough level to allow spotted frogs to continue to occupy wetlands grazed at an estimated 20%. In Bull and Hayes (2000), there was an apparent, albeit non-statistical (at $p < 0.05$), reduction in tadpole survival in grazed wetlands at an estimated average of 20% utilization of herbaceous vegetation, especially when the number of eggs are made equivalent between ungrazed and grazed breeding wetlands. By taking into account the difference in number of eggs laid between grazed and ungrazed wetlands, there were 41% fewer tadpoles that successfully metamorphosed into frogs in grazed wetlands compared to ungrazed wetlands. It is possible this would have been statistically significant at a higher significance threshold (e.g., $p < 0.1$ or higher) and it is possible that trampling by cattle could have killed tadpoles or metamorphs before counts were made by Bull and Hayes (2000), although these possibilities cannot be confirmed. Figure A.16 provides information showing that trampling of metamorphs has the potential to be fairly substantive at 80% retention of herbaceous vegetation.

Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) do no lend support to the assessment that 80% retention of total herbaceous vegetation adequately protects against adults and tadpoles being trampled, and may provide some evidence trampling was sufficiently high to affect the abundance and occupancy of frog adults and tadpoles. The studies do not provide direct evidence of this since trampling effects were not measured, but it is possible for trampling by livestock to have contributed to reductions in abundance and/or occupancy in the studies.

Limiting retention to 80% as a means to protect tadpoles and metamorphs from trampling may not be effective where sheep are watered and, therefore, additional measures would need to be evaluated and implemented as part of allotment management planning on sheep allotments. Watering by sheep involves concentrations of hundreds of sheep or more in short time periods and sheep typically do not eat graminoids typically found in wetlands and on shorelines.

Soil Looseness and Porosity

There is strong support for the assessment that limiting use of herbaceous vegetation to 10% would maintain suitable soil looseness and porosity. Eighty percent retention of total herbaceous vegetation would limit soil compaction to acceptable levels. Thurow (1991:149) presented data showing that water infiltration rates (one indicator of the extent to which soils are compacted) in pastures with moderate stocking rates were approximately 15% lower than in a livestock exclosure. Assuming “moderate” equates to 31-50% utilization of key forage species (Holechek et al. 2011:141; their conservative and moderate grazing intensities were combined for the purposes of this assessment), this roughly translates to 55-80% retention of total herbaceous vegetation, and 80% retention of herbaceous vegetation is at the very upper end of this range.

Integrity of Near-Surface Burrows and Streambanks

There is moderate to moderately-strong support for the assessment that limiting utilization of herbaceous vegetation where shallow burrows occur to no more than 20% would limit crushing of these burrows. Because shallow burrows are stationary, clay pigeons provide an approximation of the level of potential impact. An estimated 10-25% of clay pigeons would be expected to be stepped upon when livestock are in meadows (1,000 pounds/acre production) long enough to result in 20% utilization of total herbaceous vegetation (Figure A.16). In meadows with 2,000 and 3,000 pounds/acre, an estimated 25-55% and 35-70%, respectively, of clay pigeons would be expected to be stepped upon. This provides a moderately-low to moderate potential for shallow burrows being crushed and with it, a potential for occupants to be crushed in them.

There is relatively high support for the assessment that limiting utilization of herbaceous vegetation in riparian habitats to no more than 20% would limit the crushing of streambanks. This is mainly because use of streambank vegetation would be limited when utilization of total herbaceous vegetation in riparian areas remains below 20%. Livestock use of streambanks typically does not increase substantially until vegetation in moist meadows, silver sagebrush, and shrubby cinquefoil is well utilized.

Implications of Livestock Grazing Use to Multiple Stressors

Long-term Reductions in Vegetation Height and Canopy Cover

If starting herbaceous canopy cover (prior to the onset of livestock grazing) is less than near-100% but high enough to effectively retain humidity, moderate temperatures, provide shade, provide hiding and escape cover, and provide invertebrate habitat to some degree, reducing canopy cover by an estimated 5-30% could potentially reduce canopy cover, if starting canopy cover is low enough, to the point that herbaceous vegetation is no longer providing these functions (bottom of Table A.2). If starting herbaceous canopy cover is too low to retain humidity, moderate temperatures, provide shade, provide high-quality hiding and escape cover, and provide high quality invertebrate habitat, reducing canopy cover by an estimated 5-30% would make the situation somewhat worse. Similar situations would occur if starting vegetation height is too short to provide an effective canopy and to provide invertebrate habitat, for example where non-native bluegrasses dominate a plant community and where plant vigor is depressed. Starting herbaceous canopy cover and heights as described above can occur naturally, but most moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow sites are productive and typically have high percent canopy cover (e.g., in the neighborhood of 80-100%; (Norton et al. 1981:57, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). Reductions in height and percent canopy cover can result from plant mortality and reduced plant vigor caused by livestock over-use and increases in nonnative species like Kentucky bluegrass and smooth brome.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 80% retention of herbaceous retention would result in somewhat greater impacts than described in the "Examination of Herbaceous Structural Attributes at 80% Retention" section, above.

On the other hand, where percent canopy cover and/or height is naturally low or where it is lower due to reduced plant vigor and/or conversion to nonnative species like Kentucky bluegrass, smooth brome, or tarweed, 20% use of herbaceous vegetation would result in fewer impacts to water quality, wetland water levels, and survival as affected by trampling compared to effects in healthy, naturally-functioning plant communities. This is because utilization is based on weight, and if annual production is, for example, 500 pounds/acre instead of 2,000 pounds/acre, livestock would spend considerably less time in the meadow that produced 500 pounds/acre. In this example, the potential of being trampled could be roughly 3-4x lower in the meadow supporting 500 pounds/acre than if it produced 2,000 pounds/acre (Figure A.16). Furthermore, fewer spotted frogs and boreal toads would be found in the meadow producing 500 pounds/acre (both in the vegetation and in burrows), which would further reduce the potential of frogs and toads being trampled.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 80% retention of herbaceous retention would result in fewer impacts than described in the "Examination of Other Factors Influenced by 80% Retention" section, above.

If serious attempts are made to retain ≥80% of herbaceous vegetation at each monitored breeding wetland and if monitored breeding wetlands are fairly representative of other breeding wetlands (including grazing levels), herbaceous vegetation would remain at higher levels (≥90%) at some monitored and unmonitored breeding wetlands and it is likely that herbaceous vegetation would decline to ≤70% at some unmonitored breeding wetlands. First, under the best of circumstances, retention would only be monitored at a small proportion of known breeding wetlands any given year and not all allotments would be monitored every year. Second, there is a reasonable chance that grazing use will push the limits of whatever retention threshold is identified and action may not be taken until retention levels are several percentage points or more below what is identified as the minimum threshold (i.e., grazing at some monitored breeding wetlands undoubtedly would be <80%). Third, only a portion of breeding sites are known and the location of breeding sites can change from year to year. Fourth, retention levels at different breeding sites would continue to be variable.

Other Multiple Stressors: Chitrid Fungus, Climate Change, UV Radiation, & Local Human-Related Impacts

The assessments made in the preceding 15 pages relative the capability of 80% retention to provide suitable habitat for spotted frogs and boreal toads and to protect them from direct livestock impacts were completed independent of effects of livestock grazing use in the context of multiple stressors.

In combination with all multiple stressors **—** *i.e., altered vegetation conditions (previous subsection), chitrid fungus, ranavirus, climate change, UV radiation, loss of habitat and habitat fragmentation due to roads, elevated mortality due to crushing by motor vehicles, elevated mortality due to introduced fish, poisoning from rotenone, reduced spring flows due to late-seral conditions, reduced beaver-pond distribution and abundance, increases in nitrate and ammonia in wetlands from the atmosphere, loss of wetlands and other habitat due to reservoirs, loss of meadow and willow habitat due to expanding forestland, and other effects on spotted frogs and boreal toads on the BTNF* **—** the addition of effects associated with 20% utilization of herbaceous vegetation in breeding wetlands and other habitats of spotted frogs and boreal toads has potential to contribute to a relatively small increase in negative impacts on habitat, small to moderate increase in potential for elevated mortality due to trampling, and negligible negative effects due to the possibility of emergent vegetation expanding into egg and tadpole development sites.

Even though scientific studies have shown there to be negative effects on occurrence and abundance of tadpole and adult spotted frogs at an estimated utilization level of 20%, examination of additional information showed there to be moderately-strong evidence that suitable habitat conditions would be maintained and moderate to moderately strong evidence that trampling-caused mortality would be limited to relatively low levels in most situations. While 20% utilization of herbaceous vegetation would not result in shallow-water areas to remain open where they are being encroached upon by emergent vegetation, this is only a limited issue on the BTNF.

≥70% RETENTION OF TOTAL HERBACEOUS VEGETATION

There is moderate evidence that ≥70% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, assuming that substantive parts of spotted frog and boreal toad habitat retain ≥80% of total herbaceous vegetation. A retention level of ≥70% would satisfactorily "…minimize impacts to species whose viability has been identified as a concern," as required by FSM 2670.32 (WO Amendment 2600-2005-1), while also providing for substantial livestock grazing. All assessments in this section assume that plant communities have are relatively natural structure (e.g., height and vegetation density) are in healthy functioning condition. To the extent a plant community is not, higher retention levels may be needed to adjusted upward to get the same effect. A minimum of 70% retention roughly translates to a maximum 30-50% utilization of key forage species, possibly as high as 80% utilization of key forage species (Appendix B) if no restrictions are imposed on the use of key forage species. Maximum use of key forage species of 30-40% is consistent with recommendations in some range management textbooks (e.g., Vallentine 1990, Holechek et al. 2011) and a maximum 50% use of key forage species is at the take-half, leave-half level developed in the 1940s (Heady and Child 1994). An herbaceous retention level of 70% translates to 30% use of key forage species where key forage species (e.g., sedges) comprise 100% or near 100% of the plant community, and it translates to 50% use of key forage species where composition of key forage species is either in the vicinity of 50% by weight and use of non-key species is low (e.g., 10%) or the composition is as low as 25% by weight but use of non-key species is relatively high (e.g., 25%). Where the composition of key forage species is low (e.g., ≤25%) and use of non-key forage species remains low (e.g., <20%), 70% retention of herbaceous vegetation translates to severe use of key forage species (e.g., 70-80% use) (Appendix B).

The moderate support for the above assessment is based on ≥70% retention of herbaceous vegetation (including substantive areas of ≥80% retention of total herbaceous vegetation within 1/3 mile of breeding sites) providing suitable: (1) hiding cover for tadpole, juvenile, and adult frogs and toads in breeding and summer-long habitat; (2) protection from the sun and ground-level humidity for juvenile and adult frogs and toads on breeding-pool shorelines and in summer-long habitat; (3) hiding cover and structure within wetlands for tadpoles; (4) hiding cover and protection from the sun for metamorphosed and adult frogs and toads on shorelines; (5) forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat; and (6) contributions to the following year's residual thatch and litter which in turn contributes to hiding cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities; <u>as well as to indicate suitable</u> (7) water quality (as related to urination, defecation, and trampling); survival as related to trampling of tadpole, juvenile, and adult frogs and toads in and adjacent to breeding and summer wetlands pools and in migration habitat; (8) water retention in small breeding pools; (9) soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (10) integrity of near-surface burrows used by frogs and toads; and (11) retention of overhanging streambanks used by frogs or toads for hibernation. This basis for this is outlined in the following 17 pages.

A maximum of 70% retention is not without precedence for conserving sensitive species. Kogut (2008) reported on cattle grazing being reduced from an existing 60-70% down to a maximum of 30% utilization to protect a sensitive butterfly species. A maximum of 80% retention was recommended for conserving a diverse prey base for northern goshawks (Reynolds et al. 1994).

Because of the fairly marked reductions in canopy cover and biomass above 2 inches and in visual obstruction, the potential for affecting other elements like water quality and mortality due to trampling, and potential implications to frogs and toads, the implications of changes in vegetation structure to each of the different habitat/ other elements are evaluated in some detail.

Summary of Key Amphibian-Livestock Grazing Studies

Support for ≥70% Retention as a Threshold

Results of Adams et al. (2009) and Roche et al. (2012b) lend at least support to the assessment that ≥70% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, recognizing that failure to detect effects of a treatment does not provide strong support for a conclusion of "no treatment effect:"

- No effects in tadpole survival and water quality were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009), meaning that no effects would have been expected in their study at a retention level of 70%. However, there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands, although this difference was not detected statistically. Also, there were a number of factors indicating that a conclusion of "no effect" of livestock grazing on tadpole survival in their study may not be fully supported based on information presented in Adams et al. (2009).
- Roche et al. (2012b) did not statistically detect effects of ≤25% utilization of herbaceous vegetation on toad occupancy of meadows and ≤30% utilization (i.e., from near 0% to 30% utilization) would likely have had similar results in the study since it is only 5% higher.

Results Not Pertinent to Assessment of ≥70% Retention as a Threshold

Results of Bull and Hayes (2000), Shovlain et al. (2006), Roche et al. (2012a), and McIlroy et al. (2013) do not support to the assessment that ≥70% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, <u>but they also</u> do not provide any indication that ≥70% retention of total herbaceous vegetation is insufficient, with the possible exception of Bull and Hayes (2000):

- Response variables studied by Roche et al. (2012a) and McIlroy et al. (2013) (e.g., toad occupancy, tadpole density, water quality, water temperature) were measured where herbaceous utilization levels did exceed about 15% (85% retention), meaning that results are not applicable to examining 70% retention of herbaceous vegetation.
- Shovlain et al. (2006) measured changes in herbaceous vegetation, pre and post, livestock grazing through the use of pin counts, and it is not clear how "low" and "higher" grazing pressure in their study related to 70% herbaceous retention and, therefore, results were not covered in this section (i.e., the "≥70% Retention of Total Herbaceous Vegetation" section).
- It is estimated that the average percent herbaceous retention in grazed wetlands in Bull and Hayes (2000) was in the neighborhood 80% and because no statistically-significant effects were detected, these non-significant results were not covered in this section. However, see below for additional assessment.

Studies that Identify Negative Effects of ~20-30% Use of Herbaceous Vegetation

On the other hand, results of Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) indicate, for at least some wetland situations, that ≥70% retention of total herbaceous vegetation does not retain suitable herbaceous habitat and/or water quality, and/or does not adequately protect against trampling by livestock, at least in some situations:

- Munger et al. (1994) found that sites with Columbia spotted frogs had significantly lower evidence of livestock grazing use than sites unoccupied by spotted frogs. In the vicinity of about 20% use of herbaceous vegetation, occupancy of wetlands by spotted frogs dropped substantively. For wetlands having a grazing-rating of 2 (which appears to correspond to 21-40% use, which encompasses 70% retention), it was about 10x more likely for frogs to be absent than to be present. While results were not statistically significant in Munger et al. (1996), patterns were similar.

- Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetlands than in grazed wetlands (an estimated 70-85% retention), and that water quality was significantly lower in grazed wetlands compared to ungrazed wetlands.
- Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.
- Although results were not statistically significant at the $p < 0.05$ level, spotted frog tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible the effect would have been significant at a higher significance threshold, but this cannot be confirmed. Results are consistent with findings of Munger et al. (1994).

These studies indicate that a livestock grazing-use level of 30% of total herbaceous vegetation (70% retention) negatively affects spotted frogs in at least some situations. Effects occurred at a use level of 20% (Munger et al. 1994, Bull and Hayes 2000) or occurred somewhere between 70% and 85% (Schmutzer et al. 2008, Burton et al. 2009); therefore, effects would have been greater at a use level of 30%. Thirty percent use is 50% higher than 20% use (an increase of 10% use divided by 20% use = 50%). While Schmutzer et al. (2008) and Burton (2009) were not conducted in the intermountain West, results are consistent with studies conducted in Idaho and Oregon, and some of the potential mechanisms of effects are applicable.

Even though three studies identified significant negative effects of livestock grazing on spotted frogs and other frog species and another two studies were consistent with these findings, examination of the details of habitat and survival elements (the following 16 pages) indicates that suitable conditions can be provided in many situations for spotted frogs and boreal toads, so long as ≥80% of herbaceous vegetation is retained on a substantive proportion of their habitat, except that trampling may be a substantive impact in some places at some times.

Where statistically-significant effects of livestock grazing on response variables (e.g., frog/toad occupancy, tadpole abundance) were detected, it is likely that changes in one or more of the habitat and survival elements — due to livestock grazing use — were responsible, but in most cases the mechanism(s) by which response variables were affected (e.g., habitat and survival elements) were not directly studied. Water quality is an exception to this because it is a response variable measured in several studies, but there are many other possible reasons for effects of livestock grazing on tadpole and adult occupancy, abundance, and species richness. Scientific information on trampling has the potential to have contributed to reductions observed in the cited studies (see the "Survival as Affected by Trampling" section). (Changes in vegetation height/structure/biomass was used to estimate percent retention and affects the degree to which several habitat elements are altered, but vegetation height/structure/biomass does not directly address *why* occupancy, abundance, and species richness were reduced.)

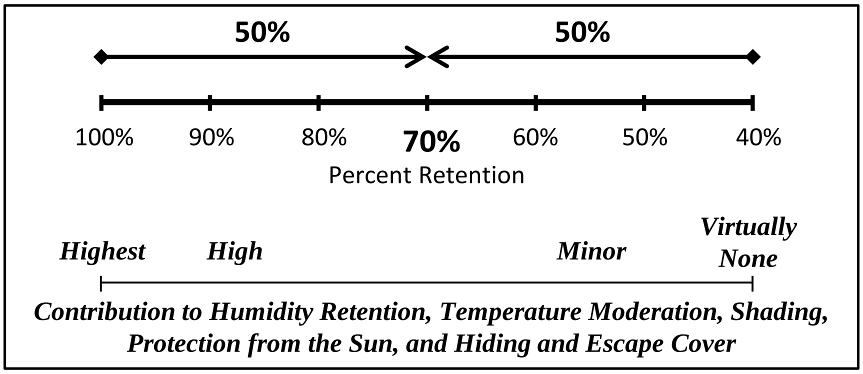
Each of these studies are examined below, relative to different levels of livestock grazing use, on each of several (e.g., humidity retention, shading, hiding cover, invertebrate habitat, water quality, survival as affected by trampling). Although the studies did not specifically measure or assess most of these habitat and survival elements, results of the studies provide additional information that can be used to assess whether given habitat and survival elements remain suitable at different herbaceous retention levels.

Examination of Herbaceous Structural Attributes at 70% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., "Humidity Retention, Temperature Moderation, and Protection from the Sun;" "Hiding and Escape Cover;" "Forage for Tadpoles;" and "Forage, Cover, and Substrate" sections). These sections should be consulted for desired conditions. Material in the "Roles of Herbaceous Canopy/Retention and Openings" section is not repeated below and should be consulted as background information.

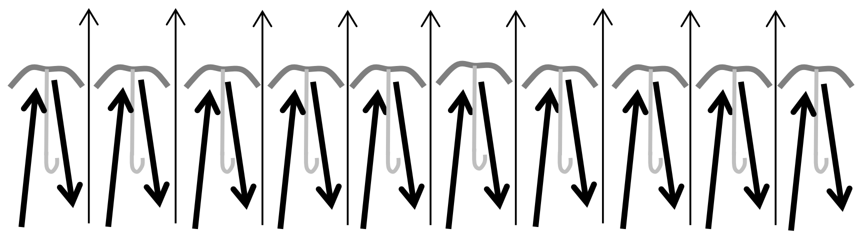
The following information sets the stage for this section by numerically characterizing 70% retention of total herbaceous vegetation:

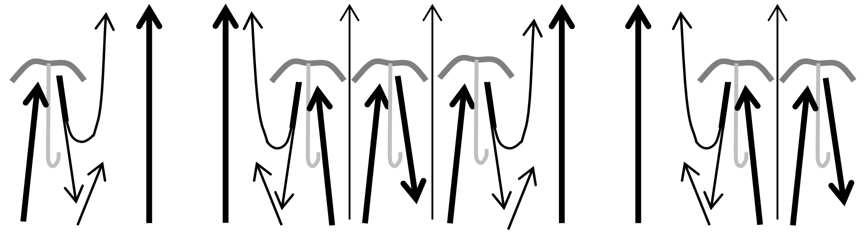
- In herbaceous communities and understories that are in healthy condition, 70% retention of total herbaceous vegetation would retain roughly half of the plant material that contributes to amphibian cover and insect forage and cover (Table A.2, Figure A.14). More specifically, 70% retention of total herbaceous vegetation would retain:
    - An estimated 50-65% of the canopy cover of relatively intact herbaceous vegetation, based on DeLong (2009b:Table 11) (Table A.2, Figure A.14, Figure A.8); skimming or topping would contribute to retaining a higher percent canopy cover.
    - An estimated 25-65% of the biomass of herbaceous vegetation above a 2-inch height, based on height-weight relationships in Kinney and Clary (1994) and BLM et al. (1999:118) including the exclusion of the weight of the bottom 2 inches of plants based on their information.
    - 20-70% of starting Robel pole readings compared to pre-grazing readings (i.e., reductions in Robel pole readings are typically 30-80%), based on DeLong (2009a) and additional data collected in 2011. These direct measures of visual obstruction, which substantiate the information in the above two bullets, provide a good indication of the degree to which hiding cover qualities are retained.
    - 15-45% of plant height if vegetation is grazed at an even height (e.g., sedge communities), based on height-weight relationship information in Kinney and Clary (1994) and BLM et al. (1999:118) (Table A.2, Figure A.14, Figure A.9).
- This numeric characterization of herbaceous communities having 70% retention generally fits within and is generally consistent with the narrative characterization of the 21-40% utilization class of the landscape appearance method in BLM (2008:27): "The rangeland may be topped, skimmed, or grazed in patches." A key characteristic is "grazed in patches." As retention declines below 70%, this characterization shifts to ungrazed patches (i.e., most of the basal area of plants is grazed).



Retaining an estimated 50-65% or more of the canopy cover of herbaceous vegetation would retain a moderate to moderately-large portion of the attributes of the vegetation that provides hiding and escape cover, provides shade, and provides habitat for a range of many invertebrate prey species, and would retain a relatively low to moderate portion of the attributes of the vegetation that retains humidity near the ground, moderate temperatures, and provides habitat for some invertebrate species. This assessment is primarily for communities with naturally moderate-height to tall, dense herbaceous vegetation, and they assume plant communities are at or near fully functioning conditions. Support for assessments made progressively declines with progressively lower ecological conditions (i.e., as factors such as overall canopy cover and plant species richness decline). The assessment in the first sentence of this paragraph is based on information provided for each of six habitat elements in the following subheadings (see the "Role of Herbaceous Retention" section for background information on each element). As little as 25% of the biomass of vegetation above a 2-inch height being retained and as little as 20% retention of pre-grazing Robel pole readings indicates that retention of these habitat elements (e.g., humidity retention, shading, hiding cover) is probably lower than "moderate" in the shorter herbaceous communities and understories, in communities with reduced canopy cover, and possibly in dry years. This caveat is also discussed in the following subheadings as pertinent.

Humidity Retention and Temperature Moderation


Humidity retention and escape — 100% Canopy Cover (umbrellas), <u>for reference</u>.


Humidity retention and escape — 60% Canopy Cover (umbrellas).

There is moderately-low to moderate support for the assessment that (1) retaining approximately half to 2/3 of the canopy cover of relatively-intact herbaceous vegetation and herbaceous biomass above 2 inches in moderate height to tall, dense herbaceous communities in moist-meadow type communities, and (2) retaining 41-50% of sedge height above 2 inches (46-57% of total height) in sedge communities would maintain enough humidity retention and temperature moderation attributes to contribute to suitable habitat for spotted frogs (Figure A.22, for sedges). Support is higher (possibly moderate to moderately-strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Canopies of short-stature willows would likely only be impacted by a small degree at this level of grazing. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to retaining near-ground humidity and moderating temperatures, but in these cases percent herbaceous retention would not be a factor for these elements (given the humidity-trapping qualities provided by willow), cattle likely would not graze these site, and willow canopy cover may be too dense to be used by boreal toads.

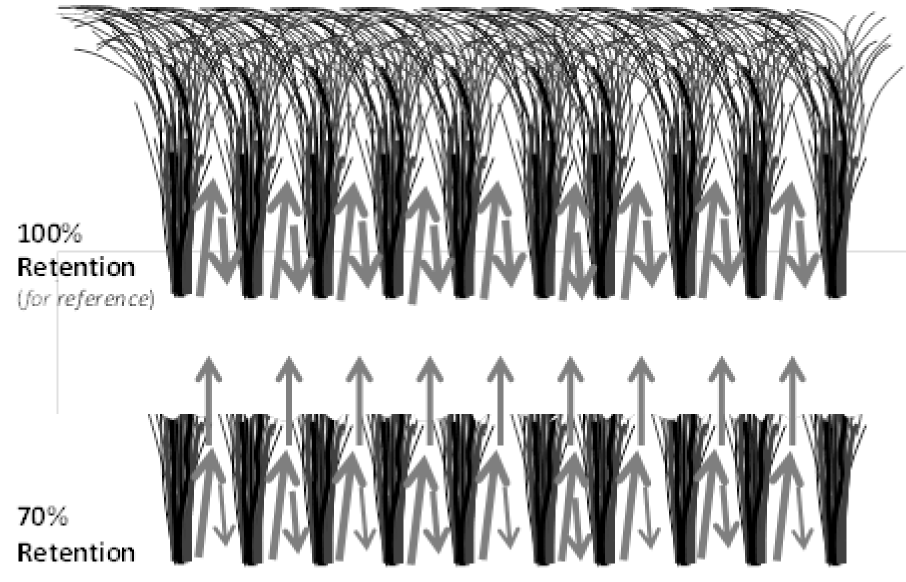


Figure A-22. Humidity retention and escape at 100% and 70% retention. Arrows indicate movement of humidity.

Since boreal toads can occupy habitat that is somewhat less humid/moist than what can be inhabited by spotted frogs, support may be as high as moderately-strong (70% retention) so long as large enough patches of relatively-intact herbaceous vegetation (or combinations of herbaceous vegetation and short-stature willows) — where humidity is retained at ground level — are readily available and well distributed. Despite the relatively-large reduction in herbaceous canopy cover at 70% herbaceous retention (Figures A.1 and A.8, and see 'umbrella' diagram this page), the likelihood of sufficient herbaceous-based microsites being retained is at least moderately high for boreal toads.

Removing 1/3 to half of the humidity-trapping canopy in moist-meadow type communities and removing the "drooping" plant material that forms the canopy in sedge communities (e.g., primarily leaving upright stalks) substantively reduces the ability of vegetation to hold-in humidity and moderate temperatures. On the other hand, relatively-intact vegetation would remain small patches in moist-meadow type communities that may be large enough to retain humidity and moderate temperatures to some degree, and stubble height in sedge communities would remain tall enough (in moderate-height to tall communities) to do the same. Additionally, the heading of this section is "≥70% Retention…" Since no portion of a plant community would dip below 70% retention and substantive portions would retain 80% or more of total herbaceous vegetation, humidity retention and temperature moderation would be suitable where this greater proportion of vegetation is retained. Ensuring that grazing does not go beyond "patchy," as described in the 21-40% utilization category in the landscape appearance method of BLM et al. (2008), would help keep percent canopy closure from dipping too low. When percent canopy cover of intact and relatively-intact vegetation declines below roughly 60%, grazing is moving beyond patchy.

Although no scientific studies were found on ground-level humidity readings at specific levels of percent canopy cover or specific herbaceous retention levels, the two basic principles of (1) a vegetation canopy being needed to retain humidity and moderate temperatures and (2) the positive relationship between percent canopy cover and humidity-retention/temperature- moderation levels (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000) dictate that reducing the canopy cover of intact and relatively-intact vegetation by 1/3 to 1/2 would substantively reduce the ability of the canopy to trap humidity and to moderate temperatures below the canopy layer. Similarly, the basic principle of a vegetation canopy being needed to retain humidity and moderate temperatures dictates that eliminating the uppermost portion of sedge plants (which contribute most to a greenhouse effect) and reducing plant height by about 50% would substantively reduce the ability of the canopy to trap humidity and to moderate temperatures below the canopy layer.

Retention of moisture-holding and temperature-moderation qualities of herbaceous vegetation may dip below suitable conditions at the lower end of the 25-65% and 20-70% ranges for biomass and Robel pole readings, respectively, which can occur in relatively short herbaceous communities. This means there is relatively low support for the assessment that ≥70% retention would maintain suitable humidity retention and temperature moderation characteristics in short herbaceous communities. Therefore, this entire section on ≥70% retention focuses primarily on moderate-height to tall herbaceous communities in healthy or relatively healthy condition.

Where canopy cover of relatively intact herbaceous vegetation is at the upper end of the half to 2/3 range and above this range where ≥80% retention of herbaceous vegetation is retained, at least some of the humidity-retaining and temperature-moderating qualities of pre-grazed meadow vegetation would likely be maintained. Marlatt (1961) found evidence of an apparent cooling effect and humidity-retention effect within 1 inch of the ground surface when herbaceous canopy cover was ≥70%, but did not find this in the 50%, 30%, and 0%-canopy-cover plots (as illustrated in Figure A.12.d). Therefore, where canopy cover of relatively intact herbaceous vegetation is at the lower end of the half to 2/3 range, much of the humidity-retaining and temperature-moderating qualities of pre-grazed meadow vegetation would likely have disappeared for the season. The loss of as much as 50% of pre-grazed overhead herbaceous vegetation would mean a substantial reduction in the ability of herbaceous vegetation to retain near-ground humidity and moderate near-ground temperatures. As a general principle, the higher the percent canopy cover of relatively-intact herbaceous vegetation the higher the level of near-ground humidity and the greater the moderation of near-ground temperature (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000).

Wind and solar radiation are important factors influencing near-ground humidity levels and temperatures. Greatly reduced wind speed near the ground surface is central to retaining near-ground humidity and moderating near-ground temperatures (Marlatt 1961, Cionco 1972, Oke 1978:118-119, Baldocchi et al. 1983). Air movement immediately above the soil surface would likely increase somewhat and possibly by a moderate degree when the percent canopy cover of relatively-intact herbaceous vegetation declines by as much as 50% (Marlatt 1961). Increased air movement near the ground surface due to wind (and less protection provided by vegetation) would reduce near-ground humidity levels and would shift near-ground temperature closer to ambient (above-canopy) temperatures. The apparent near-ground cooling effect of vegetation canopies found by Marlatt (1961) dissipated when canopy cover declined to 50%, which is the low-end threshold where 70% of herbaceous vegetation is retained, assuming a pre-grazed canopy cover of 100%. The degree to which pre-grazed canopy cover is less than 100%, post-grazed canopy cover of relatively-intact vegetation would decline accordingly. This means that patches of vegetation with ≥70% canopy cover (i.e., ≥80% retention of herbaceous vegetation) would be needed to minimize the effects of increased air movement on near-ground humidity and temperatures.

Marlatt (1961) found that net radiant energy over the 50%-canopy-cover plots was similar to that measured over full grass cover and 70% canopy cover, and 50% canopy cover is the estimated minimum that would be maintained by implementing a ≥70% retention level for herbaceous vegetation where pre-grazed canopy cover is at or near 100%. Because he found radiant energy to decline fairly sharply below 50% canopy cover, pre-grazed canopy cover below near-100% would result in <50% canopy cover when retention of herbaceous vegetation drops to 70%. Minimizing the amount of solar radiation reaching the soil surface and basal plant material helps retain near-ground humidity and moderate near-ground temperatures because radiant energy reaching the soil surface heats the soil surface and basal plant material, which increases day-time temperatures immediately above the soil surface and, subsequently, contributes to reductions in near-ground humidity levels (Marlatt 1961). Therefore, in many situations (e.g., where pre-grazed canopy cover is <80-90%), retaining relatively large patches of ≥80% of total herbaceous vegetation would be relied upon to maintain sufficiently low levels of radiant energy.

Because of the relatively large reduction in canopy cover of relatively intact vegetation and biomass above 2 inches — key attributes indicating the capability of herbaceous vegetation to hold in humidity — areas with ≥80% herbaceous retention would likely be important (see "≥80% Retention of Total Herbaceous Vegetation").

Roche et al. (2012b) lends at least some support to the assessment that ≥75% retention of total herbaceous vegetation retains suitable humidity retention and temperature moderation attributes for toads in meadow habitat. The study does not provide direct evidence of this, since humidity and temperature were not monitored, but no effects of ≤25% utilization of herbaceous vegetation (a range of conditions from 75% to 100% retention) were statistically detected on toad occupancy of meadows. However, this does not provide evidence that meadows with a consistent 75% retention across all parts of a meadow would provide sufficient habitat conditions for toads since conditions across the meadows in Roche et al. (2012b) range from 75% to 100% retention. Retention was ≥80% on 96% of meadows and was ≥90% on 82% of meadows. Results of Roche et al. (2012b) cannot be used to evaluate the effects of <75% retention of herbaceous vegetation in meadow habitat since no information on toad occupancy was available when retention levels in meadows dropped below this level.

Burton et al. (2009) does not lend support to the assessment that 80% retention of total herbaceous vegetation retains humidity, but the study does not appear to provide any evidence that humidity retention attributes of herbaceous vegetation are less-than-suitable at 70% retention. Despite significantly lower abundance of frogs at grazed wetlands (estimated 70-85% herbaceous retention), the study was conducted in wetlands and immediately around wetlands where and humidity retention is not an issue.

Shade and Protection from the Sun

There is moderate to moderately-strong support for the assessment that retaining a minimum of approximately half to 2/3 of the canopy cover of relatively-intact herbaceous vegetation in moderate height to tall, dense herbaceous communities would retain enough of the vegetation qualities in large enough patches to provide suitable shading and protection from the sun on shorelines, in movement corridors, and in summering habitat. This is based on the same line of reasoning in the "Humidity Retention and Temperature Moderation" subsection, above, and the "Hiding Cover" subsection, below. Some canopies may be somewhat more diffuse due to the reduction in biomass. Support is higher (e.g., moderately-strong or strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites.

The retained shading qualities of vegetation would continue to provide protection from the sun on the shorelines of breeding pools for metamorphosed frogs and toads, which can achieve high densities at times (Keinath and McGee 2005, Patla and Keinath 2000). If the pre-grazing herbaceous canopy cover on a particular shoreline is high (e.g., >75%), 70% retention of herbaceous vegetation should provide a sufficient amount of shading on shorelines for large concentrations of metamorphs. Support would be lower in short-stature plant communities.

Shading and protection from the sun was separated out because, while it contributes to the retention of humidity and moderation of temperatures near ground level, shading can be provided in patches even if the vegetation does not retain near-ground humidity and does not moderate temperatures

Roche et al. (2012b) lends at least some support to the assessment that ≥75% retention of total herbaceous vegetation retains shading and protection from the sun in meadow habitat. The study does not provide direct evidence of this, since shading and protection from the sun were not monitored, but no effects of ≤25% utilization of herbaceous vegetation (a range of conditions from 75% to 100% retention) were statistically detected on toad occupancy of meadows. Results of Roche et al. (2012b) cannot be used to evaluate the effects of <75% retention of herbaceous vegetation in meadow habitat since no information on toad occupancy was available when retention levels in meadows dropped below this level.

However, Munger et al. (1994), Munger et al. (1996), and Burton et al. (2009) do no lend support to the assessment that 70% retention of total herbaceous vegetation retains suitable shading and protection from the sun for spotted frogs in and around wetlands, and may provide some indication that variables like shading and protection from the sun are less-than-suitable in some wetlands where herbaceous retention is 70%. The studies do not provide direct evidence for or against this since shading and protection from the sun were not directly examined, but Munger (1994) found that (1) sites with spotted frogs had significantly lower evidence of livestock grazing use (very little evidence) than sites with livestock grazing use (an estimated retention in the neighborhood of 80%, which is higher than 70%), and (2) it was about 10x more likely for frogs to be absent than to be present where wetlands had been grazed to a rating of 2 (which appears to correspond to 21-40% use, which encompasses 70% retention. While results were not statistically significant in Munger et al. (1996), patterns were similar. Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.

Hiding and Escape Cover

There is moderate support for the assessment that (1) retaining a minimum of approximately half to 2/3 of the canopy cover of relatively-intact herbaceous vegetation and herbaceous biomass above 2 inches in moderate height to tall, dense moist-meadow type communities, and (2) retaining 41-50% of sedge height above 2 inches (46-57% of total height) in sedge communities would retain enough of the vegetation qualities to provide suitable hiding cover, assuming that plant communities had a relatively high starting (pre-grazing) canopy cover of herbaceous vegetation. Support is higher (possibly moderately-strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Canopies of short-stature willows would likely only be impacted by a small degree at this level of grazing. (See "Humidity Retention and Temperature Moderation" subsection for discussion of dense willow canopies.)

The "retained" Robel pole readings provide a good indication of the cover qualities that are retained at different retention levels. In moderate to tall herbaceous communities (e.g., those with the predominant leaf tuft height exceeding 12 inches), post-grazing readings would be expected to be in the middle to upper portion of the 20-70% range of retained Robel pole readings, meaning that 70% retention in these plant communities retains a small to moderately-large amount of hiding-cover qualities (Figure A.14). In comparison, relatively short or sparse herbaceous plant communities tend to lose cover qualities quicker (e.g., the lower portion of the 20-70% range). Relatively short vegetation is not an uncommon characteristic of meadows on the BTNF, and there is low support for 70% retention of herbaceous vegetation maintaining suitable hiding and escape cover in these meadows. Using changes in Robel pole readings avoids the need to examine both changes in relatively-intact canopy cover and vegetation height.

Maintaining visual obstruction in the upper end of the 20-70% range of retained Robel pole readings (e.g., to provide hiding and escape cover) becomes increasingly important with lower proportions of emergent vegetation cover compared to proportions of open water. Patla and Peterson (unpublished data, as cited by Patla and Keinath 2005:28) found that two thirds of wetland sites had greater than 50% cover of emergent vegetation, mostly sedges. In wetlands with nearly 100% of the area covered by emergent vegetation, reducing the height of emergent vegetation in patches may not adversely affect spotted frogs, but if the area covered by emergent vegetation is already less than 50% prior to grazing, there is low support for the assessment that retaining only 41-50% of the height above 2 inches would maintain suitable hiding cover. Where grazing creates a grazed and ungrazed patchwork (where cattle bite plants off near ground level; McKinney 1997) and where pre-grazing canopy cover is 50%, 70% retention would result in canopy cover declining to an estimated 25-33% (Table A.2), meaning that cover qualities would be relatively low after grazing.

While these are fairly marked reductions in hiding-cover qualities, a substantial amount of hiding-cover would remain relative to pre-grazed levels in wetlands in which pre-grazed canopy cover of sedges and other herbaceous vegetation is relatively high. As the potential for predation increases (e.g., predation of tadpoles by fish, tiger salamander larva), the need for hiding and escape cover for tadpoles, metamorphs, and adults correspondingly increases. Enough hiding and escape cover should remain available for adults while they are in breeding and summering pools, tadpoles in breeding pools, metamorphs on shorelines, and juveniles and adults while they are moving from wetland to wetland or otherwise using non-wetland habitat. Retaining 50-65% of the canopy cover of relatively-intact herbaceous vegetation and 20-70% of pre-grazing Robel pole readings means that small to moderate amounts of emergent and shoreline vegetation may be trampled down into the mud where it becomes unavailable for use by tadpoles and adults as hiding cover. If the pre-grazing canopy cover of moderate height to tall vegetation is high (e.g., >75%) in a wetland, sufficient hiding cover should remain available after this trampling effect, but if it is moderate or low (e.g., <60%), sufficient hiding cover may not remain available.

Roche et al. (2012b) lend at least some support to the assessment that ≥80% retention of total herbaceous vegetation retains suitable hiding and escape cover in meadow habitat where sedge and tufted hairgrass communities are in healthy condition and have relatively high production levels. Their study does not provide direct evidence of this since hiding-cover qualities of vegetation were not directly examined, but no effects of ≤25% utilization of herbaceous vegetation as measured in July were statistically detected on toad occupancy of meadows in June and July, and 96% of these meadows had ≤20% utilization (≥80% retention).

However, Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) do no lend support to the assessment that 70% retention of total herbaceous vegetation retains suitable hiding and escape cover for spotted frogs in and around wetlands, and may provide some indication of less-than-suitable hiding cover. The studies do not provide direct evidence for or against this since hiding cover were not specifically examined, but Munger (1994) found that (1) sites with spotted frogs had significantly lower evidence of livestock grazing use (very little evidence) than sites with livestock grazing use (an estimated retention in the neighborhood of 80%, which is higher than 70%), and (2) it was about 10x more likely for frogs to be absent than to be present where wetlands had been grazed to a rating of 2 (which appears to correspond to 21-40% use, which encompasses 70% retention. While results were not statistically significant in Munger et al. (1996), patterns were similar. Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetland than grazed wetlands, with grazed wetland having an estimated 70-85% herbaceous retention). Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%. Although results were not statistically significant at the $p < 0.05$ level, tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible this would have been significant at a higher significance threshold, and it is possible that reductions in hiding and escape cover were factors, but this cannot be confirmed. Also, grazed wetlands had an average 80% retention which is higher than 70% retention.

Tadpole Forage

There is moderate support for the assessment that retaining a minimum of approximately half to 2/3 of the canopy cover of relatively-intact herbaceous vegetation and herbaceous biomass above 2 inches would retain enough of the vegetation qualities in large enough patches in breeding wetlands to provide suitable forage and forage substrate for tadpoles in the current year and future years, assuming that pre-grazed canopy cover of sedges and other herbaceous vegetation is relatively high. Up to a moderate amount of vegetation would be pushed down into the mud where it becomes unavailable for direct use by tadpoles either as standing vegetation or as decaying vegetation, or for indirect use by tadpoles (e.g., as substrate for algae).

Adams et al. (2009) may lend some support for sufficient tadpole forage being provided in breeding wetlands where ≥70% of total herbaceous vegetation is retained within breeding wetlands. No effects in tadpole survival were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009), but there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands. Also, there were a number of factors indicating that a conclusion of “no effect” of livestock grazing on tadpole survival in their study may not be fully supported based on information presented in Adams et a. (2009). Results of Roche et al. (2012a) and McIlroy et al. (2013) cannot be used to evaluate the effects of <85% retention of herbaceous vegetation on tadpole forage within breeding wetlands since grazing use in these wetlands did not appear to exceed 15%.

The data for the Greater Yellowstone area, identified above in the “Hiding Cover” subsection applies here as well.

However, Schmutzer et al. (2008) provides some indication that forage for tadpoles may be less-than-suitable in some wetland situations in which herbaceous retention is reduced to 70%, and results of Bull and Hayes (2000) may also provide some indication of this. Schmutzer et al. (2008) determined that cattle grazing at an estimated herbaceous retention level of 70-85% markedly reduced the biomass of detritus (as well as water quality), and that this markedly reduced tadpole species richness and the abundance of some tadpole species. In part, Schmuzter et al. (2008) attributed markedly higher tadpole diversity and markedly higher abundance of some tadpole species in ungrazed wetlands to a 10.9x greater biomass of detritus in ungrazed wetlands in 2005 and a 3-4x greater biomass of detritus in 2006, compared to grazed wetlands. Detritus contributes to hiding and escape cover, as well as feeding sites and forage. Lower biomass of detritus likely resulted from cattle grazing (42% and 30% lower heights of emergent vegetation in grazed wetlands than in ungrazed wetlands in 2005 and 2006, respectively). Also, although not discussed in Schmutzer et al.(2008), trampling of emergent vegetation into the substrate also likely contributed to the significantly lower amount of detritus in grazed wetlands than in ungrazed wetlands, and it was not identified whether trampling of vegetation into the mud was taken into account (in Burton et al. 2009). If vegetation trampled into the mud was taken into account (e.g., as 0” readings), this may have reduced the estimates of percent retention to some degree.

Although results were not statistically significant, tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible this would have been significant at a higher significance threshold, and it is possible that reductions in tadpole forage was a factor, but this cannot be confirmed. Also, grazed wetlands had an average 80% retention which is higher than 70% retention.

Reduced food availability for tadpoles has been shown to increase the amount of time required for metamorphosis to be completed (Lind et al. 2007). This compounds the effects of declining water levels, which concurrently increases densities of tadpoles and further reduces the availability of food (in addition to the direct effects of reducing the amount of herbaceous vegetation). Increasing densities of tadpoles has been shown to increase the amount of time needed for metamorphosis to be completed (Wilbur and Collins 1973).

Invertebrate Forage, Cover, and Substrate

While there is only moderately-low to moderate support for the assessment that 70% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads as part of the larger insectivore community, there is moderate to moderately-strong support for the assessment that invertebrate species richness and abundance of individual species would be sufficient to meet the dietary needs of spotted frogs and boreal toads.

Invertebrates as Part of Wetland, Meadow, Silver Sagebrush, Meadow-Willow, and Willow-Herb Communities

There is moderately-low to moderate support for the assessment that (1) retaining a minimum of approximately half to 2/3 of the canopy cover of relatively-intact herbaceous vegetation and herbaceous biomass above 2 inches in moderate height to tall, dense moist-meadow type communities, and (2) retaining 41-50% of sedge height above 2 inches (46-57% of total height) in sedge communities would retain enough of the vegetation qualities in to provide for the habitat needs of native invertebrate-communities of moist and wet meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities. (Canopy cover and biomass would be in the middle to upper end of these ranges in moderate height to tall, dense herbaceous communities.) No studies were found demonstrating that invertebrate species composition would not change or would only change by a small degree, and several studies on the effects of livestock grazing on invertebrates showed fairly substantive to marked negative effects of livestock grazing on invertebrate communities at low utilization rates, estimated to be in the neighborhood of 80% retention (Kruess and Tscharntke 2002, Foote and Rice Hornung 2005, Samways 2005, Kimoto et al. 2012). It is not clear how much competition and interactions between insectivores play in the ability of amphibians to obtain enough prey, especially as metamorphs and juveniles. A 70% retention level is below the threshold identified by Foote and Rice Hornung (2005) for dragonflied and damselflies (see the comparable section for ≥80% retention).

Support is higher (possibly moderate or moderately-strong support) for the above assessments where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Live willow shrubs, dead stems, and fallen willow plant material contributes to invertebrate habitat. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to providing invertebrate habitat, but in these cases cattle likely would not graze these site and willow canopy cover may be too dense to be used by boreal toads.

Not only did Foote and Rice Hornung (2005) conclude that dragonfly and damselfly species richness and relative abundance declined due to livestock-induced reductions in vegetation height and structure, they also assessed that mortality of larva due to trampling or disturbance from walking cattle may be an important mortality factor in continuously grazed wetlands. They also found that species richness of dragonfly and damselfly larva was correlated with overall aquatic macro-invertebrate species richness and abundance, meaning their results applied to more than dragonflies and damselflies.

Invertebrate Communities Resulting from Increased Structural Diversity and Eutrophicaton

There is moderate to moderately-strong support for the assessment that 70% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads without consideration of any larger insectivore community. There is stronger support for this assessment than for the previous assessment because (1) at 70% retention, available information summarized in the “Forage, Cover, and Substrate for Invertebrate Prey” section near the beginning of this appendix indicates that invertebrate species richness and abundance in wet and moist meadows, silver sagebrush and shrubby cinquefoil, and meadow-willow vegetation types should remain sufficient; and (2) both spotted frogs and boreal toads are flexible in their diets. However, no studies were located that provide direct evidence that 70% retention of herbaceous vegetation allows a sufficient invertebrate prey base to be maintained.

In East and Pottinger (1983), (1) three invertebrate taxa (beetles, ants, and several species of leafhoppers and planthoppers) responded positively to increasing grazing pressure, meaning that 30% use of herbaceous vegetation would be better for these invertebrates than no grazing; and (2) three invertebrate taxa (flies, worms, and scarab beetles) initially respond favorably to increasing grazing pressure and, after some threshold, then responded negatively to increasing grazing pressure. It is likely that 30% utilization of herbaceous vegetation is not far from this threshold. Beetles and ants are common species in the diet of boreal toads as are a variety of flies (see main report), and flies, beetles, ants, and worms are among the invertebrates commonly eaten by spotted frogs (see main report). Since many ant species do not do as well in close-canopied plant communities, the conditions characteristic of plant communities with 70% retention likely are more favorable to them (East and Pottinger 1983); this would facilitate the provision of ants to boreal toads. While ants comprised 75% of the diet of boreal toads studied by Bartelt (2000, as cited by Patla 2001), with beetles comprising another 24% of their diet, it is not clear whether this diet was sufficient to sustain the population.

As outlined in the “Information on Key Amphibian-Livestock Grazing Studies Cited in this Report” section (“Studies on Yosemite Toads” subsection), results of Roche et al. (2012b) lend at least some support to the assessment that ≥75% retention of total herbaceous vegetation retains suitable invertebrate habitat for toads in meadow habitat. The study does not provide direct evidence of this, since data was not collected on invertebrates. However, because all measured retention levels were ≥75% (range of 75% to 100% retention) when toad occupancy was sampled in meadows, it may indicate that toads were finding sufficient invertebrate prey in meadows at the time of sampling. Results of Roche et al. (2012b) cannot be used to evaluate the effects of <75% retention of herbaceous vegetation in meadow habitat since no information on toad occupancy was available when retention levels in meadows dropped below this level. Also, results of Roche et al. (2012a) and McIlroy et al. (2013) cannot be used to evaluate the effects of <85% retention of herbaceous vegetation on invertebrate habitat within wetlands and on shorelines since grazing use on these sites did not appear to exceed 15%.

Shallow Waters Exposed to the Sun

There is low to moderate support for the assessment that 30% utilization of emergent vegetation would create open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, or to maintain such areas. From the standpoint of altered vegetation height and structure, 70% retention of herbaceous vegetation that is cropped at a fairly even height equates to an average height reduction of about 50-60% (not including the lowest 2 inches) in moderate to tall sedge communities (Table A.2), which probably begins increasing solar radiation reaching the water, although increases may not be substantive. However, where grazing is patchy in sedge communities, it may be possible for the canopy cover of relatively-intact vegetation to decline by as much as an estimated 35-50% (Table A.2), but this likely is an overestimate for sedge communities since cattle tend to graze from the top down in these communities. Some openings with short and/or sparse vegetation would likely be large enough to increase solar radiation reaching the water surface. Without strategically placing these openings where it would benefit egg masses and tadpoles, it is not clear how beneficial the openings would be.

There is a low probability, at this level of grazing/trampling, for the vigor and survival of emergent vegetation to be reduced sufficiently to create and maintain longer lasting patches of open or relatively-open water, except where the same patches are consistently grazed each year. For the most part, substantial live plant material would remain and it is not anticipated that vigor would be reduced (Clary and Webster 1989, Hall and Bryant 1995, Skinner 1998, Clary and Leininger 2000).

The addition of a qualifier allowing up to 20% of the breeding-wetland area to be grazed more than 30% — in wetlands with a large proportion of the area dominated by emergent vegetation — would allow for grazing and trampling pressure to be high enough in a small proportion of the wetland to create and maintain openings in the emergent vegetation cover.

Open Patches

There is moderate support for the assessment that 30% utilization of herbaceous vegetation would create small openings in large, extensive stands of herbaceous vegetation. It is moderate instead of strong because 30% use of herbaceous vegetation would “overshoot” the creation of small openings in some situations by reducing canopy cover by 35-50%.

A retention level of 70% would provide more than small openings in extensive dense emergent wetlands since percent canopy cover of relatively intact vegetation would be an estimated 50-65% of what it was prior to grazing (Table A.2), meaning that grazing at this level would go beyond the beneficial effects of creating small openings that can be used by spotted frogs and boreal toads for basking in the sun. Several authors identified one benefit of livestock grazing use in extensive dense emergent vegetation as the creation of small openings in which frogs and toads can bask in the sun (Maxell 2000, Watson et al. 2003, Bull 2005, Shovlain et al. 2006), but these references to the benefits of small openings do not support increasing openings from near 0% cover (pre-grazing) to 35-50% of the canopy of pre-grazed plant communities.

Also, while spotted frogs and boreal toads appear to benefit from small openings in otherwise large areas of consistently tall, dense herbaceous vegetation, no studies have demonstrated they are needed. Studies on

Yosemite toads in productive high elevation meadow wetlands do not support the assessment that small openings are needed in otherwise dense herbaceous vegetation (see “Open Patches” subsection of the “80% Retention of Total Herbaceous Vegetation” section).

Examination of Other Factors Influenced by 70% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Water Quality,” “Surface Water Duration in Small Pools,” “Survival as Influenced by Trampling,” and “Soil Looseness and Porosity, and Overhanging Banks” sections). These sections should be consulted for desired conditions. Material in the “Roles of Herbaceous Canopy/Retention and Openings” section is not repeated below and should be consulted as background information.

On sites where 70% of the annual production of total herbaceous vegetation is retained — including in herb-shrub and shrub-herb communities with substantive herbaceous production — effects on soil looseness and porosity would remain within acceptable limits, and water quality, retention of surface-water in small pools, and the survival of tadpoles, metamorphs, and adults as affected by trampling would remain within acceptable limits in many situations but would exceed acceptable limits in some situations. This assessment is based on information in the following subsections.

Water Quality

While there is low support for the assessment that 70% retention of herbaceous vegetation would protect against negative impacts to water quality for spotted frogs and boreal toads in all breeding wetlands grazed to this level of retention, there is at least moderate support for the assessment that 70% retention of herbaceous vegetation would protect against negative impacts to water quality for these species in a majority of breeding wetlands grazed to this level of retention. Support is somewhat higher (e.g., moderately-high support) where willows comprise a relatively large proportion of the vegetation canopy cover and herbaceous production is relatively low, but support would still be moderate where herbaceous production is relatively high in willow-herb communities (e.g., 2,000-3,000 pounds/acre). The variability in results in scientific studies, as outlined below and in the “Water Quality” section earlier in this appendix, probably is not so much an issue of conflicting results but more an issue of variability in effects under different situations (see the “Water Quality” section for citations). The scientific information summarized below and in the “Water Quality” section shows three important things: (1) water quality likely would be affected by no more than a minor degree in some wetlands; (2) water quality likely would be reduced in some wetlands; and (3) at 30% utilization of herbaceous vegetation within and immediately adjacent to wetlands, water quality in most wetlands probably would be reduced by no more than a minor degree. Compared to effects of 20% utilization of herbaceous vegetation, effects of 30% use on water quality would be more variable from wetland to wetland and there would be a higher potential for water quality to be negatively affected (Figure A.15). Compared to effects of 40% utilization of herbaceous vegetation, effects of 30% use on water quality may be just as variable from wetland to wetland, but there would be a lower potential for water quality to be negatively affected to a higher degree.

Retention of 70% of total herbaceous vegetation in and immediately around breeding wetlands should in a majority of cases indicate that use is low enough that water quality remains within an acceptable range for spotted frogs and boreal toads. However, potential exists for livestock to use a wetland for drinking while having comparatively lesser effects on vegetation due to livestock drinking and not foraging (especially sheep), and using paths already created by animals that reached the water before them or using non-vegetated portions of wetlands. These factors can contribute to higher use of wetlands than 70% retention of herbaceous vegetation may indicate, which has potential to contribute to lower water quality. Also, smaller wetlands may have a higher probability than larger wetlands of having less-than-satisfactory water quality at any given grazing use intensity due to lower water volumes (i.e., the capability for dilution is diminished). Lower water volume in smaller wetlands is partially a function of shallower depths that may occur associated with smaller surface area.

Findings of two and possibly four studies, in combination, lend support to the assessment that 70% retention of total herbaceous vegetation in and immediately around wetlands would sufficiently limit grazing intensity to maintain suitable water quality for spotted frogs, boreal toads, and their insect prey, recognizing that failure to detect significant effects provides only limited support. Water quality analysis in Adams et al. (2009) did not reveal any significant differences in pH, conductance, or acid neutralizing capacity among treatments, and analysis of several nutrients was not possible because their concentrations were at or near detection limits. It is estimated that 50-60% of total herbaceous vegetation was retained on average in wetlands grazed by cattle, meaning that impacts to water quality would not have been detected at the higher retention level of 70%. Because Adams et al. (2009) did not detect any statistically significant effects of cattle grazing on pH, conductance, or acid neutralizing capacity at lower herbaceous retention levels, and because water quality inside and outside exclosures in their study appeared to be similar, impacts to water quality would not have been detected at the higher retention level of 70%.

In the second study, Foote and Rice Hornung (2005) also did not detect any statistically significant effects of livestock grazing on total dissolved solid (TDS) urine indicators in their study of the effects of livestock grazing on dragonfly and damselfly diversity. An estimated 70%, possibly as low as 60%, of sedge biomass was retained in grazed wetlands in their study area.

Bull and Hayes (2000), the third study, lends weak support to the above assessment. They did not detect any statistically significant reductions in water quality as a consequence of livestock grazing use, and livestock grazing was light on average (an average rating of just over “slight evidence” of livestock use), which appears to roughly translate to 80% retention of herbaceous vegetation. It is possible that an average rating of just over “slight evidence” of livestock grazing activity approaches an average 70% retention (although unlikely), meaning there is a chance that non-significant results in their study would have applied to wetlands with retention levels as low as 70%. In combination, a possibility that average retention was as low as 70% and the reality that failing to detect significant effects only provides weak support for a determination of no effects, results of this study only provides weak support.

The fourth study (actually two studies: Roche et al. 2012a and McIlroy et al. 2013) also provides weak support or no support since (1) average retention levels within and in the immediate vicinity of Yosemite toad breeding wetlands was ≥85-90% when water sampling occurred, and (2) retention levels averaged about 75% in other parts other parts of meadows when water sampling occurred. Roche et al. (2012a) and McIlroy et al. (2013) did not detect any treatment effects of cattle grazing on concentrations of nitrates, nitrites, phosphorous, or dissolved oxygen, or on turbidity in breeding wetlands.

While the above studies (except possibly Roche et al. 2012a and McIlroy et al. 2013) provide at least some indication that retaining ≥70% of total herbaceous vegetation would help prevent water quality from being negatively impacted by livestock in many situations, at least two studies show that negative effects on water quality are possible in some situations at this herbaceous retention level. Schmutzer et al. (2008) found significant reductions in water quality (specific conductance, turbidity, and dissolved oxygen) in wetlands averaging 70-85% retention of herbaceous vegetation compared to cattle-excluded wetlands. Ammonia nitrogen, nitrites, and nitrates were consistently higher (5–216% higher) in grazed wetlands than in cattle-excluded wetlands, but results were not statistically significant at the P<0.10 level, ammonia may have reached levels that were biologically significant. Hornung and Rice (2003) found ammonium levels to be significantly higher in mid-July and possibly in late August in grazed wetlands than in ungrazed wetlands, and orthophosphates were found to be significantly higher in mid July and late August in grazed wetlands than in ungrazed wetlands. It is estimated that 70-80% of sedge biomass was retained in grazed wetlands their study area. Because naturally occurring nitrate, nitrate, ammonium, and phosphates can be near levels that negatively affect spotted frogs and boreal toads, these studies indicate that inputs from livestock can result in thresholds being exceeded.

Additionally, the “Water Quality” subsection of the “Roles of Herbaceous Canopy/Retention and Openings” section cites a wide range of studies that identify the negative effects of urine and feces inputs by livestock and increased turbidity caused by livestock trampling. While most of these studies did not identify livestock use levels of wetlands and ponds, it is clear that negative impacts do not all of a sudden begin at severe use by livestock (e.g., 60-70% use of total herbaceous vegetation, which equates to 65-85% use of key forage species). Impacts begin earlier, apparently in the neighborhood of 20% use in some wetlands and then incrementally increase with increasing livestock use, both in terms of negative effects in any given wetland (regardless of whether reduced water quality negatively affects frogs and toads) and in terms of the proportion of wetlands in which water quality is no longer suitable for spotted frogs and toads (Figure A.15).

As time and resources permit, water quality information should be collected with an eye toward testing the relationship between retention levels and water quality in different situations (e.g., wetland size, amount of emergent vegetation).

Surface-Water Retention in Small Pools

For most medium-size and large breeding wetlands on the BTNF, there likely is a high probability of drinking by livestock having no discernible effect on water level reductions when retention of herbaceous vegetation is ≥70% in and immediately around the wetland. For small breeding wetlands (e.g., <2,000 ft^2), limiting livestock grazing use such that ≥70% of total herbaceous vegetation is retained in and immediately around wetlands would be low enough that it should not substantively elevate the rate of decline in surface-water levels in many situations. However, small wetlands have a higher probability than larger wetlands of losing water more quickly to livestock at any given grazing use intensity due to shallower water and lower water volumes, especially where subsurface water inflows are limited or non-existent. Lower water volume in small wetlands is partially a function of shallower depths that occur associated with smaller surface area. As with water quality, the range in variability of effects on the rate of surface-water declines is higher at livestock use levels associated with 70% retention than associated with 80% retention, but lower than at livestock use levels associated with 60% retention (Figure A.15).

Even at a conservative grazing intensity that results in 70% retention of herbaceous vegetation at breeding wetlands, the rate at which water levels decline in mid to late summer will be hastened to some degree by livestock water consumption in some of the BTNF's small breeding pools, depending on a variety of factors such as recharge and evapotranspiration rates. As described in the "Surface Water Duration in Small Pools" section of the main report, it does not take many cattle to fairly quickly deplete water volumes in small pools. In some situations, pools may need to be fenced to control use and timing of the pools. If, however, water is plentiful in the general area and only small numbers of cattle typically use susceptible small breeding pools (and if cattle are routinely eating herbaceous vegetation whenever they are at the pool), a retention of 70% of total herbaceous vegetation should suffice to allow use of the pool by livestock while limiting the rate at which water-level declines are accelerated due to livestock drinking. If cattle use the pools primarily for water with only limited use and trampling of vegetation, care would need to be taken to count trampled vegetation against retention levels in order for measured or estimated retention levels to more accurately reflect livestock use levels of the pools.

This element warrants further investigation, including assessments of the types of situations in which livestock accelerate declining water levels and the extent to which 70% retention is sufficient to retain sufficient water levels in these situations.

Survival as Affected by Trampling

There is moderate support for the assessment that limiting utilization of herbaceous vegetation in summering and migration habitat to no more than 30% would limit trampling-caused mortality of adult and juvenile spotted frogs and boreal toads to relatively low levels, and there is low to moderate support for the assessment that limiting utilization of herbaceous vegetation at breeding wetlands to no more than 30% would adequately limit trampling-caused mortality of tadpoles and metamorphs to relatively low levels, with moderate support reliant on a deferred-rotation system. Support is somewhat higher (e.g., moderately-strong and moderate to moderately strong support, respectively) where willows comprise a relatively large proportion of the vegetation canopy cover due in part to protection added by willow plants. Individual and groups of livestock walking in and immediately around breeding wetlands inherently brings with it the potential of livestock stepping on tadpoles, metamorphs, juveniles, and adults.

Possibly the biggest concern with livestock grazing use in spotted frog and boreal toad habitat is elevated mortality due to trampling, especially when and where metamorphs congregate on shorelines and as they move in relatively high concentrations away from breeding areas but also when adults are in moist habitats used by livestock (Bartelt 1998, Maxell 2000, Hogrefe et al. 2001, Wind and Dupuis 2002, Keinath and McGee 2005, Bull 2009); and (1) there is little information in the proceeding analysis to demonstrate that limiting livestock grazing use to ≤30% would adequately address the concern with respect to metamorphs, and (2) there is moderate information showing that limiting use to ≤30% would adequately resolve the concern with respect to adults.

Summer and Migration Habitat

The potential for livestock to step on juvenile and adult frogs and toads in summering habitat and migration corridors can be characterized as high frequency, relatively-low impact, meaning that trampling of adults and juveniles would likely occur annually in most pastures containing frogs or toads, but the proportion trampled would likely be relatively low in most situations, with a mortality rate from trampling likely in the single digits or possibly teens for the segment of populations inhabiting habitats used by livestock. The mortality rate relative to the entire population in a given area would be lower because a percentage of individuals in these populations inhabit habitat not used by livestock or that make frogs and toads less likely to be stepped upon, for example, dense willow, forestland, and streambanks. This percentage cannot be estimated with existing information and it varies from population to population. Figure A.16 shows that an estimated 15-25% of small stationary objects are estimated to be trampled in meadows producing 500 pounds/acre, and that an estimated 50-95% of small stationary objects would be trampled in meadows producing 3,000 pounds/acre, assuming cattle are in any given meadow for 2-4 weeks. An estimated 15-75% of small stationary objects are estimated to be trampled within 2-4 weeks at 30% use (70% retention) of herbaceous vegetation in meadows producing 1,000 to 2,000 pounds/acre. This is supported in part by Paine (1996) finding that 63% of groups of pheasant eggs were trampled, and percent retention was estimated, for this report, to be roughly 70%.

Where meadows on the BTNF are producing 2,000-3,000 pounds/acre, it would take an estimated 1.2-4.5 cow-calf pairs/acre an estimated 1-2 weeks to graze down to a 70% retention level, and , it would take an estimated 0.6-1.5 cow-calf pairs/acre an estimated 4 weeks to graze down to a 70% retention level (Tables A.4 and A.5). Each of these two scenarios would result in an estimated 70-90% and 60-80% of small stationary objects being trampled (Figure A.16). Where meadows on the BTNF are producing 1,000 pounds/acre, grazing at a level of 70% herbaceous retention would require densities of about 0.3-1.5 cow-calf pairs/acre for a period of 1-2 weeks (estimated 35-45% of small stationary objects trampled), and would require densities of 0.3-0.4 cow-calf pairs/acre for a period of 4 weeks (estimated 30% of small stationary objects trampled).

There are several reasons Figure A.16 overestimates trampling rates of frogs and toads in summer and migration habitat used by livestock: (1) frogs and toads would move out of the way of livestock compared to the stationary objects in Figure A.16, which means actual trampling rates of frogs and toads are likely lower than what is shown in the graphs; (2) frogs and toads typically use wetter sites in riparian areas, meadows, and silver sagebrush communities than livestock (Roche et al. 2012b); (3) spotted frogs primarily summer in ponds and other wetlands and are able to jump out of the way of livestock in these situations; and (4) the migration period of spotted frogs — when then are in meadow, silver sagebrush, and even big sagebrush and forestland — is relatively short compared to the amount of time it takes to reach 30% utilization. As such, trampling of frogs and toads by livestock in summering and migration habitat would be less than what is shown in the graphs, likely with percentages in the single digits or teens. On the other hand, moving cattle through spotted frog and boreal toad habitat (e.g., to move them out of riparian areas) result in high densities of livestock in small areas without reduction in herbaceous vegetation, with the added impact of moving livestock which makes it harder for frogs or toads to avoid hooves. Plus, this can happen once each day in places.

Roche et a. (2012a) provides no more than limited, indirect information on the potential effects of livestock trampling on mortality of Yosemite toads in meadows because they did not assess survival of adults and juveniles after they left breeding wetlands and livestock grazing was season-long (i.e., lower than the lines in graph ‘d’ of Figure A.16) in contrast to cattle grazing on the BTNF which typically entails grazing periods of about 4-5 weeks in any given pasture.

Breeding Wetlands – Adults and Eggs

The potential for livestock to step on tadpoles and adult frogs and toads at breeding sites would be low because most eggs should be hatched prior to the onset of livestock grazing each year and most adults have left breeding wetlands by the time livestock arrive onto allotments. This does not include adults that remain at breeding wetlands; adults that summer at breeding wetlands are addressed above in the discussion of summering habitat.

Breeding Wetlands – Tadpoles and Metamorphs

At 30% utilization of herbaceous vegetation at breeding sites, there would be a (1) moderate to high potential of trampling tadpoles every year when and where livestock access wetlands containing tadpoles, and while the level of impact in any given year could vary considerably, there likely would be no more than a small percentage of tadpoles trampled in most years in most wetlands; and (2) high potential of metamorphs being killed by trampling in some years, and the maginitude of impact when incidences occur (i.e., when livestock use of wetland shorelines overlaps in time and space with concentrations of metamorphs) could range from low to high depending on the situation. Where livestock use overlaps in time and space with tadpoles, there would be a high likelihood for at least some tadpoles being trampled, and the potential for this would increase as the summer progresses and pools of water shrink.

Metamorph emergence and concentration on shorelines only occurs for several days and concentrations occur in small areas, compared to livestock which graze the area for a longer period of time and they range over substantially larger areas. Graphs in Figure A.16 likely overestimate trampling rates of tadpoles and metamorphs because the graphs present trampling rates of small stationary objects by cattle at given densities over the course of 1-4 weeks, but high concentrations of metamorphs only occur for several days. At cattle densities that would be needed to reach 30% use of a wetland in 3-4 weeks (0.6-3.0 cows/acre, assuming 2,000-3,000 pound/acre of herbaceous production; Tables A.4 and A.5), an estimated 5% to 25% of small stationary objects would be trampled in a 3-4 day period (Table A.3). This may be comparable to trampling rates of metamorphs. However, trampling would only occur when amd where there is overlap between livestock and metamorphs, and there likely are some years when use of any given wetland by livestock does not occur when metamorphs are emerging. If 30% use at a given wetland is attained in about 1 week, this equates to densities of 2.4-9.0 cows/acre, which in turn results in an estimated 30-90% being trampled in a 3-4 day period. The chances of high percentages of metamorphs being trampled would be relatively low when and where livestock and metamorphs overlap, although the chance of a moderate percentage of metamorphs being trampled would be relatively high when and where livestock and metamorphs overlap. It needs to be recognized that cattle use wetlands for more than just grazing (e.g., some to many may use a wetland for watering and not grazing), and some cattle may remain at a wetland for periods of time without grazing or drinking. To the extent this occurs, the above estimates may underestimated effects.

Results of Roche et al. (2012a) and McIlroy et al (2013) cannot be used to make any inferences of the effects of <85% retention on mortality of tadpoles, metamorphs, and adults within wetlands and on shorelines because grazing use in breeding wetlands and on shorelines did not appear to exceed 15%.

Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008),and Burton et al. (2009) do no lend support to the assessment that 70% retention of total herbaceous vegetation adequately protects against adults and tadpoles being trampled, and may provide some evidence trampling was sufficiently high to affect the abundance and occupancy of frog adults and tadpoles. The studies do not provide direct evidence of this since trampling effects were not measured, but information outlined in the “Survival as Affected by Trampling” section near the beginning of the appendix” demonstrates that trampling by livestock is a very plausible contribution to reductions in abundance and/or occupancy in the studies. Munger (1994) found spotted frog occupancy to be significantly lower in wetlands grazed by livestock (an estimated herbaceous retention in the neighborhood of 80%) than in wetlands ungrazed by cattle, and they found that it was about 10x more likely for frogs to be absent than to be present where wetlands had been grazed to a rating of 2 (which appears to correspond to 21-40% use, which encompasses 70% retention. Trampling by cattle could have been a contributing factor in the short term or over the years. While results were not statistically significant in Munger et al. (1996), patterns were similar. Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetland than grazed wetlands, with grazed wetland having an estimated 70-85% herbaceous retention). Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.

Although results were not statistically significant at the $p < 0.05$ level, tadpole survival to metamorphosis in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands. It is possible this would have been statistically significant at a higher significance threshold (e.g., $p < 0.1$ or higher), especially with additional grazing (e.g., 70% retention vs. the estimated average of 80% retention in the study), although this possibilities cannot be confirmed. It is possible that trampling by cattle could have killed tadpoles or metamorphs before counts were made by Bull and Hayes (2000). Also, grazed wetlands had an average 80% retention which is higher than 70% retention. Bull and Hayes (2000) did not include an assessment of survival by metamorphs. They did not assess the number of metamorphs that left the breeding site, and the potential exists for substantial mortality between the emergence of metamorphs (which indicated the number of tadpoles that completed metamorphosis in the study) and departure from breeding sites.

If sheep use of a wetland were to overlap with a high concentration of metamorphs on a shoreline, mortality of metamorphs due to crushing could be high at a 70% retention level in part because it is possible for a sheep band to only trample or graze a relatively small amount of herbaceous vegetation relative to the size of the wetland and shoreline area. If the place where they happened to go to water overlapps a high concentration of metamorphs, this could have major impacts on a given cohort, as observed by Bartelt (1998). Limiting retention to 70% as a means to protect metamorphs from trampling may not be effective where sheep are watered. Even at a low frequency of this happening across years, this has the potential to adversely impact local populations (Keinath and McGee 2005).

Soil Looseness and Porosity

There is high support for the assessment that limiting utilization of herbaceous vegetation in summering and migration habitat to no more than 30% would protect soil looseness and porosity. Greater than equal to 70% retention of total herbaceous vegetation would likely limit soil compaction to acceptable levels. Thurow (1991:149) presented data showing that water infiltration rates (one indicator of the extent to which soils are compacted) in pastures with moderate stocking rates were only about 15% lower than in a livestock exclosure. Assuming “moderate” equates to 31-50% utilization of key forage species (Holechek et al. 2011:141; their conservative and moderate grazing intensities were combined for the purposes of this assessment), this roughly translates to 55-80% retention of total herbaceous vegetation, and 70% retention of herbaceous vegetation is well within this range.

Integrity of Near-Surface Burrows and Streambanks

There is moderately-low to low support for the assessment that limiting utilization of herbaceous vegetation where shallow burrows occur to no more than 30% would limit crushing of these burrows. Because shallow burrows are stationary, clay pigeons provides an approximation of the level of potential impact. An estimated 15-40% of clay pigeons would be expected to be stepped upon when livestock are in meadows (1,000 pounds/acre production) long enough to result in 30% utilization of total herbaceous vegetation (Figure A.16). In meadows with 2,000 and 3,000 pounds/acre, an estimated 35-80% and 50-90%, respectively, of clay pigeons would be expected to be stepped upon. This provides a moderately low to high potential for shallow burrows being crushed, depending on the situation, and with it, a potential for occupants to be crushed in them.

There is moderate or greater support for the assessment that limiting utilization of herbaceous vegetation in riparian habitats to no more than 30% would limit the crushing of streambanks. This is mainly because use of streambank vegetation would be limited when utilization of total herbaceous vegetation on >80% of the riparian area remains below 30%. Livestock use of streambanks typically does not increase substantially until vegetation in moist meadows, silver sagebrush, and shrubby cinquefoil is well utilized.

Implications of Livestock Grazing Use to Multiple Stressors

Long-term Reductions in Vegetation Height and Canopy Cover

If starting herbaceous canopy cover (prior to the onset of livestock grazing) is less than near-100% but high enough to effectively retain humidity, moderate temperatures, provide shade, provide hiding and escape cover, and provide invertebrate habitat to some degree, reducing canopy cover by 1/3 to 1/2 could reduce canopy cover to the point that herbaceous vegetation is no longer providing these functions (bottom of Table A.2). Obviously, incrementally-lower levels of pre-grazed herbaceous canopy cover makes it increasingly possible for post-grazing canopy cover of relatively-intact vegetation to be insufficient. If starting herbaceous canopy cover is too low to retain humidity, moderate temperatures, provide shade, provide high-quality hiding and escape cover, and provide high quality invertebrate habitat, reducing canopy cover by 1/3 to 1/2 would exacerbate the situation. Similar situations would occur if starting vegetation height is too short to provide an effective canopy and to provide invertebrate habitat, for example where non-native bluegrasses dominate a plant community and where plant vigor is depressed. Starting herbaceous canopy cover and heights as described above can occur naturally, but most moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow sites are productive and typically have high percent canopy cover (e.g., in the neighborhood of 80-100%; (Norton et al. 1981:57, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). Reductions in height and percent canopy cover of key forage species and herbaceous vegetation as a whole can result from plant mortality and reduced plant vigor caused by livestock over-use (including effects of lowered water tables caused in part by livestock grazing over-use) and increases in nonnative species like Kentucky bluegrass and smooth brome (Heady 1950, Crider 1955, Dietz 1989, Holechek et al. 2011).

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 70% retention of herbaceous retention would result in greater impacts than described in the “Examination of Herbaceous Structural Attributes at 70% Retention” section, above.

On the other hand, where percent canopy cover and/or height is naturally low or where it is lower due to reduced plant vigor and/or conversion to nonnative species like Kentucky bluegrass, smooth brome, or tarweed, 30% use of herbaceous vegetation would result in fewer impacts to water quality, wetland water levels, and survival as affected by trampling compared to effects in healthy, naturally-functioning plant communities. This is because utilization is based on weight, and if annual production is, for example, 500 pounds/acre instead of 2,000 pounds/acre, livestock would spend considerably less time in the meadow that produced 500 pounds/acre. In this example, the potential of being trampled could be 4x lower in the meadow supporting 500 pounds/acre than if it produced 2,000 pounds/acre (Figure A.16). Furthermore, fewer spotted frogs and boreal toads would be found in the meadow producing 500 pounds/acre (both in the vegetation and in burrows), which would further reduce the potential of being trampled.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 70% retention of herbaceous retention would result in fewer impacts than described in the “Examination of Other Factors Influenced by 70% Retention” section, above.

If serious attempts are made to retain ≥70% of herbaceous vegetation at each monitored breeding wetland and if monitored breeding wetlands are fairly representative of other breeding wetlands (including grazing levels), herbaceous vegetation would remain at moderately-high or higher levels (≥80%) at some monitored and unmonitored breeding wetlands and it is likely that herbaceous vegetation would decline to ≤60% at some unmonitored breeding wetlands. First, under the best of circumstances, retention would only be monitored at a small proportion of known breeding wetlands any given year and not all allotments would be monitored every year. Second, there is a reasonable chance that grazing use will push the limits of whatever retention threshold is identified and action may not be taken until retention levels are several percentage points or more below what is identified as the minimum threshold (i.e., grazing at some monitored breeding wetlands undoubtedly would be <70%). Third, only a portion of breeding sites are known and the location of breeding sites can change from year to year. Fourth, retention levels at different breeding sites would continue to be variable.

Other Multiple Stressors: Chitrid Fungus, Climate Change, UV Radiation, & Local Human-Related Impacts

The assessments made in the preceding 18 pages relative the capability of 70% retention to provide suitable habitat for spotted frogs and boreal toads and to protect them from direct livestock impacts were completed independent of effects of livestock grazing use in the context of multiple stressors.

In combination with all multiple stressors **—** *i.e., altered vegetation conditions (previous subsection), chitrid fungus, ranavirus, climate change, UV radiation, loss of habitat and habitat fragmentation due to roads, elevated mortality due to crushing by motor vehicles, elevated mortality due to introduced fish, reduced spring flows due to* *late-seral conditions, reduced beaver-pond distribution and abundance, increases in nitrate and ammonia in wetlands from the atmosphere, loss of wetlands and other habitat due to reservoirs, loss of meadow and willow habitat due to expanding forestland, poisoning from rotenone, and other artificial factors affecting spotted frogs and boreal toads on the BTNF* **—** the addition of the wide range of effects associated with 30% utilization of herbaceous vegetation in breeding wetlands and other habitats of spotted frogs and boreal toads would increase the potential for further reductions in the size of metapopulations and increases the potential for extirpation of individual metapopulations.

Chitrid fungus can result in annual reductions in populations of 5-7% (Pilliod et al. 2010), other artificial stressors have the potential to increase this percentage, and livestock grazing use associated with 70% retention of herbaceous vegetation has the potential to increase it even further. Occupancy of wetlands by spotted frogs was substantively lower at this retention level in eastern Idaho compared to ungrazed wetlands (Munger 1994, Munger 1996) and tadpole survival was substantively lower in wetlands at a somewhat higher retention level in Oregon (Bull and Hayes 2000) (see also Schmutzer et al. 2008, Burton et al. 2009), which in combination with multiple stressors has the potential to affect population levels of metapopulations and persistence of metapopulations. While no studies were found on the effects of livestock grazing on boreal/western toads in which herbaceous retention levels declined to 70% where and when toads occurred, similar mechanisms apply.

Reduced humidity retention, temperature moderation, shading, hiding cover, tadpole forage, and invertebrate habitat all have the potential to compound the effects of the other multiple stressors by contributing to lower survival of tadpoles, metamorphs, and adults in individual metapopulations, although at this retention level, effects likely would not be substantive in most situations. Reduced water quality and trampling by livestock at a retention level of 70% have higher potential, compared to the habitat elements in the previous sentence, to compound the effects of the other multiple stressors. While water quality in some wetlands would not be noticeably reduced at this level of grazing, it would likely decline substantively in some wetlands, which has the potential to reduce tadpole survival. It is likely, at this level of grazing use, that livestock trampling (including of toads in burrows) would likely increase mortality of metamorphs within metapopulations, markedly on a periodic basis, and would likely increase mortality of adults on a consistent basis but at a small percentage (single digits). With all of the multitude of stressors acting on spotted frogs and boreal toads, periodic spikes in mortality of metamorphs and even small increases in mortality of adults has the potential to contribute to metapopulation-level effects. Accelerated declines in water levels in small breeding ponds has the potential to have major effects on a limited number of metapopulations, as this only has the potential to affect small, isolated breeding wetlands when and where livestock are using them for watering.

By limiting livestock grazing use to a 70% retention level, reductions in water quality, trampling by livestock, and accelerations of water-level declines would be somewhat limited in most situations and should not measurably reduce population levels of metapopulations more than a minor degree. Sufficient habitat (with respect to contributions by herbaceous vegetation) would remain available within areas occupied by metapopulations and wetlands with sufficient water quality and low trampling effects should remain available to provide for sufficient survival to offset impacts where increased mortality results from reduced water quality, trampling, and accelerated declines in water levels.

≥60% AND ≥50% RETENTION OF TOTAL HERBACEOUS VEGETATION

There is low to moderately-low evidence that 60% retention of herbaceous vegetation and no more than low evidence that 50% retention of herbaceous vegetation, would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads. There is very little to no information demonstrating that these retention levels would be in keeping with Forest Service policy to "Avoid or minimize impacts to species whose viability has been identified as a concern [i.e., sensitive species]" (FSM 2670.32, WO Amendment 2600-2005-1), especially given the large amount of information showing that these retention levels would adversely affect spotted frogs and boreal toads in a variety of ways. All assessments in this section assume that plant communities have are relatively natural structure (e.g., height and vegetation density) are in healthy functioning condition. To the extent a plant community is not, higher retention levels may be needed to adjusted upward to get the same effect. A minimum of 60% retention roughly translates to a maximum 40-80% or higher utilization of key forage species, and a minimum of 50% retention roughly translates to a maximum 50-80% utilization or higher of key forage species (Appendix B).

This assessment stems from there being low to moderately-low support for the assessment that 60% retention of total herbaceous vegetation and no more than low support for the assessment that 50% retention of total herbaceous vegetation would retain sufficient attributes of the herbaceous community or understory to provide suitable (1) hiding cover for tadpole, juvenile, and adult frogs and toads in breeding and summer-long habitat; (2) protection from the sun and ground-level humidity for juvenile and adult frogs and toads on breeding-pool shorelines and in summer-long habitat; (3) hiding cover and structure within wetlands for tadpoles; (4) hiding cover and protection from the sun for metamorphosed and adult frogs and toads on shorelines; (5) forage, cover, and structure for a diverse invertebrate community in wetland, on the shoreline, and in summer-long habitat; and (6) contributions to the following year's residual thatch and litter which in turn contributes to hiding cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities; <u>as well as to indicate suitable</u> (7) water quality (as related to urination, defecation, and trampling); survival as related to trampling of tadpole, juvenile, and adult frogs and toads in and adjacent to breeding and summer wetlands pools and in migration habitat; (8) water retention in small breeding pools; (9) soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (10) integrity of near-surface burrows used by frogs and toads; and (11) retention of overhanging streambanks used by frogs or toads for hibernation.

An important consideration in evaluating available information and, ultimately in deciding on a herbaceous retention objective to adopt for spotted frogs and boreal toads on the BTNF, is as follows: Incrementally lower retention levels brings with it a disproportionately higher potential for direct and direct adverse impacts as well as the potential for unforeseen or unknown compounding or synergistic impacts. At moderately-high retention levels (e.g., 80%), there is fairly low potential for adverse impacts and, if an adverse impact occurs, it would be relatively small and of short duration. At a moderately-low retention level with respect to vegetation attributes meaningful to frogs and toads (e.g., 60% retention), there is at least a moderate potential (boreal toads) and moderately-high potential (spotted frogs) for some local populations of these species to be adversely impacted.

Summary of Key Amphibian-Livestock Grazing Studies

Support for ≥60% and ≥60% Retention as a Threshold

Results of Adams et al. (2009) lends at least support to the assessment that ≥70% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, recognizing that failure to detect effects of a treatment does not provide strong support for a conclusion of "no treatment effect:"

- No effects in tadpole survival and water quality were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention in Adams et al. (2009). However, there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands, although this difference was not detected statistically. Also, there were a number of factors indicating that a conclusion of "no effect" of livestock grazing on tadpole survival in their study may not be fully supported based on information presented in Adams et al. (2009).

Results Not Pertinent to Assessment of ≥60% or ≥50% Retention as a Threshold

Results of Bull and Hayes (2000), Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013) do not support to the assessment that ≥70% retention of total herbaceous vegetation retains suitable herbaceous habitat and water quality, and adequately protects against trampling by livestock, but they also do not provide any indication that ≥70% retention of total herbaceous vegetation is insufficient, with the possible exception of Bull and Hayes:

- Response variables studied by Roche et al. (2012b), Roche et al. (2012a) and McIlroy et al. (2013) (e.g., toad occupancy, tadpole density, water quality, water temperature) were measured where herbaceous utilization levels did exceed about 25% (75% retention) in meadows and about 15% (85% retention) in wetlands, meaning that results are not applicable to examining 60% or 50% retention of herbaceous vegetation.

- It is estimated that the average percent herbaceous retention in grazed wetlands in Bull and Hayes (2000) was in the neighborhood 80% and because no statistically-significant effects were detected, these non-significant results were not covered in this section. However, see below for additional assessment.

Studies that Identify Negative Effects of ~20-40% Use of Herbaceous Vegetation

On the other hand, results of Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) indicate, for at least some wetland situations, that 60% and 50% retention of total herbaceous vegetation do not retain suitable herbaceous habitat and/or water quality, and/or do not adequately protect against trampling by livestock:

- Munger et al. (1994) found that sites with Columbia spotted frogs had significantly lower evidence of livestock grazing use than sites unoccupied by spotted frogs. For wetlands having a grazing-rating of 2 or 3 (which appears to correspond to 21-40% use and 41-60% use, which encompasses 60% and 50% retention), it was about 10x more likely for frogs to be absent than to be present. While results were not statistically significant in Munger et al. (1996), patterns were similar.
- Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetlands than in grazed wetlands (an estimated 70-85% retention), and that water quality was significantly lower in grazed wetlands compared to ungrazed wetlands.
- Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.
- Results of Shovlain et al. (2006) appear to indicate that 40% and 50% herbaceous utilization (60% and 50% herbaceous retention) negatively affected spotted frogs, even though it is not clear how vegetation pin counts translates to measures of biomass. They found that spotted frogs did not preferentially use habitat inside exclosures when livestock grazing was fairly light. However, "as grazing pressure increased, frogs preferred ungrazed livestock exclosures" over the grazed areas (Shovlain et al. 2006:2).
- Although results were not statistically significant at the $p < 0.05$ level, spotted frog tadpole survival in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands; grazed wetlands had an estimated average herbaceous retention level in the neighborhood of 80%. It is possible the effect would have been significant at a higher significance threshold, but this cannot be confirmed. Additionally, the estimated average percent retention in Bull and Hayes (2000) was in the neighborhood of 80%, which is substantially higher than 60% and 50%, meaning that greater negative effects would be expected at these higher levels of livestock grazing use.

These studies indicate that a livestock grazing-use level of 40% of total herbaceous vegetation (60% retention) negatively affects spotted frogs in a range of situations. Effects occurred at a use level of 20% or occurred somewhere between 70% and 85% (except in Shovlain et al. 2006 where the effects level is unknown), meaning that effects in the studies would have been greater at a use level of 40%. Forty percent use is 100% higher than 20% use. While Schmutzer et al. (2008) and Burton (2009) were not conducted in the intermountain West, results are consistent with studies conducted in Idaho and Oregon, and some of the potential mechanisms of effects are applicable.

Where statistically-significant effects of livestock grazing on response variables (e.g., frog/toad occupancy, tadpole abundance) were detected, it is likely that changes in one or more of the habitat and survival elements — due to livestock grazing use — were responsible, but in most cases the mechanism(s) by which response variables were affected (e.g., habitat and survival elements) were not directly studied. Water quality is an exception to this because it is a response variable measured in several studies, but there are many other possible reasons for effects of livestock grazing on tadpole and adult occupancy, abundance, and species richness. (Changes in vegetation height/structure/biomass was used to estimate percent retention and affects the degree to which several habitat elements are altered, but vegetation height/structure/biomass does not directly address *why* occupancy, abundance, and species richness were reduced.)

Each of these studies are examined below, relative to different levels of livestock grazing use, on each of several (e.g., humidity retention, shading, hiding cover, invertebrate habitat, water quality, survival as affected by trampling). Although the studies did not specifically measure or assess most of these habitat and survival elements, results of the studies provide additional information that can be used to assess whether given habitat and survival elements remain suitable at different herbaceous retention levels.

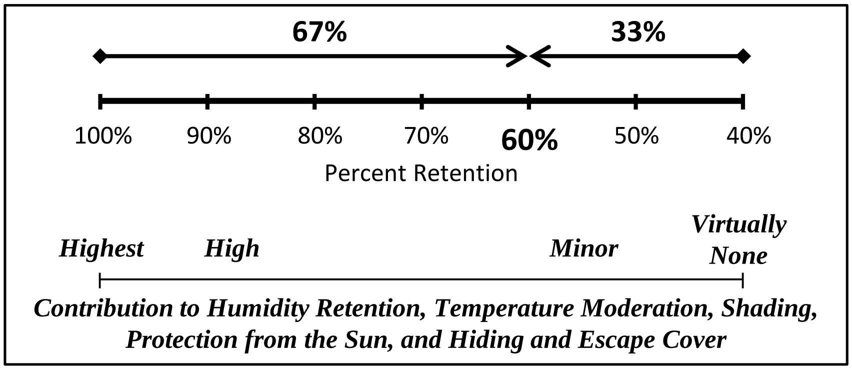
Examination of Herbaceous Structural Attributes at 60% and 50% Retention

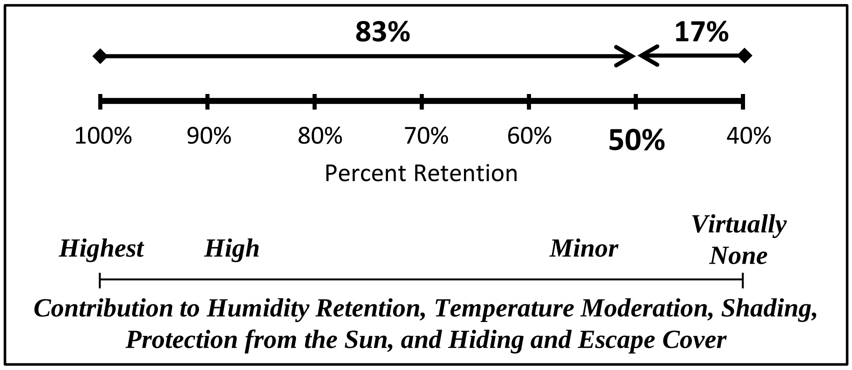
The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Humidity Retention, Temperature Moderation, and Protection from the Sun;” “Hiding and Escape Cover;” “Forage for Tadpoles;” and “Forage, Cover, and Substrate” sections). These sections should be consulted for desired conditions. Material in the “Roles of Herbaceous Canopy/Retention and Openings” section is not repeated below and should be consulted as background information.

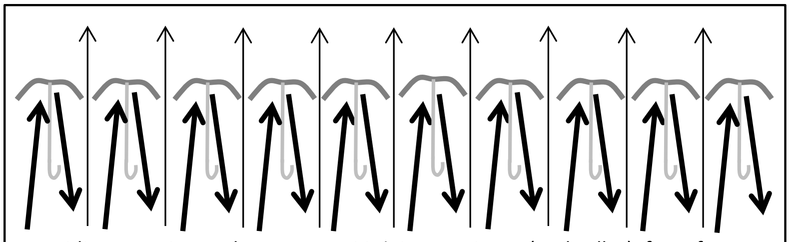
The following information sets the stage for this section by numerically characterizing 60% and 50% retention of total herbaceous vegetation:

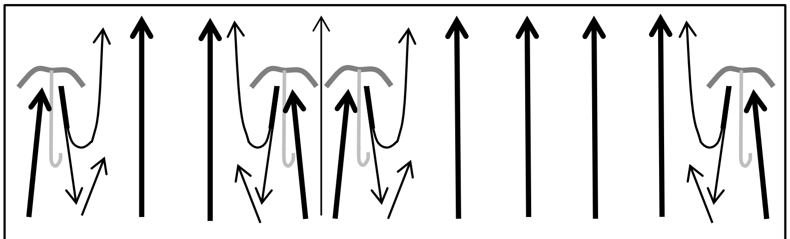
- In herbaceous communities and understories that are in healthy condition, 60% and 50% retention of total herbaceous vegetation would retain a minority of the plant material that contributes to amphibian cover and insect forage and cover (Table A.2, Figure A.14, Figure A.24). More specifically, 60% and 50% retention of total herbaceous vegetation would retain:
    - ▫ An estimated 35-50% and 20-35%, respectively, of the canopy cover of relatively intact herbaceous vegetation, based on DeLong (2009b:Table 11) (Table A.2, Figure A.14, Figure A.8).
    - ▫ An estimated 0-53% and 0-41%, respectively, of the biomass of herbaceous vegetation above a 2-inch height, based on height-weight relationships in Kinney and Clary (1994) and BLM et al. (1999:118) including the exclusion of the weight of the bottom 2 inches of plants based on their information.
    - ▫ 10-50% and 0-40% of starting Robel pole readings compared to pre-grazing readings (i.e., reductions in Robel pole readings are typically 50-100%), based on DeLong (2009a) and additional data collected in 2011. These results contribute to the substantiation of the information in the above two bullets. Robel pole readings decline relatively sharply from about 90% retention down to about 60% or 70% retention (Figure A.14).
    - ▫ 10-40% and 5-30%, respectively, of plant height if vegetation is grazed at an even height (e.g., wetland-sedge communities), based on height-weight relationship information in Kinney and Clary (1994) and BLM et al. (1999:118) (Table A.2, Figure A.14, Figure A.9).
- Vegetation structure in herbaceous communities makes a pivotal transition as retention declines from about 70% down to 60% because this is where vegetation structure changes from being characterization as grazed patches in a matrix of taller vegetation to a characterization of ungrazed patches within a matrix of grazed vegetation. This is illustrated by the shift in estimated canopy cover in communities with 70% retention (50-65% canopy cover above 2 inches) to estimated canopy cover in communities with 60% retention (35-50% canopy cover above 2 inches). This characterization is consistent with estimated changes in the percent of biomass retained above 2 inches and differences in Robel pole measurements, as well as being consistent with descriptions in BLM et al. (2008:27) that characterize vegetation that is grazed in patches to vegetation that appears entirely covered as natural features allow.

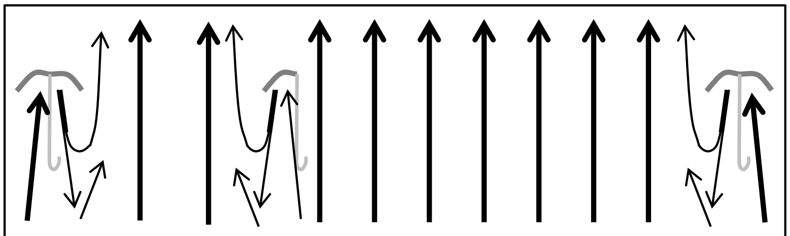
Retaining an estimated 20-50% of the canopy cover would retain only a small to moderate portion of the attributes of the vegetation that provide hiding cover, provide shade, retain humidity near the ground surface, moderate temperatures, and provide habitat for invertebrate prey. This assessment is primarily for communities with naturally moderate-height to tall, dense herbaceous vegetation, and they assume plant communities are at or near healthy functioning conditions. Support for assessments made progressively declines with progressively lower ecological conditions (i.e., as factors such as overall canopy cover and plant species richness decline). The assessment in the first sentence of this paragraph is based on information provided for each of six habitat elements in the following subheadings. See the “Role of Herbaceous Retention” section for background information on each element. Potentially less than 20% of the biomass of vegetation above a 2-inch height being retained indicates that retention of these habitat elements may be lower than “small” in the shorter herbaceous communities and understories, and possibly in dry years. This caveat is also discussed in the following subheadings as pertinent.






Humidity retention and escape — 100% Canopy Cover (umbrellas), <u>for reference</u>.


Humidity retention and escape — 40% Canopy Cover (umbrellas).


Humidity retention and escape — 25% Canopy Cover (umbrellas).

Humidity Retention and Temperature Moderation

There is low to moderately-low support (≥60% retention) and no support (≥50% retention) for the assessment that (1) retaining a 1/3 to 1/2 (≥60% retention) 1/5 and 1/3 (≥50% retention) canopy cover, respectively, in moist-meadow type vegetation, and (2) retaining 29-38% and 21-30%, respectively, of sedge height above 2 inches (35-43% and 28-36% of total height) in sedge communities would maintain enough humidity retention and temperature moderation attributes to contribute to suitable habitat for spotted frogs (Figure A.23, for sedges). This level of canopy cover and vegetation height would maintain little if any semblance of the humidity-trapping and temperature-moderation qualities of the original vegetation structure in moist meadow, silver sagebrush, shrubby cinquefoil, and wet meadow (with no standing water) communities in healthy functioning conditions (Figure A.3, Figure A.8, Figure A.24). Support is higher (possibly moderate and low support, respectively) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites.

Since boreal toads can occupy habitat that is somewhat less humid/moist than what can be inhabited by spotted frogs, support may be as high as moderate (60% retention) so long as large enough patches of relatively-intact herbaceous vegetation (or combinations of herbaceous vegetation and short-stature willows) — where humidity is retained at ground level — are readily available and well distributed. However, given the large reduction in herbaceous canopy cover at 60% herbaceous retention (Figure A.8, and see 'umbrella' diagram on the previous page), the likelihood of sufficient herbaceous-based microsites being retained is low. There would be no support for 50% retention of herbaceous vegetation since this would not provide any functional canopy (Figures A.1 and A.8). Because boreal toads can occupy somewhat drier environments than spotted frogs, some toads may be found "eeking out" a living in such habitats, but the occurrence of toads in a given habitat does not always mean conditions are suitable.

Although no scientific studies were found on ground-level humidity readings at specific levels of percent canopy cover or sedge stubble heights, the two basic principles of (1) a vegetation canopy being needed to retain humidity and moderate temperatures and (2) the positive relationship between percent canopy cover and humidity-retention/temperature-moderation levels (Marlatt 1961, Goudriaan 1977, Baldocchi et al. 1983, Honek 1988, Honek and Jarosik 2000) dictate that retaining only 1/3 to 1/2 or 1/5 to 1/3 of the original canopy and only 10-40% and 5-30% of the original height would make it physically not possible to trap humidity under the canopy layer or to moderate temperatures more than to a minor or small degree. Similarly, the basic principle of a vegetation canopy being needed to retain humidity and moderate temperatures dictates that removing more than half to 2/3 of the upper portion of sedge plant material (60% retention) or 2/3 or more of the upper portion of sedge plant material (50% retention) greatly reduces the ability to trap humidity and to moderate temperatures near ground level.

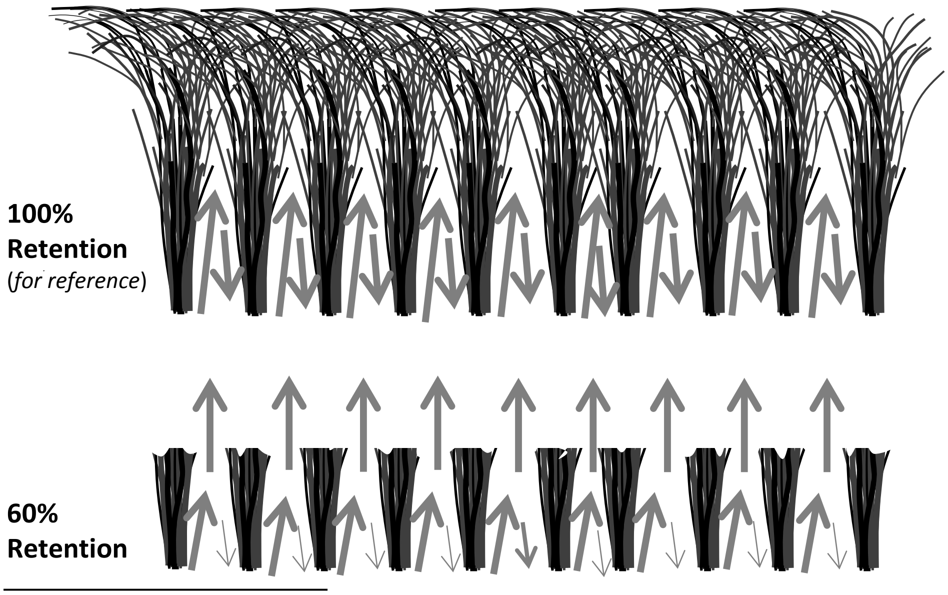


Figure A.23. Humidity retention and escape at 100% and 60% retention. Arrows indicate movement of humidity.

In wetland-sedge communities, This would be compounded by sunlight hitting plant stubble near the ground surface, matted vegetation, litter, rocks, and the bare soil, which would elevate ground-level temperatures to temperatures above ambient temperatures which in turn would contribute further to reductions in near-ground humidity levels. This would be further compounded where pre-grazing canopy cover is lower than natural levels due to lowered ecological condition (Table A.2).

Based on Marlatt (1961), net radiant energy over the top of sites with 20-35% canopy cover of relatively-intact herbaceous vegetation — e.g., associated with the low end of the canopy cover range at 60% retention and the high end of the canopy cover range at 50% retention on sites that started with 100% canopy cover — would be substantially lower than net radiant energy over the top of the site prior to any grazing. He determined that sites with 30% grass cover was nearly the same as that over bare soils, which was substantially less than sites with full grass cover. One implication is that more solar radiation making it to the soil surface results in more heating (both

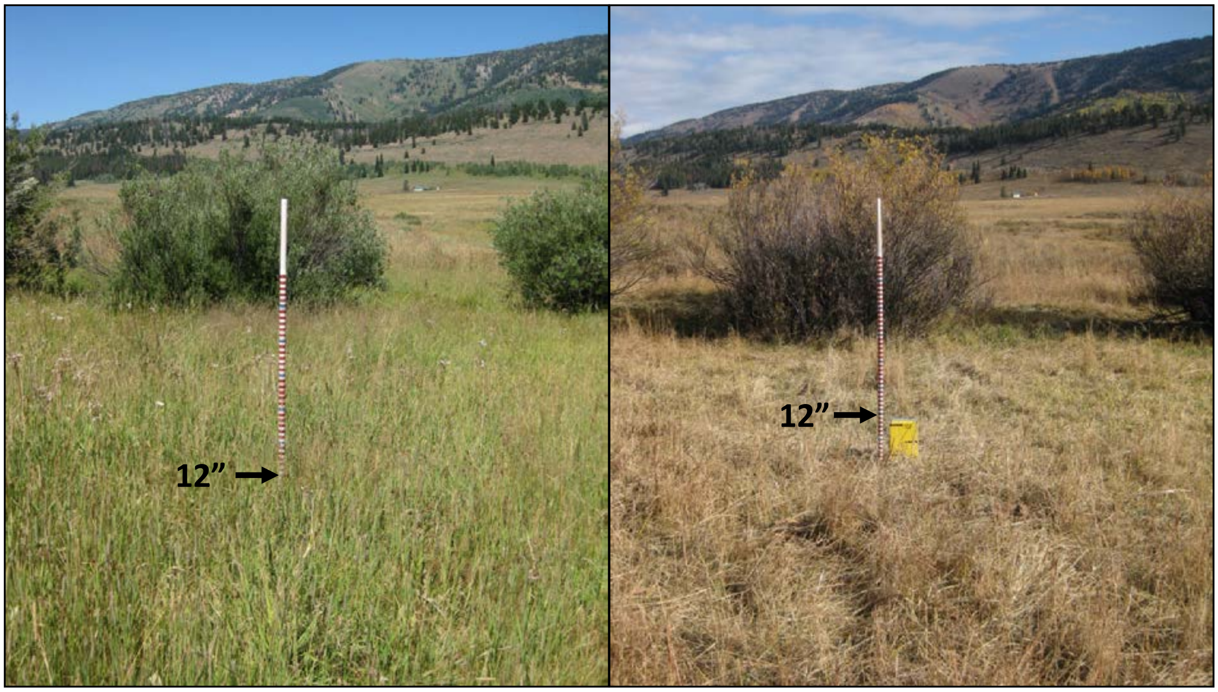


Figure A.24. Example of an estimated 50-60% retention of total herbaceous vegetation (right picture) in a moist meadow community. Total height of most grasses prior to grazing was 24-34 inches, and the predominant tuft height was approximately 8-10 inches (left picture). After grazing, about 75% of site had 2-4 inch stubble height and heights of the remainder of vegetation ranged from about 4 inches to 24 inches (<10% of site had vegetation taller than 10 inches). Visual obstruction, as measured by the Robel pole, declined by 74% (from 4 meters) and 92% (from 1 meter).

Figure A.25. Example of an estimated 20-25% retention of total herbaceous vegetation in a sedge community. Vegetation height declined from approximately 20-24 inches to an average of about 3 inches. Visual obstruction, as measured by the Robel pole, declined by 88% (from 4 meters) and 100% (from 1 meter).

radiated and conducted heat) and higher rates of evaporation, ultimately contributing to lower levels of humidity near the ground. Honek (1985, as cited in Honek and Jarosik 2000) determined that the difference in temperatures of shaded ground surfaces and bare ground surfaces in a wheat field on sunny days in June-July was about 26 ºF. Productive meadows have considerably more shading than a wheat field, which would likely increase the difference in temperatures. Therefore, while grazed patches in meadows have vegetation on them, the difference in near-surface temperatures likely is substantial given the shortness of this vegetation and either bare ground or litter cover. The net radiant energy associated with 60% retention would be somewhat higher given the higher percent canopy cover, but may still indicate substantial near-ground heating and moisture loss.

The apparent cooling effect on the air within 1 inch of the ground surface for a short distance out from the base of plants, discussed by Marlatt (1961) would likely not take place in meadows with only 60% or 50% retention for two reasons. First, Marlatt (1961) did not find this effect to occur in 50% or 30%-canopy-cover plots, and 60% and 50% retention in meadows would retain less than 50% of the herbaceous canopy cover. Second, the patches of ungrazed or lightly grazed vegetation would likely not be large enough in most cases to produce this cooling effect.

Also, enough relatively intact vegetation would likely not remain to reduce wind speeds near the grounds surface, which would help maintain higher humidity near the ground surface and moderate temperatures to some degree (Marlatt 1961, Oke 1978). Marlatt (1961) attributed the higher water loss from 50%-canopy-cover plots than 70%-canopy-cover plots to reduced air movement immediately above the ground surface in the 70%-canopy-cover plots.

Toads have greater protection against losing body water and they are able to withstand greater loss of body water than ranid frogs, as assessed by Burton et al. (2009) with several supporting references. Even though they do not require the same level of microsite moisture or humidity as spotted frogs, most experts contend that moist/humid microsites are crucial habitat components of suitable boreal toad habitat (Patla 2001, Maxell 2000, Wind and Dupuis 2002, Keinath and McGee 2005, Rittenhouse et al. 2008).

Results of the study by Roche et al. (2012b) provides no more than weak support for the assessment that ≥60% retention of total herbaceous vegetation in meadow habitats maintains suitable ground-level humidity retention and temperature moderation for Yosemite toads because (1) retention ranged from 75% to 100% in meadow habitats used by Yosemite toads during the period when toad occupancy was being sampled; and (2) it is not known whether toads remained in meadows when retention levels declined further and whether those remaining in meadows shifted their distribution to parts of meadows with higher retention levels. Retention levels following toad sampling ranged from about 95% down to about 50% and averaged close to 60%, with half of the utilization sample sites being >70% which provided many opportunities to inhabit areas of higher retention; plus, higher retention levels coincided with moister habitats and this is where toads apparently tended to be more common. Because toad occupancy in meadows was not sampled after July, only weak inferences can be made between retention levels (an average of about 60% in September) and toad occupancy and use of meadows in August and September.

Shade and Protection from the Sun

There is moderate support for the assessment that retaining a minimum of approximately 1/3 to 1/2 of the canopy cover of relatively-intact herbaceous vegetation (60% retention) in moderate height to tall, dense herbaceous communities would retain enough of the vegetation qualities in large enough patches to provide suitable shading and protection from the sun on shorelines, in movement corridors, and in summering habitat. There is low to moderately-low support for the assessment that retaining a minimum of approximately 1/5 to 1/3 of the canopy cover of relatively-intact herbaceous vegetation (50% retention) in moderate height to tall, dense herbaceous communities would retain enough of the vegetation qualities in large enough patches to provide suitable shading and protection from the sun on shorelines, in movement corridors, and in summering habitat. Support is higher (e.g., moderately-strong and moderate support, respectively) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Willow canopies would continue to provide shade.

Despite only 1/3 to 1/2 of the original canopy cover being maintained at a herbaceous retention level of 60%, it appears this may provide suitable shading for boreal toads, albeit minimally, while they occur in meadow habitat. However, results of the study by Allen-Diaz et al. (2010) provides low to moderate support for the assessment that ≥60% retention of total herbaceous vegetation in meadow habitats maintains suitable shading and protection from the sun for boreal toads for the same reasons a outlined in the "Humidity Retention and Temperature Moderation" subsection, above. Results obtained by Allen-Diaz et al. (2010) were obtained in wetlands with relatively high canopy cover of herbaceous vegetation, primarily sedges, surrounded by meadowland having tufted hairgrass as a dominant species (i.e., apparently in healthy condition), and results could be different when pre-grazing height and percent canopy cover are below that of healthy, properly functioning communities.

Even though shading is of somewhat lesser importance to boreal toads than for spotted frogs, shading is important, and there is little or no indication that 50% retention would provide suitable shading for boreal toads. This is especially true of shorelines where sometimes large concentrations of metamorphs may compete for space in shaded spots on hot days (e.g., note Bartelts' observation in Keinath and McGee 2005:38).

On the other hand, there is low support to no information indicating that maintaining 1/3 to 1/2 (60% retention) or 1/5 to 1/3 (50% retention), respectively, of the original shading qualities of herbaceous vegetation (Figure A.3, Figure A.8) would be suitable for spotted frogs. Under the same line of reasoning as outlined in the previous subsection, there is little indication that enough of the shading qualities of the original vegetation would be retained to provide spotted frogs protection from the sun.

Although herbaceous utilization averaged 40% for the entire season in studies by Roche et al. (2012a) and McIlroy et al. (2013), herbaceous utilization was 0-25% when Yosemite toads were sample, and therefore, results of their study cannot be used to assess potential effects of 40% utilization (60% herbaceous retention) on boreal toads on the BTNF.

Shovlain et al. (2006) may provide some indication that reductions in shading due to relatively-heavy grazing pressure resulted in too little shade and protection from the sun being provided. The study did not provide direct evidence for this since shading and protection from the sun were not directly examined.

Munger et al. (1994), Munger et al. (1996), and Burton et al. (2009) may provide some evidence that shading and protection from the sun are less-than-suitable in some wetlands where herbaceous retention is 60% and 50% since (1) frog abundance and occupancy were significantly lower in grazed wetlands in these studies, and (2) estimated retention levels were 80% and 7-85% in these sets of studies, which are substantially higher than 60% and 50% retention. The studies do not provide direct evidence for this since shading and protection from the sun were not directly examined. However, Munger (1994) found that sites with spotted frogs had significantly lower evidence of livestock grazing use than sites with livestock grazing use (an estimated retention in the neighborhood of 80%). While results were not statistically significant in Munger et al. (1996), patterns were similar. Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.

Hiding and Escape Cover

There is low to moderately-low support for the assessment that (1) retaining a 1/3 to 1/2 (≥60% retention) 1/5 and 1/3 (≥50% retention) canopy cover, respectively, in moist-meadow type vegetation, and (2) retaining 29-38% and 21-30%, respectively, of sedge height above 2 inches (35-43% and 28-36% of total height) in sedge communities would maintain suitable hiding cover and escape cover for boreal toads and spotted frogs while in meadow habitat, assuming pre-grazed canopy cover of herbaceous vegetation is relatively high. Only approximately 20-50% of Robel pole readings (index of visual obstruction) would be maintained. Support is higher (possibly moderate or moderately-strong support) where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Canopies of short-stature willows would likely be impacted to some degree at this level of grazing, but substantial willow structure would remain. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to hiding and escape cover, but in these cases percent herbaceous retention would not be a factor for these elements (given the hiding-cover qualities provided by willow) and willow canopy cover may be too dense to be used by boreal toads.

There is no indication that maintaining only 1/5 to 1/3 (50% retention) of the original canopy cover and biomass of herbaceous vegetation above 2 inches would maintain suitable hiding cover and escape cover for spotted frogs. The large reductions in canopy cover and visual obstruction, as measured by Robel poles, show that hiding cover would be reduced by 60% to as high as 100% for retention levels of 50% (only 0-40% of Robel pole readings would be maintained). Especially where pre-grazing canopy cover in wetlands and on shorelines is considerably less than 100%, the proportion of hiding-cover qualities that would be maintained with 60% and 50% retention of herbaceous vegetation would be small. For example, if canopy cover starts at 50% in a part of a wetland or on a part of a shoreline used by tadpoles, metamorphs, or adults, 60% retention would result in only an estimated 18-25% canopy cover and 50% would result in an estimated 10-18% (Table A.2), which provides considerably less visual protection than the pre-grazing canopy cover.

Therefore, the canopy cover of emergent vegetation would be allowed to decline to levels well below what Patla and Peterson (unpublished data, as cited by Patla and Keinath 2005:28) found for wetlands used by spotted frogs the Greater Yellowstone area (two thirds of wetland sites had greater than 50% cover of emergent vegetation).

Although Roche et al. (2012a) and McIlroy et al. (2013) reported no detectable effects of cattle grazing (at a Forest Plan maximum allowable use of 40%) on Yosemite toad tadpoles, retention levels in breeding wetlands were higher than 60% and appear to have been about 85% to near 100% during the period when tadpoles were sampled. Therefore, their results have no application to assessing whether a minimum of 60% retention is sufficient in the breeding wetland for tadpole hiding cover. Similarly, although herbaceous utilization averaged 40% for the entire season in studies by Roche et al. (2012b), Roche et al. (2012a), and McIlroy et al. (2013), herbaceous utilization was 0-25% when Yosemite toad occupancy was sample, and therefore, results of their study cannot be used to assess potential effects of 40% utilization (60% herbaceous retention) on boreal toads on the BTNF.

Shovlain et al. (2006) may provide some indication that reductions in hiding cover due to relatively-heavy grazing pressure resulted in too little hiding cover being provided. The study did not provide direct evidence for this since hiding cover was not directly examined.

Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008), and Burton et al. (2009) provide some indication that 60% retention of herbaceous vegetation maintains less-than-suitable hiding cover. The studies do not provide direct evidence of this since hiding cover was not specifically examined, but Munger (1994) found that sites with spotted frogs had significantly lower evidence of livestock grazing use (very little evidence) than sites with livestock grazing use (an estimated retention in the neighborhood of 80%, which is substantially higher than 60%). While results were not statistically significant in Munger et al. (1996), patterns were similar. Schmutzer et al. (2008) found that species richness of frog tadpoles was about 2.7x higher in wetlands not used by cattle (a statistically significant difference), that tadpoles of some frog species were substantially more abundant (e.g., green frogs were 5x more abundant), and that tadpoles of several species were significantly larger in wetlands not used by cattle. (Grazed wetlands had retention levels in the neighborhood of 70-85%.) Some of these effects may be attributable to hiding cover being too low for tadpoles in grazed wetlands, and Warkentin (1992) found that reduced hiding cover in wetlands can increase the rate of predation on tadpoles (Warkentin 1992). Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%.

Tadpole Forage

There is only limited information indicating that sufficient forage for tadpoles, including provision of residual vegetation for future years, would be retained for tadpoles at 60% retention of herbaceous vegetation at breeding sites, especially in wetlands were the canopy cover of emergent vegetation is relatively low prior to the onset of livestock grazing. There is no information indicating that sufficient forage for tadpoles would be retained at 50% retention of herbaceous vegetation at the breeding site.

Adams et al. (2009) may lend some support for sufficient tadpole forage being provided in breeding wetlands where ≥60% and ≥60% of total herbaceous vegetation is retained within breeding wetlands. This is because no effects in tadpole survival were statistically detected between ungrazed wetlands and grazed wetlands with an estimated average 50-60% retention. However, there was a 40% reduction in tadpole survival in grazed wetlands compared to a 14% reduction in ungrazed wetlands. Also, there were a number of factors indicating that a conclusion of "no effect" of livestock grazing on tadpole survival in their study may not be fully supported based on information presented in Adams et a. (2009). Results of Roche et al. (2012a) and McIlroy et al. (2013) cannot be used to evaluate the effects of <85% retention of herbaceous vegetation on tadpole forage within breeding wetlands since grazing use in these wetlands did not appear to exceed 15%.

Because Schmutzer et al. (2008) provides evidence that 70-85% herbaceous retention in breeding wetlands may be too low in some situations, it provides even stronger evidence that 60% herbaceous retention is insufficient in some situations. Although results were not statistically significant, tadpole survival in grazed wetlands (estimated average of approximately 80% retention) of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands. It is possible this would have been significant at a higher significance threshold, and it is possible that reductions in tadpole forage was a factor, but this cannot be confirmed. Also, because 60% retention is substantially lower than 80% retention, any effects would be greater where herbaceous retention is 60%.

Results of Roche et al. (2012a) and McIlroy et al. (2013) do not appear to contribute information to this discussion, as pointed out in the "Hiding and Escape Cover" subsection, above.

Invertebrate Forage, Cover, and Substrate

There is low support for the assessment that 60% retention of herbaceous vegetation and little or no support for the assessment that 50% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads as part of the larger insectivore community, but there is low to moderate support for the assessment that invertebrate species richness and abundance of individual species would be sufficient at these retention levels to meet the dietary needs of spotted frogs and boreal toads.

Invertebrates as Part of Wetland, Meadow, Silver Sagebrush, Meadow-Willow, and Willow-Herb Communities

There is low support for the assessment that (1) retaining a 1/3 to 1/2 (≥60% retention) 1/5 and 1/3 (≥50% retention) canopy cover, respectively, in moist-meadow type vegetation, and (2) retaining 29-38% and 21-30%, respectively, of sedge height above 2 inches (35-43% and 28-36% of total height) in sedge communities would maintain enough of the vegetation qualities in large enough patches to provide for the habitat needs of native invertebrate-communities of moist and wet meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow communities. (Canopy cover and biomass would be in the middle to upper end of these ranges in moderate height to tall, dense herbaceous communities.) No studies were found demonstrating that invertebrate species composition would be minimally changed and no information was found demonstrating that the invertebrate species composition would even vaguely be approximate native invertebrate-communities.

Support is higher (possibly moderate support) for the above assessments where willows comprise a relatively large proportion of the vegetation canopy cover but where willow canopy cover is not high enough to exert a major limitation on herbaceous production and openings for basking sites. Live willow shrubs, dead stems, and fallen willow plant material contributes to invertebrate habitat. Dense willow canopies (e.g., to the extent that herbaceous production is substantively limited) also contribute to providing invertebrate habitat, but in these cases cattle likely would not graze these site and willow canopy cover may be too dense to be used by boreal toads.

The major changes to the structure of herbaceous vegetation, as described above and as illustrated in Figure A.3, Figure A.14, Figure A.8, Figure A.9, Figure A.24, indicates that the invertebrate community could be greatly altered when retention levels decline to 60% and 50%. A wide range of invertebrate researchers have concluded that livestock grazing and mowing, depending on the level, can markedly alter invertebrate species composition and at high levels (e.g., mowing or grazing to vegetation height of only a few inches) can impoverish invertebrate communities (Morris and Plant 1983, Morris 2000, Kruess and Tscharntke 2002, Hornung and Rice 2003, Black et al. 2007, Black et al. 2011, Kimoto et al. 2012). Herbaceous communities with a 50% retention level are dominated by short vegetation (e.g., 1-4 inches tall) with scattered tufts of taller plant material.

Changes in herbaceous vegetation at 60% and 50% retention of total herbaceous vegetation that would affect invertebrate diversity and abundance include major reductions in the overall height, availability of specific and varied plant parts (e.g., seedheads, flowers, upper stalks, upper leaves), availability of specific plant parts of certain plant species, and in the ability of the canopy to retain humidity and to moderate temperatures. The structure of forbs, including a substantial amount of their leaf biomass in the upper two-thirds of the height of plants (Figure A.12.e) serves to illustrate forb-dependent invertebrates could very well begin to be markedly affected when patchy grazing (e.g., 70% retention in Figure A.8) progresses into grazing that leaves remnant small patches of standing vegetation (e.g., 60% retention in Figure A.8). At this level of grazing, a substantial amount of ungrazed plant material in grazed microsites is bent-over and broken, thereby reducing the availability of plant parts important to a wide range of invertebrate species in addition to substantial changes to the structure of the community and its microclimate.

Also, depending on the timing of grazing, a large number of eggs or pupae of some species may be eliminated by livestock biting off and eating plant parts with eggs or pupae attached to them (several studies cited by Black et al. 2007), which can disproportionately affect invertebrates whose host plant species are favored by livestock.

Retention levels of 60% and 50% total herbaceous vegetation are well below the apparent threshold illustrated in Figures 4 and 6 of Foote and Rice Hornung (2005) for dragonflies and damselflies using sedges and hardstem bulrush communities and they are below the apparent threshold under which insect communities in Kruess and Tscharntke (2002) were substantively impacted, meaning that fairly large negative impacts would be expected at 60% and 50% retention. Additionally, the higher intensity of livestock use associated with 60% and 50% retention, as compared to that of 70% retention, could result in larger impacts to aquatic insects as a result of trampling by livestock, which is a concern identified in Foote and Rice Hornung (2005).

East and Pottinger (1983) demonstrated negative responses of a large majority of invertebrate taxa to grazing, compared to only a small proportion that either initially respond favorably to grazing and then negatively at higher intensities or respond favorably to increasing levels of grazing.

Invertebrate Communities Resulting from Increased Structural Diversity and Eutrophicaton

There is low to moderate support for the assessment that 60% and 50% retention of herbaceous vegetation would provide for the prey needs of spotted frogs and boreal toads without consideration of any larger insectivore community. Despite the major changes to invertebrate habitat at 60% and 50% retention of herbaceous vegetation, it may be possible for invertebrate-prey species richness and abundance to remain large enough — as supplemented by potential increases in beetles, ants, and possibly other invertebrate taxa — to provide for the dietary needs of spotted frogs and boreal toads, but no studies were found that provide evidence of this.

There are relatively few invertebrate taxa that respond favorably to relatively high intensities of grazing (e.g., associated 60% and 50% retention of herbaceous vegetation), compared to lower intensities (East and Pottinger 1983). In East and Pottinger (1983), (1) three invertebrate taxa (beetles, ants, and several species of leafhoppers and planthoppers) responded positively to increasing grazing pressure, meaning that 40-50% use of herbaceous vegetation would appear to be better for these invertebrates than no grazing; and (2) three invertebrate taxa (flies, worms, and scarab beetles) initially respond favorably to increasing grazing pressure and, after some threshold, then responded negatively to increasing grazing pressure. It is likely that 40-50% utilization of herbaceous vegetation is beyond this threshold, meaning that this level of grazing is negative for these taxa. Beetles and ants are common species in the diet of boreal toads (see main report). Since many ant species do not do as well in close-canopied plant communities, the conditions characteristic of plant communities with 70% retention likely are more favorable to them (East and Pottinger 1983); this would facilitate the provision of ants to boreal toads. Ants comprised 75% of the diet of boreal toads studied by Bartelt (2000, as cited by Patla 2001), with beetles comprising another 24% of their diet.

Despite some invertebrate taxa (e.g., ants, beetles) increasing with increasing grazing pressure, support was characterized as “low to moderate” for several reasons. First, even though ants, beetles, and possibly other taxa could increase in species richness and abundance with 40-50% utilization of herbaceous vegetation, the overall range of available invertebrate prey species would decline, possibly substantively, which would reduce options. This can be especially important with chytrid fungus and other multiple stressors acting on populations. Second, no scientific information was found indicating whether a diet comprised mostly of ants can sustain individuals and meet nutritional needs of juveniles and adults (e.g., for overwinter survival) and of females (e.g., overwinter survival and then production of eggs).

Shallow Waters Exposed to the Sun

60% Retention

There is moderate support for the assessment that 40% utilization of emergent vegetation would create open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, or to maintain such areas. From the standpoint of altered vegetation height and structure, 60% retention of herbaceous vegetation that is cropped at a fairly even height equates to an average height reduction of about 60-70% (not including the lowest 2 inches) in moderate to tall sedge communities (Table A.2), which probably increases solar radiation reaching the water to some degree. Where grazing is patchy in sedge communities, it may be possible for the canopy cover of relatively-intact vegetation to decline by as much as an estimated 50-65% (Table A.2), but this likely is an overestimate for sedge communities since cattle tend to graze from the top down in these communities. Some openings with short and/or sparse vegetation would be large enough to increase solar radiation reaching the water surface.

There would appear to be low to moderate potential, at this level of grazing/trampling, for the vigor and survival of emergent vegetation to be reduced in patches sufficiently to create and maintain longer lasting patches of open or relatively-open water. Because some individual sedges and rushes would be grazed substantively more than 40%, it is possible for patches of plants to be reduced in vigor and possibly survival (Clary and Webster 1989, Hall and Bryant 1995, Clary and Leininger 2000), but it is unlikely that survival would decline in these patches to form longer lasting openings.

The addition of a qualifier allowing up to 20% of the breeding-wetland area to be grazed more than 40% **—** in wetlands with a large proportion of the area dominated by emergent vegetation **—** would allow for grazing and trampling pressure to be high enough in a small proportion of the wetland to create and maintain openings in the emergent vegetation cover.

50% Retention

There is moderate support for the assessment that 50% utilization of emergent vegetation would create open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, or to maintain such areas. From the standpoint of altered vegetation height and structure, 50% retention of herbaceous vegetation that is cropped at a fairly even height equates to an average height reduction of 70-80% (not including the lowest 2 inches) in moderate to tall sedge communities (Table A.2), which likely would increase solar radiation reaching the water by a fair amount. Where grazing is patchy in sedge communities, it may be possible for the canopy cover of relatively-intact vegetation to decline by as much as an estimated 65-80% (Table A.2), with some sites within patches being grazed substantively more than 50%. Many openings with short and/or sparse vegetation would be large enough to increase solar radiation reaching the water surface, but few openings would consist of very short or very sparse vegetation, or mud substrate.

There would appear to be moderate potential, at this level of grazing/trampling, for the vigor and survival of emergent vegetation to be reduced in patches sufficiently to create and maintain longer lasting patches of open or relatively-open water. Because some individual sedges and rushes would be grazed substantively more than 50%, it is possible for patches of plants to be reduced in vigor and possibly survival (Clary and Webster 1989, Hall and Bryant 1995, Clary and Leininger 2000), and it is possible for vigor and survival to decline in some patches to form longer lasting openings if the same patches are grazed year after year.

Open Patches

There is no support for the assessment that 40% and 50% utilization of herbaceous vegetation would create small openings in large, extensive stands of herbaceous vegetation. This is because 40% and 50% use of herbaceous vegetation would substantially “overshoot” the creation of small openings.

Retention levels of 60% and 50% would provide far more than small openings in extensive dense emergent wetlands, thereby going well beyond the beneficial effects of light grazing observed by some researchers (Watson et al. 2003, Bull 2005), to the point that effects would be detrimental as described above. Where large, extensive dense stands of sedges without any small pockets of open water (near 0% cover of openings) exist, retention levels of 60% and 50% would correspond to openings comprising 50-65% and 65-80% of stands, respectively; i.e., plant communities would go from a near absence of openings to mostly open.

Examination of Other Factors Influenced by 60% and 50% Retention

The foundations of each of the elements covered below are outlined in corresponding sections at the beginning of this report (e.g., “Water Quality,” “Surface Water Duration in Small Pools,” “Survival as Influenced by Trampling,” and “Soil Looseness and Porosity, and Overhanging Banks” sections). These sections should be consulted for desired conditions. Material in the “Roles of Herbaceous Canopy/Retention and Openings” section is not repeated below and should be consulted as background information.

On sites where 60% and 50% of the annual production of total herbaceous vegetation are retained **—** including in herb-shrub and shrub-herb communities with substantive herbaceous production **—** effects on water quality; retention of surface-water in small pools; survival of tadpoles, metamorphs, and adults as affected by trampling; and soil looseness and porosity would be mixed. Soil looseness and porosity would likely remain within acceptable levels at a 60% retention level, and there would be a high degree of variability — from effects that probably do not materially impact spotted frogs and boreal toads in some situations to effects that do in many other situations — in water quality; retention of surface-water in small pools; survival of tadpoles, metamorphs, and adults as affected by trampling. At 50% retention, there some situations in which effects on water quality; retention of surface-water in small pools; survival of tadpoles, metamorphs, and adults as affected by trampling; and soil looseness and porosity would remain within acceptable limits, but in many situations they would not. These assessments are based on information in the following subsections.

Water Quality

There is little support (60% retention) to no support (50% retention) for assessments that 60% and 50% retention of herbaceous vegetation would protect against negative impacts to water quality for spotted frogs and boreal toads in all breeding wetlands grazed to these levels of retention, and there is low support and no support for assessments that 60% and 50% retention of herbaceous vegetation, respectively, would protect against negative impacts to water quality for these species in a majority of breeding wetlands grazed to these levels of retention. Support is somewhat higher (e.g., moderately-low support) where willows comprise a relatively large proportion of the vegetation canopy cover and herbaceous production is relatively low, but support would still be low where herbaceous production is relatively high in willow-herb communities (e.g., 2,000-3,000 pounds/acre). The scientific information summarized below and in the “Water Quality” section shows three important things: (1) water quality likely would be affected by no more than a minor degree in some wetlands; (2) water quality likely would be reduced in some wetlands; and (3) at 40% and 50% utilization of herbaceous vegetation within and immediately adjacent to wetlands, water quality has the potential to be negatively affected in many or most wetlands, particularly relatively small wetlands not directly connected to streams.

Two studies were found in which the authors did not detect any statistically significant differences in water quality (pH, conductance, and acid neutralizing capacity) between ungrazed wetlands and the wetlands grazed at an estimated 60% retention (Foote and Rice Hornung 2005, Adams et al. 2009). Foote and Rice Hornung (2005) did not detect any statistically significant effects of livestock grazing (sedge retention estimated to be 70%, possibly as low as 60%) on total dissolved solid (TDS) urine indicators at a p-value threshold of <0.10, but because they did not present actual p-values, data, or results of specific tests, it is not possible to make judgments about the probabilities of treatment effects actually occurring in their study (e.g., if P=0.12, this could be statistically significant for the purposes at hand); this is particularly relevant since estimates for percent herbaceous retention are closer to 70% than 60%. Adams et al. (2009) presented data summaries and results of individual statistical tests, and there were no apparent numeric differences in pH, conductance, acid neutralizing capacity between grazed wetlands and ungrazed wetlands, and additionally did not detect any statistically significant differences (P = 0.226 and higher). They reported that nitrates, nitrites, ammonia, and orthophosphates were at or below detectable limits in most wetlands. However, there were several reasons why significant differences may not have been detected, one of which was identified by the authors (see "Information on Key Amphibian-Livestock Grazing Studies Cited in this Report").

While one of the above studies, possibly both, indicate that retaining ≥60% of total herbaceous vegetation would help prevent water quality from being negatively impacted by livestock, at least two studies show that negative effects on water quality are possible in some situations at this herbaceous retention level. Schmutzer et al. (2008) found statistically significantly higher turbidity (3.5x to 3.7x higher) and specific conductance (68-70% higher) and significantly lower dissolved oxygen (28% lower) in grazed wetlands (estimated 70-85% retention of herbaceous vegetation) compared to cattle-excluded wetlands, meaning they would have found significant effects at 60% and 50% retention. Also, unionized ammonia, nitrites, and nitrates were consistently higher in wetlands used by cattle (not statistically different at the P = 0.07 level), compared to cattle-excluded wetlands. Even if differences at the p = 0.7 level are not viewed as statistically significant, a larger gap between cattle-excluded and grazed wetlands at the 60% retention level would be statistically significant. Schmutzer et al. (2008) concluded that ammonia may have reached biologically significant levels in wetlands used by livestock (averaging an estimated 70-85% retention of herbaceous vegetation). Ammonia concentrations in the grazed wetlands exceeded levels reported to be lethal to green frog embryos (Burton et al. 2009). Schmutzer et al. (2008) concurrently found that species richness of frog tadpoles was about 2.7x higher in wetlands not used by cattle (a statistically significant difference, that tadpoles of some frog species were substantially more abundant (e.g., green frogs were 5x more abundant), and that tadpoles of several species were significantly larger in wetlands not used by cattle. (See also discussion for "Forage for Tadpoles," above.)

On the other hand, ammonia concentrations in grazed wetlands in Schmutzer et al's. (2008) study remained lower than what has been reported to be lethal to American toad embryos (Burton et al. 2009) and this may have been one reason that allowed numbers of American toads to be higher in grazed wetlands than in ungrazed wetlands. Of the five amphibian species studied, Marco et al. (1999) found that tadpoles of western toads (*bufo boreas*) were least sensitive of five amphibian species, including Oregon spotted frogs, to nitrates and nitrites. Oregon spotted frog tadpoles were considerably more sensitive than western toad tadpoles. Nonetheless, however, contaminants below but near thresholds of lethality are not within the realms of suitable water quality because organisms are still impacted at these concentrations, just not to the point of large die-offs directly from the contaminant.

Hornung and Rice (2003) found ammonium levels to be significantly higher in mid-July and possibly in late August in grazed wetlands than in ungrazed wetlands, and orthophosphates were found to be significantly higher in mid July and late August in grazed wetlands than in ungrazed wetlands. It is estimated that 70-80% of sedge biomass was retained in grazed wetlands their study area, meaning the authors would have found statistically different effects at 60% and 50% retention. Also, because naturally occurring nitrate, nitrate, ammonium, and phosphates can be near levels that negatively affect spotted frogs and boreal toads, these studies show that inputs from livestock could result in thresholds being exceeded.

Additionally, the "Water Quality" subsection of the "Roles of Herbaceous Canopy/Retention and Openings" section cites a wide range of studies that identify the negative effects of urine and feces inputs by livestock and increased turbidity caused by livestock trampling. While most of these studies did not identify livestock use levels of wetlands and ponds, it is clear that negative impacts do not all of a sudden begin at severe use by livestock (e.g., 60-70% use of total herbaceous vegetation, or 65-85% use of key forage species). Impacts begin earlier, apparently in the neighborhood of 20% use in some situations and then incrementally increase with increasing livestock use, both in terms of negative effects in any given wetland (regardless of whether reduced water quality negatively affects frogs and toads) and in terms of the proportion of wetlands in which water quality is no longer suitable for spotted frogs and toads (Figure A.15). Forty to 50% use of herbaceous vegetation is well beyond 20% use and is approaching 60-70% use.

While one and possibly two studies provide at least some indication that it may be possible in some situations for livestock to use ponds and wetlands at a herbaceous retention level as low as 60% without negatively affecting water quality for tadpoles, there are at least four reasons for not concluding that 60% retention would adequately protect against reductions in water quality. First, two of four applicable studies (above) found significant negative effects at estimated 70-85% and 70-80% retention of herbaceous vegetation, and 60% retention represents 1/3 to 1/2 more livestock inputs of urine, feces, and trampling than 70-85% retention. Second, a large number of studies have shown there to be significant reductions in water quality — including increases in nitrate, nitrites, ammonium, phosphorus, conductance, and turbidity, and reductions in dissolved oxygen — due to livestock grazing use (see the "Water Quality" subsection in the "Roles of Herbaceous Canopy/Retention and Openings" section for an extensive discussion supported by a large number of scientific studies). Third, it is not known whether changes in water quality in Foote and Rice Hornung (2005) would have been statistically significant at another p-value (e.g., P<0.15, or P<0.20). While few of the studies in the "Water Quality" subsection of the "Roles of Herbaceous Canopy/Retention and Openings" section provided measures of livestock use, they demonstrate that water quality declines as livestock use of ponds and wetlands increases. Especially in small wetlands and shallow moderate size wetlands with relatively high percent canopy cover of moderate-height to tall herbaceous vegetation, livestock use that results in 60% retention indicates a high level of use per volume of water. Fourth, basic tenants of statistical analyses are that (1) while rejection of a null hypothesis provides direct evidence of a treatment effect, failure to reject a null hypothesis does not provide direct evidence of there not being a treatment effect; and (2) failure to reject a null hypothesis means that treatment effects may have occurred, they were just not detected using the particular methods in the study (see "Dealing with Limited Definitive Scientific Information" section in the main report). At best, after several studies have been unable to reject the null hypothesis under similar circumstances, there are grounds to at least begin formulating a working hypothesis that treatments do not have material effects on the response variables. This is in large part because statistical analyses are traditionally designed to make it very difficult to reject the null hypothesis in order to be sure that, when conclusions of treatment effect are made, confidence of this is high to very high (e.g., P<0.10, P<0.05, P<0.01). A down-side of this is that treatment effects could have occurred in the study, but they were not detected at the p-value used in the study.

Surface-Water Retention in Small Pools

With the increasing intensity of use at small pools under retention levels of 60% and 50% and given the potential for disproportionately high use even at 70% retention, there is little support for the assessment that 60% or 50% retention of total herbaceous vegetation would adequately limit use of susceptible small pools. Use by livestock would be 1/3 to 2/3 higher than at wetlands where retention levels are at 70%. As the level of livestock use increases in a wetland, there may be a greater potential for the use of the wetland while not having retention levels accurately reflect this (i.e., more drinking than foraging, trailing into and out of wetlands).

Survival as Affected by Trampling

There is low support for the assessment that limiting livestock use of herbaceous vegetation in summering and migration habitat to no more than 40% or 50% would limit trampling-caused mortality of adult and juvenile spotted frogs and boreal toads to relatively low levels, and there is low support or no support for the assessment that limiting livestock use of herbaceous vegetation at breeding wetlands to no more than 40% or 50% would adequately limit trampling-caused mortality of tadpoles and metamorphs to relatively low levels. Individual and groups of livestock walking in and immediately around breeding wetlands inherently brings with it the potential of livestock stepping on tadpoles, metamorphs, juveniles, and adults. Support would be somewhat higher (e.g., moderately-low and low to moderately low support, respectively) where willows comprise a relatively large proportion of the vegetation canopy cover due in part to protection added by willow plants. As compared to 30%

use, livestock could spend 33-67% more time in any given area grazed at 40% or 50% use[M], or the number of animals could be 33-67% higher.

Possibly the biggest concern with livestock grazing use in spotted frog and boreal toad habitat is elevated mortality due to trampling, especially when and where metamorphs congregate on shorelines and as they move in relatively high concentrations away from breeding areas but also when adults are in moist habitats used by livestock (Bartelt 1998, Maxell 2000, Hogrefe et al. 2001, Wind and Dupuis 2002, Keinath and McGee 2005, Bull 2009); and (1) there is little or no information in the proceeding analysis to demonstrate that limiting livestock grazing use to ≤40% or ≤50% would adequately address the concern with respect to metamorphs, and (2) there is little information showing that limiting use to ≤40% or ≤50% would adequately resolve the concern with respect to adults.

Given the potential for trampling by livestock, retaining 60% or 50% of herbaceous vegetation would do little "…to ensure that activities do not cause: (1) long-term or further decline in population numbers or habitats supporting these populations; and, (2) trends toward federal listing," as called for in Objective 3.3(a).

There is no scientific information refuting the information summarized below — that retaining 60% or 50% retention of herbaceous vegetation is largely insufficient to protect against a large proportion of eggs, tadpoles, metamorphs, juveniles, and adults being trampled by livestock on an annual basis or periodically.

Summer and Migration Habitat

The potential for livestock to step on juvenile and adult frogs and toads in summering habitat and migration corridors can be characterized as high frequency, relatively-low to moderate impact, meaning that trampling of adults and juveniles would likely occur annually in most pastures containing frogs or toads, and the proportion trampled would likely be relatively low to moderately low in most situations, with a mortality rate from trampling likely in the single digits or teens (or possibly higher) for the segment of populations inhabiting habitats used by livestock. The mortality rate relative to the entire population in a given area would be lower because a percentage of individuals in these populations inhabit habitat not used by livestock or that make frogs and toads less likely to be stepped upon, for example, dense willow, forestland, and streambanks. This percentage cannot be estimated with existing information and it varies from population to population. For 60% retention of herbaceous vegetation, Figure A.16 shows that an estimated 15-30% of small stationary objects are estimated to be trampled in meadows producing 500 pounds/acre, and that an estimated 60-100% of small stationary objects would be trampled in meadows producing 3,000 pounds/acre, assuming cattle are in any given meadow for 2-4 weeks. An estimated 20-85% of small stationary objects are estimated to be trampled within 2-4 weeks at 40% use (60% retention) of herbaceous vegetation in meadows producing 1,000 to 2,000 pounds/acre. For 50% retention of herbaceous vegetation, Figure A.16 shows that an estimated 20-40% of small stationary objects are estimated to be trampled in meadows producing 500 pounds/acre, and that an estimated 70-100% of small stationary objects would be trampled in meadows producing 3,000 pounds/acre, assuming cattle are in any given meadow for 2-4 weeks. An estimated 25-95% of small stationary objects are estimated to be trampled within 2-4 weeks at 50% use (50% retention) of herbaceous vegetation in meadows producing 1,000 to 2,000 pounds/acre.

The reasons outlined in the 70% retention discussion as to why Figure A.16 overestimates trampling rates of frogs and toads in summer and migration habitat used by livestock apply here as well. However, where use levels reach 40% or 50% in meadows due to larger groups sizes of cattle (e.g., as compared to 30% use), there would be a higher probability of frogs or toads being stepped upon, beyond the increase in trampling due just to the higher use level. This is because, as group size increases, there is a greater likelihood of frogs or toads hopping away from one set of hooves just to be crushed by another set of hooves. Furthermore, moving cattle through spotted frog and boreal toad habitat (e.g., to move them out of riparian areas) result in high densities of livestock in small areas without reduction in herbaceous vegetation, with the added impact of moving livestock which makes it harder for frogs or toads to avoid hooves. Plus, this can happen once each day in places.

[M] The difference between 30% and 40% use is 20% and the difference between 30% use and 50% use is 20%; 10% is 33% of 30% and 20%; and 20% is 67% of 30%.

Roche et a. (2012a) provides no more than limited, indirect information on the potential effects of livestock trampling on mortality of Yosemite toads in meadows because they did not assess survival of adults and juveniles after they left breeding wetlands and livestock grazing was season-long (i.e., lower than the lines in graph 'd' of Figure A.16) in contrast to cattle grazing on the BTNF which typically entails grazing periods of about 4-5 weeks in any given pasture.

Breeding Wetlands – Adults and Eggs

The potential for livestock to step on tadpoles and adult frogs and toads at breeding sites would be low because most eggs should be hatched prior to the onset of livestock grazing each year and most adults should have left breeding wetlands before the onset of livestock grazing. This does not include adults that remain at breeding wetlands; adults that summer at breeding wetlands were addressed above.

Breeding Wetlands – Tadpoles and Metamorphs

At 40% or 50% utilization of herbaceous vegetation at breeding sites, there would be a (1) relatively high potential of trampling tadpoles every year when and where livestock have access to wetlands containing tadpoles, and the level of impact in any given year could vary considerably; and (2) moderate to high potential of trampling metamorphs in any given year when and where livestock access wetlands during the metamorphosis period, and the level of impact could range from low to high depending on the situation (but higher than at a 30% utilization level). Where livestock use overlaps in time and space with tadpoles, there would be a high likelihood of at least some tadpoles being trampled, and the potential for this would increase as the summer progresses and pools of water shrink.

Metamorph emergence and concentration on shorelines would only occur for several days and concentrations occur in small areas, compared to livestock which graze the area for a longer period of time and they range over substantially larger areas. Graphs in Figure A.16 likely overestimate trampling rates of tadpoles and metamorphs because the graphs present trampling rates of small stationary objects by cattle at given densities over the course of 1-4 weeks, but high concentrations of metamorphs only occur for several days. At cattle densities required to reach 40% and 50% use of a wetland in 3-4 weeks (0.8-4.0 cows/acre and 1.0-5.0 cows/acre, respectively, assuming 2,000-3,000 pound/acre of herbaceous production; Tables A.4 and A.5), an estimated <10% to 40% and <10% to 50% of small stationary objects would be trampled in a 3-4 day period (Table A.3). This may be comparable to trampling rates of metamorphs. However, trampling would only occur when and where there is overlap between livestock and metamorphs, and there likely are some years when use of any given wetland by livestock does not occur when metamorphs are emerging. If 40% or 50% use at a given wetland is attained in about 1 week, this equates to densities of 3.2-12.0 and 4.0-15.0 cows/acre, which in turn results in an estimated 40-100% and 50-95%, respectively, being trampled in a 3-4 day period (with a large majority of readings well above 50%). This means the chances of high percentages of metamorphs being trampled would be relatively high when and where metamorphs and livestock overlap. It needs to be recognized that cattle use wetlands for more than just grazing (e.g., some to many may use a wetland for watering and not grazing), and some cattle may remain at a wetland for periods of time without grazing or drinking. To the extent this occurs, the above estimates may underestimated effects.

Munger et al. (1994), Munger et al. (1996), Schmutzer et al. (2008),and Burton et al. (2009) do no lend support to the assessment that 60% retention of total herbaceous vegetation adequately protects against adults and tadpoles being trampled, and may provide some evidence trampling was sufficiently high to affect the abundance and occupancy of frog adults and tadpoles. The studies do not provide direct evidence of this since trampling effects were not measured, but information outlined in the "Survival as Affected by Trampling" section near the beginning of the appendix" demonstrates that trampling by livestock is a very plausible contribution to reductions in abundance and/or occupancy in the studies. Munger (1994) found spotted frog occupancy to be significantly lower in wetlands grazed by livestock (an estimated herbaceous retention in the neighborhood of 80%) than in wetlands ungrazed by cattle. While results were not statistically significant in Munger et al. (1996), patterns were similar. Schmutzer et al. (2008) found that tadpole abundance was significantly higher in ungrazed wetland than grazed wetlands, with grazed wetland having an estimated 70-85% herbaceous retention). Burton et al. (2009) found that use of ungrazed wetlands by frogs was significantly higher than at grazed wetlands (an estimated 70-

85% retention), although this was not true of toads; densities of toads was higher in grazed wetlands, but herbaceous retention levels were an estimated 70-85%. The potential for trampling would be greater in wetlands where only 60% or 50% of herbaceous vegetation is retained.

Although results were not statistically significant at the $p < 0.05$ level, tadpole survival to metamorphosis in grazed wetlands of Bull and Hayes (2000) was 32-41% lower than in ungrazed wetlands. It is possible this would have been statistically significant at a higher significance threshold (e.g., $p < 0.1$ or higher), especially with additional grazing (e.g., 60% or 50% retention vs. the estimated average of 80% retention in the study), although this possibilities cannot be confirmed. It is possible that trampling by cattle could have killed tadpoles or metamorphs before counts were made by Bull and Hayes (2000). Also, grazed wetlands had an average 80% retention which is higher than 60% and 50% retention. Bull and Hayes (2000) did not include an assessment of survival by metamorphs. They did not assess the number of metamorphs that left the breeding site, and the potential exists for substantial mortality between the emergence of metamorphs (which indicated the number of tadpoles that completed metamorphosis in the study) and departure from breeding sites.

If sheep use of a wetland were to overlap with a high concentration of metamorphs on a shoreline, mortality of metamorphs due to crushing could be high at 60% and 50% retention levels in part because it is possible for a sheep band to only trample or graze a relatively small amount of herbaceous vegetation relative to the size of the wetland and shoreline area. If the place where they happened to go to water overlaps a high concentration of metamorphs, this could have major impacts on a given cohort, as observed by Bartelt (1998). Limiting retention to 60% or 50% as a means to protect metamorphs from trampling likely would not be effective where sheep are watered. Even at a low frequency of this happening across years, this has the potential to adversely impact local populations (Keinath and McGee 2005).

Soil Looseness and Porosity

At 60% retention of total herbaceous vegetation, soil compaction would likely be limited to acceptable levels, but possibly near the low end of acceptability (i.e., a moderate level of support). Thurow (1991:149) presented graphed data (from Thurow 1988) showing that water infiltration rates (one indicator of the extent to which soils are compacted) in pastures with moderate stocking rates were approximately 15% lower than in a livestock exclosure. Assuming “moderate” equates to 31-50% utilization of key forage species (Holechek et al. 2011:141; their conservative and moderate grazing intensities were combined for the purposes of this assessment), this roughly translates to 65-80% retention of total herbaceous vegetation if key forage species composition was in the neighborhood of 50% and retention of non-key species averaged 80-90% or translates to as low as 55-75% retention of total herbaceous vegetation if key forage species composition was as high as 75% and retention of non-key species averaged as low as 70-80% (Appendix B). As a comparison, short-duration rotation grazing, stocked at 1.75 times the moderate intensity, reduced infiltration rates by about 40-65% compared to the exclosure.

Integrity of Near-Surface Burrows and Streambanks

There is low support for the assessment that limiting utilization of herbaceous vegetation where shallow burrows occur to no more than 40% and 50% would limit crushing of these burrows. Because shallow burrows are stationary, clay pigeons provides an approximation of the level of potential impact. An estimated 20-50% and 25-60% (for 40% and 50% use, respectively) of clay pigeons would be expected to be stepped upon when livestock are in meadows (1,000 pounds/acre production) long enough to result in 30% utilization of total herbaceous vegetation (Figure A.16). In meadows with 2,000 and 3,000 pounds/acre, an estimated 40-85% and 50-95% (for 40% and 50% use, respectively) and 60-100% and 75-100% (for 40% and 50% use, respectively) of clay pigeons would be expected to be stepped upon. This provides a moderate to very high potential for shallow burrows being crushed, depending on the situation, and with it, a potential for occupants to be crushed in them.

There is moderately-low to moderate support for the assessment that limiting utilization of herbaceous vegetation in riparian habitats to no more than 40% and 50% would limit the crushing of streambanks. This is mainly because use of streambank vegetation would be limited when utilization of total herbaceous vegetation in riparian areas remains 40% or less (or 50% or less). Livestock use of streambanks typically does not increase substantially until vegetation in moist meadows, silver sagebrush, and shrubby cinquefoil is well utilized.

Implications of Livestock Grazing Use to Multiple Stressors

Long-term Reductions in Vegetation Height and Canopy Cover

If starting herbaceous canopy cover (prior to the onset of livestock grazing) is less than near-100% but high enough to effectively retain humidity, moderate temperatures, provide shade, provide hiding and escape cover, and provide invertebrate habitat to some degree, reducing canopy cover by 1/2 to 2/3 (60% retention) or 2/3 to 4/5 (50% retention) would definitely reduce canopy cover to the point that herbaceous vegetation is no longer providing these functions (bottom of Table A.2). If starting herbaceous canopy cover is too low to retain humidity, moderate temperatures, provide shade, provide high-quality hiding and escape cover, and provide high-quality invertebrate habitat, reducing canopy cover by 1/2 to 2/3 (60% retention) or 2/3 to 4/5 (50% retention) would make unsuitable conditions worse. Similar situations would occur if starting vegetation height is too short to provide an effective canopy and to provide invertebrate habitat, for example where non-native bluegrasses dominate a plant community and where plant vigor is depressed. Starting herbaceous canopy cover and heights as described above can occur naturally, but most moist meadow, silver sagebrush, shrubby cinquefoil, and meadow-willow sites are productive and typically have high percent canopy cover (e.g., in the neighborhood of 80-100%; (Norton et al. 1981:57, Youngblood et al. 1985:App. B, Padgett et al. 1989:App. B, Manning and Padgett 1995, NRCS 2008a:Reference Sheets, NRCS 2008b:Reference Sheets). Reductions in height and percent canopy cover can result from plant mortality and reduced plant vigor caused by livestock over-use and increases in nonnative species like Kentucky bluegrass and smooth brome.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 60% or 50% retention of herbaceous retention would result in greater impacts than described in the “Examination of Herbaceous Structural Attributes at 60% and 50% Retention” section, above.

On the other hand, where percent canopy cover and/or height is naturally low or where it is lower due to reduced plant vigor and/or conversion to nonnative species like Kentucky bluegrass, smooth brome, or tarweed, 40% and 50% use of herbaceous vegetation would result in fewer impacts to water quality, wetland water levels, and survival as affected by trampling compared to effects in healthy, naturally-functioning plant communities. This is because utilization is based on weight, and if annual production is, for example, 500 pounds/acre instead of 2,000 pounds/acre, livestock would spend considerably less time in the meadow that produced 500 pounds/acre. In this example, the potential of being trampled could be roughly 3x lower in the meadow supporting 500 pounds/acre than if it produced 2,000 pounds/acre (Figure A.16). Furthermore, fewer spotted frogs and boreal toads would be found in the meadow producing 500 pounds/acre (both in the vegetation and in burrows), which would further reduce the potential of being trampled.

Therefore, in the situations outlined in the previous paragraph, implementing a threshold of 60% and 50% retention of herbaceous retention would result in fewer impacts than described in the “Examination of Other Factors Influenced by 60% and 50% Retention” section, above.

If serious attempts are made to retain ≥60% or 50% of herbaceous vegetation at each monitored breeding wetland and if monitored breeding wetlands are fairly representative of other breeding wetlands (including grazing levels), herbaceous vegetation may remain at moderate or moderately-low levels (≥70% or ≥60% retention, respectively) at some monitored and unmonitored breeding wetlands and it is likely that herbaceous vegetation would decline to ≤50% or ≥40% at some unmonitored breeding wetlands. First, under the best of circumstances, retention would only be monitored at a small proportion of known breeding wetlands any given year and not all allotments would be monitored every year. Second, there is a reasonable chance that grazing use will push the limits of whatever retention threshold is identified and action may not be taken until retention levels are several percentage points or more below what is identified as the minimum threshold (i.e., grazing at some monitored breeding wetlands undoubtedly would be <60% or 50%, respectively). Third, only a portion of breeding sites are known and the location of breeding sites can change from year to year. Fourth, retention levels at different breeding sites would continue to be variable.

Other Multiple Stressors: Chitrid Fungus, Climate Change, UV Radiation, & Local Human-Related Impacts

The assessments made in the preceding 17 pages relative the capability of 60% and 50% retention to provide suitable habitat for spotted frogs and boreal toads and to protect them from direct livestock impacts were completed independent of effects of livestock grazing use in the context of multiple stressors.

In combination with all multiple stressors **—** *i.e., altered vegetation conditions (previous subsection), chitrid fungus, ranavirus, climate change, UV radiation, loss of habitat and habitat fragmentation due to roads, elevated mortality due to crushing by motor vehicles, elevated mortality due to introduced fish, poisoning from rotenone, reduced spring flows due to late-seral conditions, reduced beaver-pond distribution and abundance, increases in nitrate and ammonia in wetlands from the atmosphere, loss of wetlands and other habitat due to reservoirs, loss of meadow and willow habitat due to expanding forestland, and other effects on spotted frogs and boreal toads on the BTNF* **—** the addition of effects associated with 30% utilization of herbaceous vegetation in breeding wetlands and other habitats of spotted frogs and boreal toads has potential to contribute to a moderate or greater increase in negative impacts on habitat, moderate or greater increase in potential for elevated mortality due to trampling, and benefits due to the ability to maintain openings where emergent vegetation otherwise would expand into egg and tadpole development sites.

≥40% AND LOWER RETENTION OF TOTAL HERBACEOUS VEGETATION

There is virtually no evidence that 40% retention of herbaceous vegetation and no evidence that 30%, 20%, or 10% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, with one exception (see below). There was no reason to explore ≥40%, ≥30%, ≥20%, or ≥10% retention levels in any detail because (1) there is no evidence (with one exception) that 40% retention of herbaceous vegetation would support the attainment of Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, and (2) there is no information (with one exception) demonstrating that 40% retention would be in keeping with Forest Service policy to "Avoid or minimize impacts to species whose viability has been identified as a concern [i.e., sensitive species]" (FSM 2670.32, WO Amendment 2600-2005-1), especially given the large amount of information showing that this retention level would adversely affect spotted frogs and boreal toads.

The exception outlined below pertains only to small areas within a small subset of breeding wetlands on the BTNF. Given the wide range and large number of negative impacts of 60% utilization (and higher utilization levels) on spotted frogs and boreal toads, extensively managed livestock grazing would result in this one small benefit being far outweighed by negative impacts. The only way to produce and sustain open areas in shallow waters otherwise dominated by emergent vegetation, while minimizing negative effects, is to implement prescriptive, highly-controlled grazing/trampling at specific wetlands (see the "Openings Providing Sun Exposure" section).

Shallow Water Exposed to the Sun

There is greater than moderate support for the assessment that 60% utilization of emergent vegetation would create and maintain open areas of shallow water exposed to the sun in otherwise extensive stands of relatively-tall, dense emergent vegetation, and high support for 70% and 80% utilization. From the standpoint of altered vegetation height and structure, 40% retention of herbaceous vegetation that is cropped at a fairly even height equates to an average height reduction of about 80-90% (not including the lowest 2 inches) in moderate to tall sedge communities (Table A.2), which undoubtedly increases solar radiation reaching the water. Stubble height would be less than 4-6 inches (Kinney and Clary 1994). Canopy cover of relatively-intact vegetation would decline by an estimated 85-100% (Table A.2), with some patches being grazed more than 60% use.

There would appear to be high potential, at 60% utilization of herbaceous vegetation, for the vigor and survival of emergent vegetation to be reduced in patches sufficiently to create and maintain longer lasting patches of open or relatively-open water. Because some individual sedges and rushes would be grazed substantively more than 60%, it is probable for some patches of plants to be reduced in vigor and possibly survival (Clary and Webster 1989, Hall and Bryant 1995, Clary and Leininger 2000), which would facilitate the formation of longer lasting openings where the same patches are grazed year after year.

At 70% and greater utilization, the likelihood is high of producing and maintaining short-stature vegetation and patches of unvegetated shallow waters. Stubble height would be shorter than 3-5 inches (Kinney and Clary 1994).

4-INCH STUBBLE HEIGHT

> ***Note:*** The following assessment in no way negates the application of minimum stubble heights of 4-8 inches on green-lines for the purpose of limiting livestock use to ensure the proper functioning of streams. The application along the green-line involves a very narrow band and its application typically does not extend beyond this band. The following discussion is limited to assessing whether 4-inch tall herbaceous vegetation in wetlands, wet meadows, moist meadows, silver sagebrush, shrubby cinquefoil, and meadow-willow communities would provide suitable habitat for spotted frogs and boreal toads.

Loeffler et al. (2001) and Keinath and McGee (2005) recommended retaining a minimum 3-4 inch stubble height in spring-use pastures and a minimum 4-6 inch stubble height in summer/fall use pastures, but according to Loeffler et al. (2001:65), this was specifically recommended "To maintain proper functioning riparian areas…," and Keinath and McGee (2005:44) used similar language. If there was any intent by Keinath and McGee (2005) to apply this to boreal toad habitat (e.g., to retain hiding cover, humidity retention), no scientific support was provided and no scientific support was identified in the analysis for this appendix. While no scientific support was cited in Loeffler et al. (2001) or Keinath and McGee (2005), the minimum 4-6 inch stubble height, for the purposes of maintaining riparian health, is well supported (Clary and Webster 1989, Hall and Bryant 1995, Skinner 1998, Clary and Leininger 2000).

With one exception, no information was found supporting an assessment that an average 4-inch stubble height in and around breeding and summering wetlands, other summer habitat, and in migration habitat would be sufficient to meet habitat needs of spotted frogs and boreal toads, including no information showing herbaceous vegetation would provide protection to frogs and toads from the sun; retain ground-level moisture; moderate temperatures; provide hiding and escape cover; provide suitable forage, cover, and structure for a diverse insect community; and contribute to thatch and litter. Also, no information was found demonstrating that livestock use of wetlands associated with a 4-inch stubble height would be low enough to maintain suitable water quality, maintain mortality from crushing within acceptable limits, and maintain water-level reductions in small pools (as a result of drinking by livestock) within acceptable limits.

Humidity Retention, Temperature Moderation, Shading, and Hiding and Escape Cover

An average stubble height of 4 inches for sedges in a wetland or wet meadow — which equates to herbaceous retention levels of 30-40% (60-70% utilization) assuming starting sedge heights of 14-28 inches (Kinney and Clary 1994) — would provide little protection from the sun and predators and would adversely impact insect habitat (DeLong 2009b). As an example, where pre-grazing sedge height is 18-24 inches, reducing the height to 4 inches constitutes a major alteration of plant community structure, more so than was evaluated in the "50% and 60% Retention of Total Herbaceous Vegetation." Where pre-grazed vegetation height is taller than 24-28 inches, e.g., as tall as 36 inches, utilization associated with reductions to 4 inches would be even more severe. Figure A.9 and Figure A.25 illustrate the vegetation structure that would remain when sedges are grazed to a height of about 4 inches. While Figure A.25 illustrates a stubble height of an average of about 3 inches, this is close to the effects of an average 4-inch stubble height in a typical sedge community.

Humidity retention and temperature moderation qualities of the herbaceous vegetation would essentially be eliminated (Marlatt 1961, Oke 1978, Honek 1988, Honek and Jarosik 2000), and shading and hiding cover would be reduced by a major amount (e.g., 60-95% reductions in visual obstruction as per Robel pole readings). Not only would the herbaceous canopy be completely gone — which would allow moisture to escape into the atmosphere and for ambient temperatures to reach near-ground level — sunlight hitting exposed ground and vegetation stubble near the ground would raise temperatures near ground level above ambient temperatures (Marlatt 1961, Oke 1978). Elevated temperatures could contribute to even lower humidity levels near the ground.

Small patches of shade may remain where sprigs of taller vegetation remain, but given the elevated daytime temperatures and lower humidity levels near ground level, this shade would be mostly ineffective.

Tadpole Forage

The amount of herbaceous vegetation contributing to tadpole forage and providing a substrate for tadpole forage would decline by a major amount. With much less of a reduction in herbaceous biomass, Schmuzter et al. (2008) found significantly lower tadpole diversity and abundance of some tadpole species.

Invertebrate Habitat

Invertebrate species richness and abundance would be expected to be reduced by a major amount (East and Pottinger 1983, Morris and Plant 1983, Morris 2000, Kruess and Tscharntke 2002, Foote and Rice Hornung 2005, Black et al. 2007, Black et al. 2011). Contributions to thatch and litter would be minor, which would reduce the capacity to provide suitable habitat for frogs, toads, and invertebrate prey populations in future years.

Water Quality, Water-Level Declines, and Mortality

The high level of livestock use needed to reduce stubble height to 4 inches — especially in moderately to tall plant communities (e.g., >18-24 inches tall where retention of herbaceous vegetation would be 30-40% or less) could result in a substantial increase in the rate of water level declines in small pools having little or no recharge (due to livestock drinking), which would elevate the potential for tadpoles dying before metamorphosing (see the "Surface Water Duration in Small Pools (Retention of Water into Mid and Late Summer" section)). This high level of livestock use also runs a high risk of substantial mortality of spotted frogs or boreal toads, particularly where tadpoles congregate in shallow waters, where metamorphs congregate on breeding pool shorelines, and where adult spotted frogs are inhabiting or moving through wet meadow habitat during summer months (see the "Survival, as Affected by Vehicles, Heavy Equipment, and Livestock" section).

Assuming a pre-grazed sedge community height of about 14-28 inches and annual production of about 2,000-3,000 pounds/acre, an estimated 60-100% of small stationary objects are estimated to be trampled within 2-4 weeks when vegetation has been grazed to an average of 4 inches (i.e., 60-70% utilization of herbaceous vegetation) (Figure A.16). Where annual production is 1,000 pounds/acre, an estimated 30-75% of small stationary objects would be trampled within 2-4 weeks when vegetation has been grazed to an average of 4 inches. Although the trampling rates in Figure A.16 overestimate trampling of tadpole, metamorph, and adult spotted frogs and boreal toads, the gap between estimated trampling rates of small stationary objects and the actual trampling rate of frogs and toads narrows with increasing utilization levels in part because, as the group size of livestock increases, there is a greater probability of a frog or toad hopping away from one set of hooves just to be crushed by another set of hooves. Also, although the maximum possible percent of small stationary objects being crushed is 100%, the trajectory of lines in graphs c and d for cow-calves (i.e., the upper three lines) if it were not for leveling off, would exceed the 100% line. This means that, although a 100% trampling rate is an overestimate for frogs and toads, there is a greater likelihood of frogs and toads being trampled at 60% and 70% utilization (i.e., 4-inch stubble height) than there is at, say, 40% utilization, even though the range of percentages in Figure A.16 are not substantially different. If the pre-grazed height is taller than 28 inches, the trampling rate would be higher.

Also, an average stubble height of 4 inches which would allow for stubble heights as low as 2 inches or less in parts of wetland areas, further exacerbating impacts. It would take a relatively small proportion of ungrazed or lightly grazed plants of, say, 12 inches or taller to result in a large proportion of a site being grazed to 2 inches or less… in order for an average of 4 inches to be maintained. Vegetation below about 2 inches contributes little if anything to hiding cover, shading, or insect habitat.

If sedge heights are moderately uneven (e.g., half the plants average 6 inches and half the plants average 2 inches), effects may not be much different than described above since half the site would have somewhat taller vegetation (assuming an overall average of a 4-inch stubble height). However, if sedge heights are considerably different (e.g., 30% of plants are 8-10 inches tall and 70% of plants are about 2 inches tall), impacts could be more severe (still assuming an overall average of a 4-inch stubble height). The reason the effects would be more severe is that the plant community is dominated by 2-inch tall plants.

Using a minimum 4-inch stubble height on the green-line as a proxy for maintaining suitable habitat for spotted frogs and boreal toads away from streambanks does not appear to have any merit since, but the time cattle and/or horses have grazed streambank sedges down to a height of 4 inches, riparian vegetation in many places away from the streambank has been heavily grazed. There is no information demonstrating that a 4-inch stubble height on the green-line would provide a proxy for maintaining suitable herbaceous habitat for spotted frogs and boreal toads away from streambanks.

Basking Sites

Where otherwise tall, dense herbaceous vegetation is reduced to a 4-inch stubble height, this would allow sunlight to penetrate to the ground or near the ground. An average 4-inch stubble height would far surpass the provision of small, open patches for basking.

Shallow Waters Exposed to the Sun

Where an average 4-inch stubble height is produced in what was an extensive stand of emergent vegetation in shallow water, this would allow sunlight to heat the water, thereby providing warmer water which would facilitate tadpole development. Because tadpole development occurs during the growing season of emergent vegetation, grazing of vegetation would need to continue in order to keep the vegetation short. Additionally, there would appear to be high potential, at 60-70% utilization of herbaceous vegetation, for the vigor and survival of emergent vegetation to be reduced (Duncan and D'Herbes 1982, Clary and Webster 1989, Hall and Bryant 1995, Clary and Leininger 2000, Ausden et al. 2005, Jones et al. 2010), which would facilitate the formation of longer lasting openings where the same patches are grazed year after year.

Because grazing and trampling in these situations would necessarily occur during the tadpole development period, a utilization rate of an estimated 60-70% or more would have high potential for water quality to be impacted; for tadpoles, as well as adults and metamorphs, to be trampled; and for water-declines to be accelerated (due to drinking by livestock).

Adequate Extent of Suitable Retention Levels

There are two parts of Forest Plan objectives dealing with herbaceous retention for sensitive species: (1) suitability of habitat conditions on a site-by-site basis, and (2) amount of suitable habitat that is provided in any given area or across a landscape. The threshold of 70% retention of herbaceous vegetation applies to the suitability of habitat, and the discussion below addresses the proportion of spotted frog and boreal toad habitat in which 70-100% of herbaceous vegetation needs to be retained.

TWO GEOGRAPHIC SCALES

Spotted frogs and boreal toads use a variety of habitats during spring, summer, and fall months and this involves inhabiting favored habitat for extended periods and it involves movement between favored habitats. Two geographic spatial scales are important for retaining herbaceous vegetation: the immediate vicinity of breeding wetlands and an area that encompasses a majority of breeding and summer-long habitat. Placing minimum retention levels on herbaceous vegetation within the area encompassed by a perimeter that is 10 feet beyond the high-water mark of breeding wetlands and on herbaceous vegetation within 1/3-mile of breeding pools would be sufficient to provide for the needs of most individuals of both species. The basis for these two "buffer zones" is outlined in the "Buffer Zones and Levels of Protection" section near the beginning of the main report.

Breeding Wetlands

Likely the most important geographic scale for managing the effects of livestock grazing is that of the breeding wetland (Maxell 2000, Engle 2001, Loeffler et al. 2001, Patla 2001, Hogrefe et al. 2005, Keinath and McGee

2005, Patla and Keinath 2005, Shovlain et al. 2006, Schmutzer et al. 2008, Bull 2009). There are several reasons for this. This is where reproduction occurs and effects on reproduction can have substantive effects on populations. Livestock grazing use in breeding wetlands can impact egg survival, tadpole survival, metamorph survival, and adult survival (Bull and Hayes 2000, Jansen and Healey 2003, Schmutzer et al. 2008, Bull 2009, Burton et al. 2009); see discussion in the "Information on Key Amphibian-Livestock Grazing Studies Cited in this Report" section for Bull and Hayes (2000). Maxell (2000:90) recommended excluding livestock "…from boreal toad breeding sites at the time of breeding and at the time of metamorphosis in order to prevent mass mortality of aggregations of adults or metamorphs as a result of trampling." USFWS (2002:55765) noted that "habitat protection and removal of grazing at Mona Springs has resulted in significant improvements to spotted frog habitat."

Livestock grazing can affect a large number and variety of negative impacts on spotted frogs and boreal toads at breeding sites, including reduced hiding and escape cover for tadpoles, metamorphs, and adults; reduced shading on shorelines; reduced substrate for tadpole forage; reduced habitat for invertebrate prey; reduced water quality for tadpoles and larva of invertebrate prey; accelerated declines in water levels; and increased mortality of tadpoles, metamorphs, and adults due to trampling (numerous citations throughout this appendix).

Breeding sites are by far the most common habitat area of spotted frogs and boreal toads for which livestock exclusion has been recommended (Bartelt 2000, Maxell 2000, Engle 2001, Loeffler et al. 2001, Patla 2001, Hogrefe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Shovlain et al. 2006, Schmutzer et al. 2008). While livestock exclusion is not being recommended as an outcome of the analysis in this appendix, recommendations by these authors — sometimes provided for specific situations — exemplifies that the greatest potential for impacts by livestock is at breeding sites. This includes concern in some of these documents about the high potential for major impacts due to trampling of metamorphs (Maxell 2000, Loeffler et al. 2001, Patla 2001, Hogrefe et al. 2005, Keinath and McGee 2005), as well as other literature documenting major impacts on metamorphs (Bartelt 1998, Bull 2009) and information on the increased probability of stepping on small stationary objects with increasing livestock densities (see the "Survival as Influenced by Trampling" section).

The area encompassed by a perimeter 10 feet beyond the high-water mark of breeding wetlands was identified to represent the "breeding wetland" for the purposes of this geographic scale because it encompasses the entire wetland and the 10-ft. zone immediately above the high-water mark encompasses the shoreline without causing a "dilution effect" that would occur by encompassing too much of the adjoining meadow habitat. An important part of focusing on this geographic scale is to manage livestock grazing effects within the wetland and on the shoreline. If a 100-ft. zone were to be used, this encompasses more than just the shoreline of a wetland and, to the extent it has higher retention levels than the shoreline, it would mask negative effects on the shoreline and in the wetland. The same can be true of including vegetation that is in water too deep for frog and toad breeding (and recognizing that livestock would use these deeper zones to a much lesser degree), but a cut-off has not been identified and this would be more difficult to apply.

If a minimum retention level was only applied to the 1/3-mile zone around breeding wetlands, and given the allowance for over-use to occur on as much as 20% of spotted frog and boreal toad habitat, this could result in breeding wetlands being part of this 20%, which could have major negative impacts on reproductive success.

Within 1/3-Mile of Breeding Wetlands

The basis for the 1/3-mile zone around breeding wetlands is outlined in the "Buffer Zones and Levels of Protection" section in the main report.

In summary, approximately 75% to nearly 100% of spotted frogs in all movement studies (Turner 1960, Hollenbeck 1974, Bull and Hayes 2001, Pilliod et al. 2002) and 75% to nearly 100% of boreal toads in two movement studies remained within 1/3-mile of breeding wetlands (Muths 2003, Bartelt et al. 2004). This was the main information that was assessed in the draft report when 1/3-mile was identified as the geographic zone for applying the 70% herbaceous retention threshold. However, since then, additional studies have been located showing that a relatively large proportion of boreal toads move beyond 1/3-mile of breeding sites. More specifically, >50% of boreal toads moved beyond 1/3-mile from breeding sites in four studies (Bull 2006, Schmetterling and Young 2008, Bull 2009, Browne and Paszkowski 2010), and up to 25% of boreal toads in three of these studies moved beyond 1½ miles (Bull 2006, Schmetterling and Young 2008, Bull 2009). The area within 1/3-mile of known breeding sites also has the potential to include additional breeding areas that have not yet been discovered.

Specific to livestock grazing, several literature reviews, conservation assessments, and plans highlight the importance of controlling livestock grazing use beyond breeding wetlands to include summering habitat, migration and dispersal habitat, and overwintering habitat, including the use of fencing to exclude livestock from these habitats (Maxell 2000, Keinath and McGee 2005, Patla and Keinath 2005). For amphibians in general, Maxell (2000) recommended fencing livestock from all parts of riparian areas that provide critical breeding, foraging, or overwintering habitats or that serve as important migratory or dispersal corridors in order to protect these critical areas from damage, as well as preventing mass mortality as a result of trampling or disease at the time of metamorphosis. Patla and Keinath (2005:58) recommended, for spotted frogs, fencing critical breeding, foraging, and over-wintering habitat (e.g., ponds, springs, riparian areas) and movement corridors between breeding and wintering sites. Keinath and McGee (2005:44,38) recommended locating and protecting boreal toad movement corridors and protecting them from impacts of livestock grazing and recommended “reducing interactions between livestock and boreal toads during critical periods,” possibly including exclusion. They identified critical periods as the breeding period (mid-May to mid-June, to July at higher elevations), hatching of eggs (late May to late June, to late July at higher elevations), metamorphosis (late July to late August, to late September at higher elevations), toadlet dispersal (highly variable), and overwintering (late September to mid-May).

In riparian and adjoining habitats that are dominated by herbaceous vegetation within 1/3-mile of breeding sites, herbaceous vegetation is important for providing moist and humid habitat, moderating temperatures, shade and protection from the sun, hiding and escape cover, and invertebrate habitat (see the “Roles of Canopy/Herbaceous Retention and Openings” section). Livestock grazing can, if not sufficiently controlled, reduce or eliminate these functions of herbaceous habitat.

Metamorphs can move away from breeding sites in relatively high concentrations, and these relatively high concentrations (typically in riparian corridors) can extend up to and beyond 1/3-mile (Bull 2009). If these movements coincide with livestock grazing use in the habitats they are moving through, information in the “Survival as Influenced by Trampling” section shows an elevated potential for being stepped upon by livestock. Although the potential for trampling of adults is lower, particularly given their lower density, livestock grazing in summering habitat of boreal toads and spotted frogs elevates the potential for mortality. Both species do not breed for their first few years and survival of adults is highly important (discussed in the “Survival as Influenced by Trampling” section). Thus, any elevation in mortality has the potential to affect populations.

Within 1½-Mile of Breeding Wetlands

Also, where important summer, migration, and/or dispersal habitat is identified for either species beyond the 1/3 mile perimeter and if livestock grazing is permitted in these areas, retention levels should be applied to these areas. A larger proportion of boreal toads move beyond 1/3-mile than originally estimated (in the first draft of the report). While only a relatively small proportion of spotted frogs moved beyond 1/3-mile in movement studies, >50% of boreal toads moved beyond 1/3-mile from breeding sites in four studies (Bull 2006, Schmetterling and Young 2008, Bull 2009, Browne and Paszkowski 2010), making it especially important to address habitat needs of boreal toads beyond 1/3-mile of breeding sites. Most boreal toads stayed within 1½ miles of breeding sites in three studies of boreal toad movemens (Muths 2003, Bartelt et al. 2004, Browne and Paszkowski 2010), but up to 25% of boreal toads in the three other studies moved beyond 1½ miles (Bull 2006, Schmetterling and Young 2008, Bull 2009). It is, therefore, important to have a provision for addressing herbaceous retention beyond 1/3-mile and at least up to 1½ miles. This is where the recommendation of Pilliod et al. (2002) to protect groups of diverse water bodies and surrounding uplands within about 2/3-mile of spotted frog breeding ponds could be taken into consideration.

BASIS OF THE 80% (ADEQUATE AMOUNT) FIGURE

The basis of allowing as much as 20% of designated habitats/areas to be over-used is nearly exclusively to accommodate commercial livestock grazing, and this is beyond accommodations made by lowering the minimum retention level to something that would accommodate more livestock grazing. From the standpoint of spotted frogs and boreal toads, applying a minimum of 70% retention to 100% of their habitat would be most defensible. However, this is not practical from the standpoint of commercial livestock grazing operations because it is nearly impossible to avoid over-use of some areas. There is too much variability in a large variety of factors (e.g., forage preferences that vary among plant communities by season, highly variable production levels among plant communities, a wide range of distances from water, percent slope) and herding is not nearly intensive enough to expect even distribution of use across even small areas. Areas with highly favored forage will get grazed substantially more than areas with forage of lesser favorability, and inevitably. A prime example of this are moist meadow, silver sagebrush, and other plant communities in which the communities or understories have been converted to domination by nonnative bluegrasses, particularly Kentucky bluegrass (Youngblood et al. 1985, Padgett et al. 1989). An allowance for as much as 20% of moist meadow, silver sagebrush, and other types to be over-used would allow for the reality that sites dominated by nonnative bluegrasses will be grazed to >30% use of herbaceous vegetation, but only to the extent that these sites cover <20% of the area.

Holechek et al. (2011) and WAFWA (2009) recognized that over-use of vegetation is an inherent part of livestock grazing on public lands. On rangelands in general, Holechek et al. (2011) felt that it would be reasonable for public land ranchers to over-use as much as 30% of key areas. Similarly, WAFWA (2009) suggested, likely based on Holechek et al. (2011), there may be some tolerance of heavy use on as much as 30% of grazable lands. Neither of these publications specified whether this applied to lands emphasizing livestock use or other uses/resources and, therefore, is taken to apply to all lands in general regardless of emphasis. No science was provided in support of the 30% figure.

Allowing for nearly one-third of the habitat of a sensitive species to be over-used is excessive, and allowing for 20% of the habitat of a sensitive species to be over-used may also be excessive, but only allowing for 10% is getting close to not allowing for any over-use and would appear to have no practical value.

In breeding wetlands where shallow waters of a given wetland are dominated by extensive stands of relatively-tall, dense cover of emergent vegetation with few or no open patches, heavy use of emergent vegetation in a small portion of shallow waters would likely benefit spotted frogs and boreal toads by allowing the sun to increase water temperatures. However, given the large size of pastures (several thousand acres), the broad scale at which livestock are managed, and the large number and variety of negative impacts of livestock grazing, it would not be reasonable to assume that livestock grazing and trampling would be heavy enough exactly where it is needed on far less than 1 acres worth of shallow wetland habitat while also being light enough across a large majority of the rest of wetland acres not needing disturbance and across the rest of the thousands of acres.

Any use of livestock grazing and trampling to open dense stands of emergent vegetation in shallow waters of wetlands would need to be prescriptive. Prior to livestock grazing/trampling being specifically used to create and/or maintain open areas in shallow waters for the benefit of egg and tadpole development, objectives, management prescription to achieve the objectives, and design features to minimize adverse effects would need to be developed prior to implementation.

GEOGRAPHIC SCOPE OF THE 80% AREA WITHIN 1/3-MILE

The 70% retention threshold within 1/3-mile of breeding wetlands, as it is currently written, applies to 80% of the area within each of three major vegetation type groupings: (1) wetlands, wet meadow, and moist meadow types; (2) silver sagebrush and shrubby cinquefoil types; and (3) meadow-willow types. This is discussed in the last subsection, below.

The following discussions identify three options that were considered and some of the pros and cons of each.

80% within Each Plant Community Type

This was in the wording in the draft report that went out for external review. The purpose of specifying “each plant community type (wetland, wet meadow, moist meadow, silver sagebrush, shrubby cinquefoil, and willow-meadow communities)” was to ensure that the allowance for greater than 30% use of herbaceous vegetation on 20% of the area would not be concentrated in one or two vegetation types (see the explanation in the next paragraph). By allowing greater than 30% use across as much as 20% of each major vegetation type, this would ensure that any given type would not receive a majority of the over-use. This approach recognizes the different levels of importance of different vegetation types to spotted frogs and boreal toads and to cattle (Table A.6).

This is probably the best approach for wildlife as a whole since it would not allow any given vegetation type to be unduly impacted, which has the potential to impact wildlife species tied to that type. However, it is not as applicable to spotted frogs and toads because they use a broad range of habitats at different times of the summer.

This approach would be burdensome to monitor.

Table A.6. Relative importance of types of habitat to major life history phases of spotted frogs and boreal toads, and relative importance of these habitats to cattle.

Type of Habitat	**Major Life History Phases of Frogs/Toads**				**Favored Use by Cattle**
	Breeding	**Summer/ Feeding**	**Migration & Dispersal**	**Hibernation**	
Wetland	1	1	1	1	1
Wet Meadow	2	1	1	1	1
Moist Meadow	–	1	1	2 or 3	1
Meadow-Willow	–	1	1	1 or 2	1
Willow-Herb	–	1	1	1 or 2	1
Silver Sagebrush	–	2	2	3 or –	1
Shrubby Cinquefoil	–	2	2	3 or –	1
Aspen w/in 100 yards of water	–	2	2	3	2
beyond 100 yards of water	–	–	3	–	2
Open Conifer w/in 100 yards of water	–	2	2	3	3
beyond 100 yards of water	–	–	3	–	3
Big Sagebrush & Mtn. Shrubland w/in 100 yards of water	–	3	3	–	2
beyond 100 yards of water	–	–	3	–	2
Grassland & Forbland w/in 100 yards of water	–	3	3	–	2-3
beyond 100 yards of water	–	–	3	–	2-3
Closed Willow	–	–	3	–	–
Closed Conifer w/in 100 yards of water	–	–	3	–	–
beyond 100 yards of water	–	–	–	–	–

1 = Most important; core habitat (e.g., wetlands, riparian areas).
2 = Important, but used less than no. 1.
3 = Also important, but only peripherally or seasonally used.
– = Typically not used.

80% of Frog and Toad Habitat

This would allow >30% use of herbaceous vegetation to occur on 20% frog and toad habitat as a whole, regardless of the differential importance of habitats within 1/3 mile of breeding sites, which has the potential to allow the 20% to cover the entirety of one or two types of habitat (e.g., wet meadow, moist meadow). This approach is supported to some degree by the broad use of habitats by boreal toads away from wetlands and broad use of habitats by spotted frogs during migrations. However, a major downside of this approach is that it has the potential to result in the over-use of large proportions of one or two vegetation types (e.g., wet meadow, moist meadow) while herbaceous in some vegetation types remains well above 70% (e.g., in mountain big sagebrush, open conifer). Compounding this effect is that the vegetation types most likely to be over-used are the types most important to spotted frogs and boreal toads (Table A.6). As such, it would be possible for the 20% of frog and toad habitat that is over-used to encompass 100% of one or two vegetation types that are among the most important to spotted frogs and/or boreal toads.

This approach may be the easiest to monitor.

80% within Major Vegetation Type Groupings

This approach is intermediate between the two approaches outlined above. Monitoring would not be as burdensome as applying the 80% rule to each vegetation type, but it would not allow large portions or as much as 100% of key frog and toad habitat to be over-used by livestock, as could occur in the approach outlined in “80% of Frog and Toad Habitat,” above. Of most importance it would limit over-use of wetland, wet meadow, and moist meadow types to no more than 20% of the combined acreage of these types within 1/3-mile of breeding sites, and it would do the same for the meadow-willow and willow-herb types and the silver sagebrush and shrubby cinquefoil types. Each of the three groupings serves different roles in the natural history of spotted frogs and boreal toads (Table A.6). The meadow-willow/willow-herb grouping typifies willow-dominated riparian bottoms, and can include mixed riparian shrub and cottonwood types.

Groupings for the other vegetation types in Table A.6 are not specifically identified because, while it is important to retain 70% of herbaceous vegetation in these types, they are not as important as the habitats identified in the groupings and because cattle typically do not graze these as hard as those identified in the groupings.

By applying a minimum retention level of 70% of total herbaceous vegetation across at least 80% of each major vegetation type grouping (wetland/wet meadow/moist meadow; meadow-willow/willow-herb; and silver sagebrush/shrubby cinquefoil communities) within 1/3 mile of each breeding site, this would provide a reasonably high probability that livestock use would remain low enough to (1) retain a suitable level of hiding cover, protection from the sun, ground-level humidity, and temperature moderation for juvenile and adult frogs and toads in the summer-long habitat, including permanent water sources; (2) retain suitable forage, cover, and structure for a diverse insect community; (3) maintain water quality (as related to urination, defecation, and trampling) within acceptable levels; (4) maintain soil looseness and porosity, which allows for burrowing and contributes to near-ground humidity and the plant-community health; (5) minimize the potential of trampling adult and juvenile frogs and toads in and adjacent to wetlands and in migration habitat; (6) minimize the extent to which livestock break through the soil surface and cave-in burrows or crush frogs or toads in shallow burrows; (7) minimize the extent to which livestock drinking in small pools speeds the disappearance of surface water in these pools; (8) minimize impacts to streambanks where frogs or toads may otherwise use for hibernation; and (9) contribute to the following year’s residual thatch and litter which in turn contributes to hiding cover, protection from the sun, ground-level humidity, insect habitat, and the sustainability of plant communities. The retention level would also allow for small parts of the summer-long habitat to be more heavily impacted, thereby allowing for commercial livestock grazing use.

Complexity of monitoring may be midway between the previous two approaches, but may also be the easiest to monitor. Monitoring would be simplified if only the most important habitat grouping and the habitat grouping that is most susceptible to livestock grazing is monitored (i.e., wetland/wet meadow/moist meadow). It is possible that, if 70-100% retention is maintained across ≥80% of this acreage that it would be maintained in the other groupings. Site-specific considerations would need to be considered because the silver sagebrush type can be susceptible to heavy grazing.

Suitable Condition Statements

The following suitable condition statement is based on Forest Plan objectives and standards, Forest Service policy and legal requirements on sensitive species, the scientific information provided in this appendix, as well as information provided in the “A.4. Herbaceous Species Composition” section of the main report. Suitable condition statements define conditions that must be provided in order to meet portions of Objective 3.3(a), Objective 4.7(d), and the Sensitive Species Management Standard requiring that adequate amounts of suitable habitat be provided for spotted frogs and boreal toads.

1. Retain a minimum of approximately 60% of the pre-grazed herbaceous canopy cover. This is a central intent of statements 2 and 3, below.
2. Of the total herbaceous biomass produced within the area encompassed by a perimeter 10 feet beyond the high-water mark of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of the vegetated portion of the area except in wetlands in which emergent and shoreline vegetation cover less than half this area; then 70-100% is retained across ≥95% of the vegetated portion of the area.
3. Of the total herbaceous biomass produced within 1/3 mile of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of each major vegetation type grouping (wetland/wet meadow/moist meadow; meadow-willow/willow-herb; and silver sagebrush/shrubby cinquefoil communities), except where important summer habitat is identified for either species beyond the 1/3 mile perimeter and if livestock grazing is permitted in these areas, a minimum of 70% retention of herbaceous vegetation should be applied to 80% of each major vegetation type grouping within the larger area.

   This suitable condition statement generally would not apply to small patches of the identified vegetation types in wide valley bottoms where (1) dense willow communities are extensive and comprise ≥90% of the acreage, (2) willow canopy cover is at natural levels or relatively natural levels, (3) herbaceous species composition in the understories is at or near the potential species composition, and (4) extensive trail networks in willows do not exist.

   Where nonnative bluegrass species such as Kentucky bluegrass dominate plant communities and/or understories across more than 20% of any given major vegetation type grouping within 1/3-mile of a breeding site, additional measures may be needed to ensure that habitat remains suitable for spotted frogs and boreal toads while also accommodating livestock grazing in the area to the extent possible.
4. Of the total herbaceous biomass produced within 1/3 mile of known existing and historic breeding sites having capable amphibian wetland habitat, 70-100% is retained across ≥80% of the area encompassing grassland, big sagebrush, mountain shrubland, aspen, and open conifer forestland communities.

The four suitable condition statements are listed in priority order, recognizing that upland habitats are increasingly being recognized as important for restoring and sustaining amphibian populations (Skelly et al. 1999, Marsh and Trenham 2001, Pilliod et al. 2002). Attainment of suitable condition statements 2-4 would result in suitable condition statement 1 being attained.

The suitable condition statements are tied to “known existing and historic breeding sites having capable wetland habitat” because it is important to apply the objectives to existing breeding sites and potential future breeding sites, but it also needs to be recognized that applying the part of the objectives dealing with herbaceous retention across all capable habitat may be stretching the requirements for sensitive species since no determinations have been made at the BTNF level that these or similar retention levels are needed for native wildlife-communities as a whole.

Percent canopy cover of intact and relatively-intact herbaceous vegetation is one of the most important herbaceous attributes for maintaining suitable humidity retention, temperature moderation, shade and protection from the sun, hiding and escape cover, tadpole forage, and invertebrate-prey habitat. A central intent of retaining more than 70% of the annual production of herbaceous vegetation is to retain a minimum of approximately 60% of the pre-grazed herbaceous canopy cover. While percent canopy cover of intact and relatively-intact herbaceous vegetation provides a more direct reflection of herbaceous habitat conditions than measures or estimates of percent retention of annual production, it may be more difficult to accurately measure or estimate and it would have lesser application to sedge-dominated communities since cattle tend to graze sedges from the top down and not from the bottom. Also, while percent canopy cover of intact and relatively-intact herbaceous vegetation provides a rough proxy for factors such as water quality, survival as influenced by trampling, and surface water duration — since it is inversely related to livestock grazing intensity — (1) it is a more distant proxy, and (2) it applies more to grass-dominated communities than to sedge-dominated communities since cattle tend to graze sedges from the top down.

Given the relatively large reductions in biomass and canopy cover above 2 inches when herbaceous retention levels drop to 70%, it is important that parts of spotted frog and boreal toad habitat have retention levels of ≥80%. This is one reason for expressing suitable retention level as a range and not a minimum threshold.

Suitable herbaceous species composition is paramount to the identified minimum retention level of 70%. To the extent that pre-grazed herbaceous species composition (as driven by plant species composition, as well as plant vigor and soil moisture) does not approximate a natural height and density for the given site, retention levels would need to be incrementally higher than 70%.

The retention levels identified in suitable condition statements are most directly applicable to emergent marsh, wet meadow, moist meadow communities, silver sagebrush, shrubby cinquefoil, meadow-willow (meadow with low percent canopy cover of willows) communities, and short willow-herb communities. Herbaceous retention is of relatively little importance where canopy cover of moderately tall to tall willows is high (e.g., ≥80% canopy cover) because willow canopy cover retains humidity and helps moderate ground-level temperatures and, because of the lack of basking areas, these stands probably do not receive much use by spotted frogs and boreal toads. Furthermore, herbaceous vegetation is naturally limited under such willow canopies and it is very difficult for cattle to venture into stands that are this thick (i.e., herbaceous retention levels have little applicability).

The 70-100% retention level does not directly apply to moderate-height and tall willow communities or to shorter willow communities having high percent shrub canopy cover and naturally low amounts of herbaceous vegetation in their understories. However, retaining ≥70% of total herbaceous vegetation in these communities would run parallel with maintaining low enough browsing levels and low enough levels of mechanical damage of willows such that healthy willow communities would be maintained over the long term. Where willow canopy cover is high, but willow height is short and where herbaceous canopy cover is naturally high, suitable condition statement no. 2 would apply. The bottom line is that, where plant communities naturally produce high amounts of canopy cover (regardless of whether it's graminoid, forb, or willow cover) sufficient to maintain substantially higher near-ground humidity levels, substantially lower temperatures, high protection from the sun, and a high level of hiding/escape cover, ≥80% of the acreage needs to retain these qualities.

Literature Cited (see Appendix E)

Appendix B

Crosswalk from Utilization of Key Forage Species to Utilization of Total Herbaceous Vegetation

Prepared by Don DeLong, Greys River RD – BTNF

2-23-2015

Converting the percent retention of key forage species (KFS) to percent retention of total herbaceous vegetation (THV) and visa versa are straightforward, involving only three variables. Recognition, however, needs to be given to the reality that the outcome of the crosswalks is a range. The outcome is a range in both cases unless field data can be used to ascertain the composition of key forage species (as a percent of the weight of the herbaceous plant community) and the percent retention of non-key forage species at any given total retention level.

Converting percent retention of key forage species to percent retention of total herbaceous vegetation and visa versa are matters of simple mathematics. Going in either direction, there are three variables:

To Determine THV from KFS:	To Determine KFS from THV:
1. Percent retention of KFS	1. Percent retention of THV
2. Percent retention of non-KFS	2. Percent retention of non-KFS
3. Composition of key forage species in the plant community (by weight)	3. Composition of key forage species in the plant community (by weight)

Figures in the shaded cells of Tables B.1 and B.2 were calculated based on the three variables listed above, respectively, for each table.

For Table B.1, the following formula was used. The first line expresses the formula in words and the second and third lines provides an example using numbers from Table B.1. Percent composition in the formula needs to be expressed as a decimal.

% retention of THV = ((% comp. KFS)(% retention of KFS)) + (1 – comp. of KFS)(% retention of non-KFS))

% retention of THV = ((0.25)(40%)) + (1 – 0.25)(80%))

% retention of THV = 70%

For Table B.2, the following formula was used. The first line expresses the formula in words and the second and third lines provides an example using numbers from Table B.1. Percent composition in the formula needs to be expressed as a decimal.

% retention of KFS = % retention of THV – ((1 – comp. of KFS)(% retention of non-KFS)) – comp. of KFS

% retention of KFS = 70% – (1 – 0.25)(80%)) / 0.25

% retention of KFS = 40%

While Smith et al. (2007) used slightly different terms and took a slightly different approach, their report provides a published report by range professionals that describes the basic approach used in the crosswalks in this appendix.

Table B.1. Crosswalk from percent retention of key forage species to percent retention of total herbaceous vegetation. Prepared by D. DeLong, Greys River RD, 10-29-2010.

(Figures in shaded cells refer to percent retention of Total Herbaceous Vegetation)

Retention Rate of Key Forage Species	**Retention Rate of Non-Key Plant Species**	**Composition of Key Forage Species (% of Total Herbaceous Vegetation)**				
		10%	25%	50%	75%	90%
90%	100%	99%	97.50%	95%	92.50%	91%
80%	100%	**98%**	**95%**	**90%**	**85%**	**92%**
	90%	**89%**	**87.50%**	**85%**	**82.50%**	**81%**
70%	100%	**97%**	**92.50%**	**85%**	**77.50%**	**73%**
	90%	**88%**	**85%**	**80%**	**75%**	**72%**
	80%	**79%**	**77.50%**	**75%**	**72.50%**	**71%**
60%	100%	**96%**	**90%**	**80%**	**70%**	**64%**
	90%	**87%**	**82.50%**	**75%**	**67.50%**	**63%**
	80%	**78%**	**75%**	**70%**	**65%**	**62%**
	70%	**69%**	**67.50%**	**65%**	**62.50%**	**61%**
50%	90%	**86%**	**80%**	**70%**	**60%**	**54%**
	80%	**77%**	**72.50%**	**65%**	**57.50%**	**53%**
	70%	**68%**	**65%**	**60%**	**55%**	**52%**
	60%	**59%**	**57.50%**	**55%**	**52.50%**	**51%**
40%	80%	**76%**	**70%**	**60%**	**50%**	**44%**
	70%	**67%**	**62.50%**	**55%**	**47.50%**	**43%**
	60%	**58%**	**55%**	**50%**	**45%**	**42%**
	50%	**49%**	**47.50%**	**45%**	**42.50%**	**41%**
30%	70%	**66%**	**60%**	**50%**	**40%**	**34%**
	60%	**57%**	**52.50%**	**45%**	**37.50%**	**33%**
	50%	**48%**	**45%**	**40%**	**35%**	**32%**
	40%	**39%**	**37.50%**	**35%**	**32.50%**	**31%**
20%	60%	**56%**	**50%**	**40%**	**30%**	**24%**
	50%	**47%**	**42.50%**	**35%**	**27.50%**	**23%**
	40%	**38%**	**35%**	**30%**	**25%**	**22%**
	30%	**29%**	**27.50%**	**25%**	**22.50%**	**21%**

Table B.1. Crosswalk from percent retention of total herbaceous vegetation to key forage species. Prepared by D. DeLong, Greys River RD, 10-29-2010.

(Figures in shaded cells refer to percent retention of Key Forage Species)

Retention Rate of Total Herbaceous Vegetation (%)	Retention Rate of Non-Key Plant Species (%)	Composition of Key Forage Species (% Weight of Plant Community)					
		10	25	50	75	90	100
100	100	50%	80%	90%	93%	94%	95%
90	100	0%	60%	80%	87%	81%	90%
85	100	0%	40%	70%	80%	83%	85%
85	90	40%	70%	80%	83%	84%	85%
80	100	0%	20%	60%	73%	78%	80%
80	90	0%	50%	70%	77%	79%	80%
75	100	0%	0%	50%	67%	72%	75%
75	90	0%	30%	60%	70%	83%	75%
70	100	0%	0%	40%	60%	67%	70%
70	90	0%	10%	50%	63%	68%	70%
70	80	0%	40%	60%	67%	69%	70%
65	100	0%	0%	30%	53%	61%	65%
65	90	0%	0%	40%	57%	62%	65%
65	80	0%	20%	50%	60%	63%	65%
65	70	20%	50%	60%	63%	64%	65%
60	100	0%	0%	20%	47%	56%	60%
60	90	0%	0%	30%	50%	57%	60%
60	80	0%	0%	40%	53%	58%	60%
60	70	0%	30%	50%	57%	59%	60%
55	90	0%	0%	20%	43%	51%	55%
55	80	0%	0%	30%	47%	52%	55%
55	70	0%	10%	40%	50%	53%	55%
50	90	0%	0%	10%	37%	46%	50%
50	80	0%	0%	20%	40%	47%	50%
50	70	0%	0%	30%	43%	48%	50%
45	90	0%	0%	0%	30%	40%	45%
45	80	0%	0%	10%	33%	41%	45%
45	70	0%	0%	20%	37%	42%	45%
40	80	0%	0%	0%	27%	36%	40%
40	70	0%	0%	10%	30%	37%	40%
40	60	0%	0%	20%	33%	38%	40%
35	70	0%	0%	0%	28%	31%	55%
35	60	0%	0%	10%	27%	32%	55%
35	50	0%	0%	20%	30%	33%	55%
30	70	0%	0%	0%	17%	26%	30%
30	60	0%	0%	0%	20%	27%	30%
30	50	0%	0%	10%	23%	28%	30%
25	60	0%	0%	0%	13%	21%	25%
25	50	0%	0%	0%	17%	22%	25%
25	40	0%	0%	10%	20%	23%	25%

Note regarding "100%" utilization: (1) some calculations resulted in >100%, but because this is not possible, figures of >100% were revised to 100%; (2) where >100% figures were changed to 100%, the percent use of non-key species (and total herbaceous vegetation) and/or the composition of key forage species would need to be correspondingly increased to make the figures "add up"; and (3) it is not possible to achieve 100% utilization in a grazing situation.

Figure B-1 presents the crosswalk outlined in Table B.1.

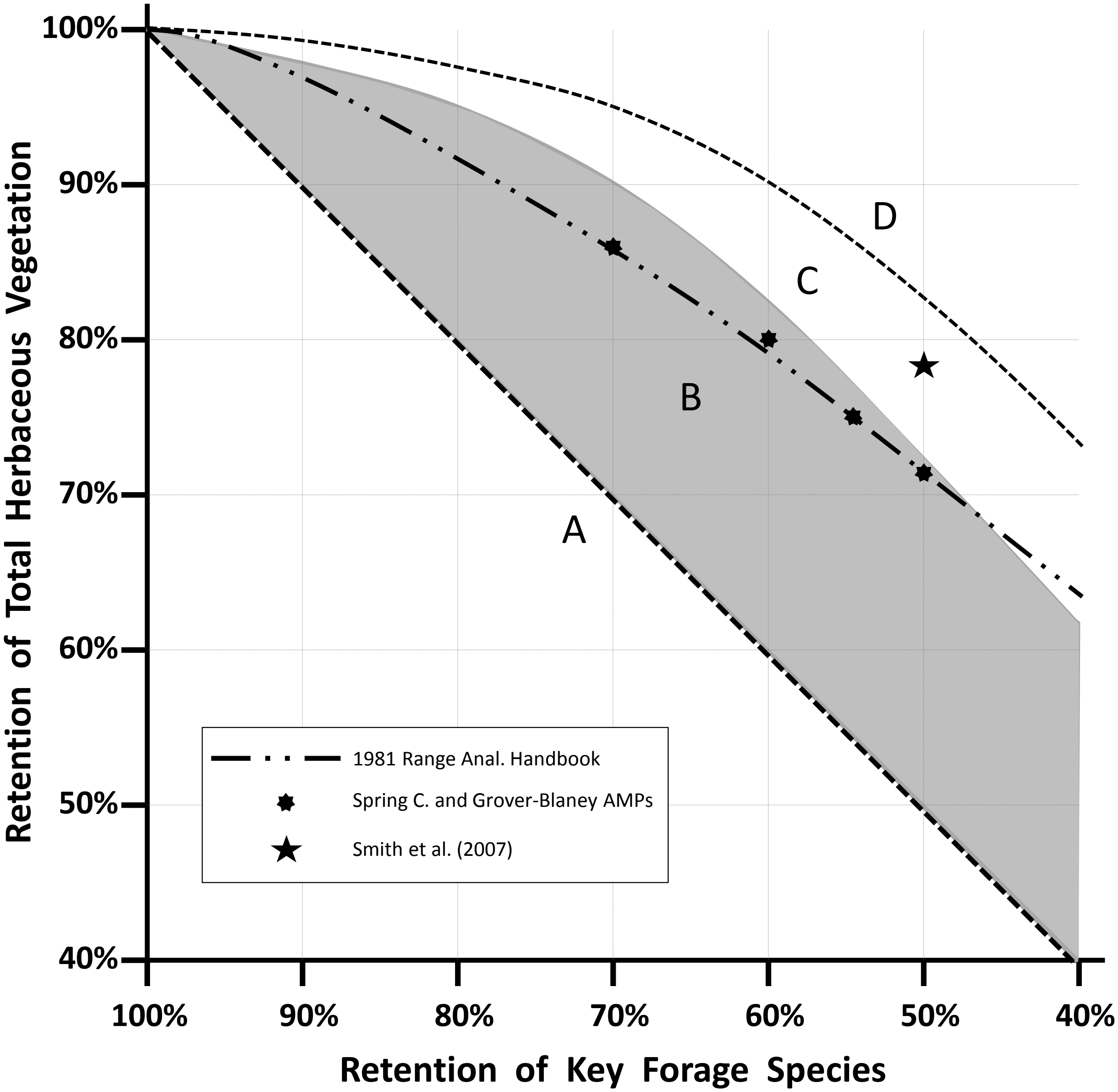


Figure B-1. Percent retention of total herbaceous vegetation at different levels of percent retention of key forage species. (A) it is not biologically possible for percent total herbaceous vegetation to be below the bottom dashed line; (B) most total herbaceous vegetation retention readings likely fall within the gray portion of the graph, with only sedge communities falling near the lower dashed line (e.g., where beaked/water sedge makes up 95% of the weight of a community and beaked and water sedge are the key forage species; (C) total herbaceous vegetation retention levels can fall above the gray area where the composition of key forage species is low (e.g., <25% and utilization of non-key forage species is substantially lower than utilization of key forage species; and (D) it would be very unlikely for percent retention of herbaceous vegetation to fall above the upper dashed line. If actual-use monitoring reveals that total herbaceous retention falls below the bottom dashed line, this would be one indication that key forage species have been improperly identified.

Table B.3 Percent retention on sedge sites relative to starting heights of the sedge site and post-grazing heights, based on Kinney and Clary (1994). Levels of percent retention are expressed as mid-points; the range for each cell can be calculated from information presented in Kinney and Clary (1994).

Starting Height of Sedges (ave. for site)

Retained Height of Sedges (ave. for site)

	36”	32”	28”	24”	20”	18”	16”	14”	12”	10”	8”	6”
36”	100%											
32”	96%	100%										
28”	92%	95%	100%									
24”	83%	88%	94%	100%								
20”	74%	78%	86%	93%	100%							
18”	70%	74%	79%	88%	96%	100%						
16”	65%	70%	75%	83%	92%	96%	100%					
14”	58%	65%	70%	76%	85%	92%	95%	100%				
12”	50%	55%	63%	70%	77%	83%	88%	94%	100%			
10”	45%	48%	54%	62%	70%	74%	78%	86%	93%	100%		
8”	40%	43%	46%	50%	60%	65%	70%	75%	83%	92%	100%	
6”	30%	34%	38%	43%	48%	50%	55%	63%	70%	77%	88%	100%
5”	25%	28%	32%	38%	43%	45%	48%	54%	62%	70%	78%	93%
4”	20%	24%	26%	30%	36%	40%	43%	46%	50%	60%	70%	83%
3”	15%	17%	20%	24%	26%	30%	34%	38%	43%	48%	55%	70%
2”	11%	13%	14%	15%	18%	20%	24%	26%	30%	36%	43%	50%
1”	5%	6%	6%	7%	10%	11%	13%	14%	15%	18%	24%	30%

Appendix C

Comparison of Herbaceous Retention to Changes in Forest Structure and Implications of 70% Herbaceous Retention to Native Wildlife Communities

9-23-2014, Don DeLong

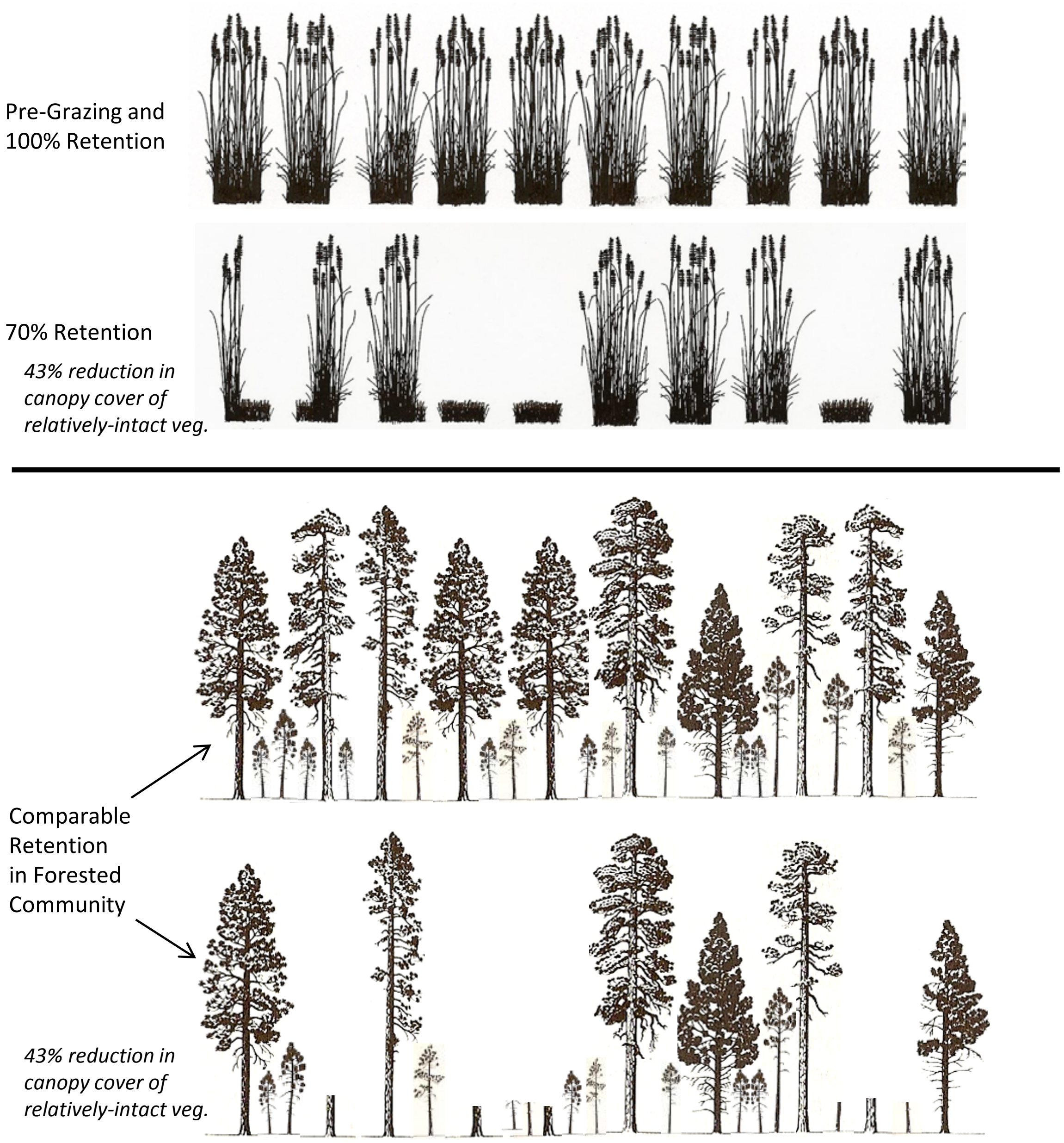


Figure C.1. Comparison of 70% retention of herbaceous vegetation in a meadow to a comparable relatively-intact canopy cover in a forested situation.

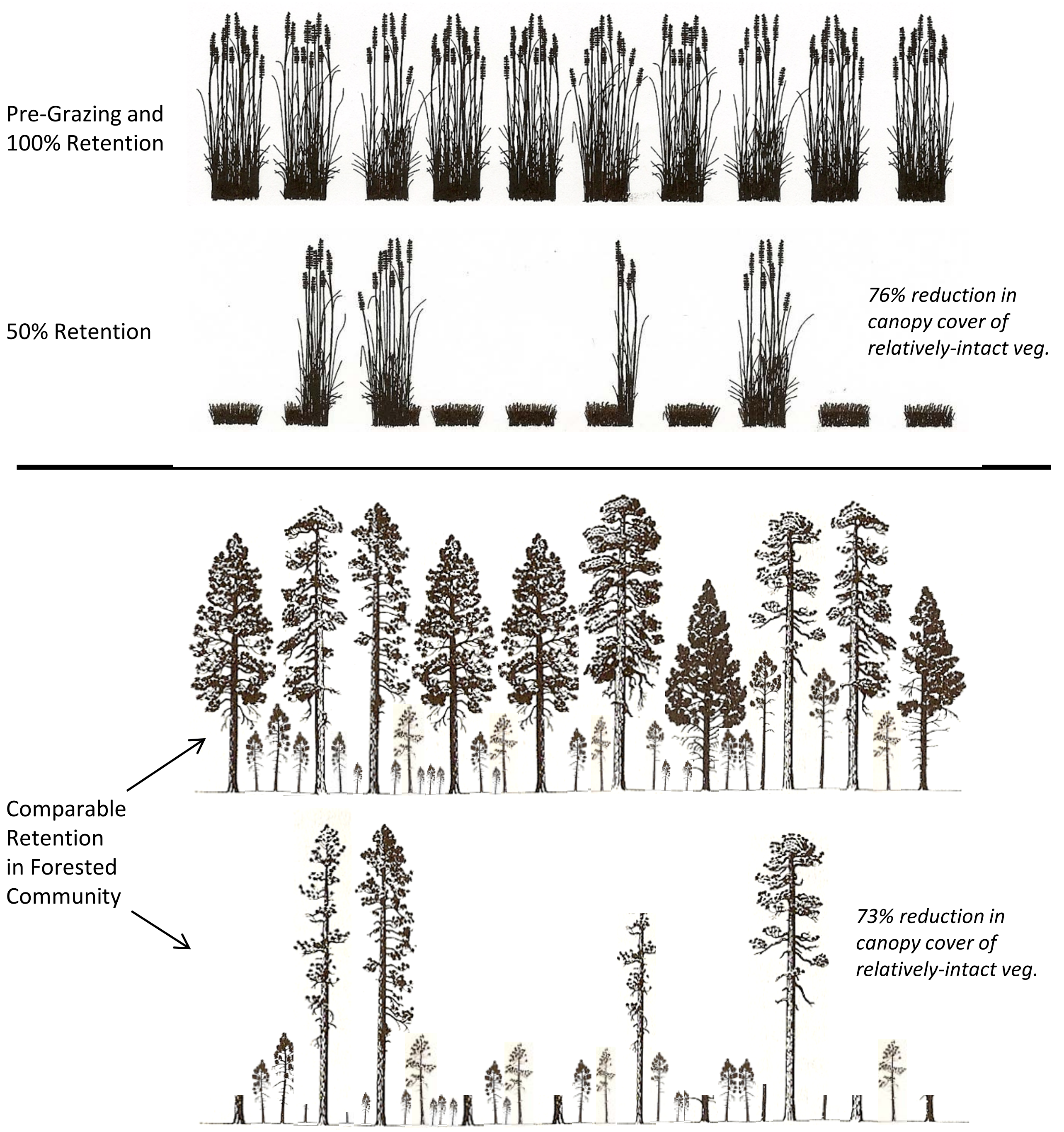


Figure C.2. Comparison of 50% retention of herbaceous vegetation in a meadow to a comparable relatively-intact canopy cover in a forested situation.

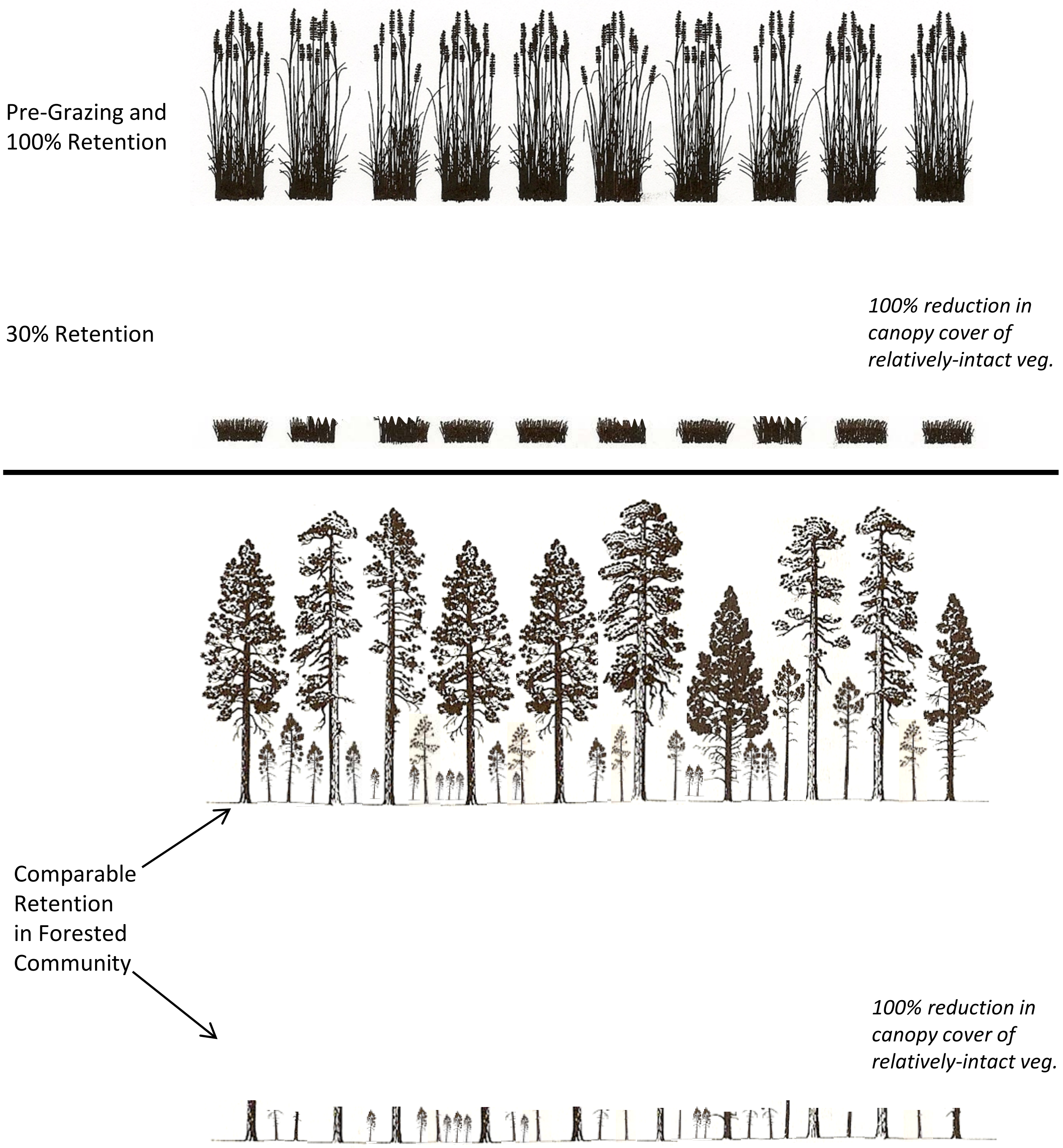


Figure C.3. Comparison of 30% retention of herbaceous vegetation in a meadow to a comparable relatively-intact canopy cover in a forested situation.

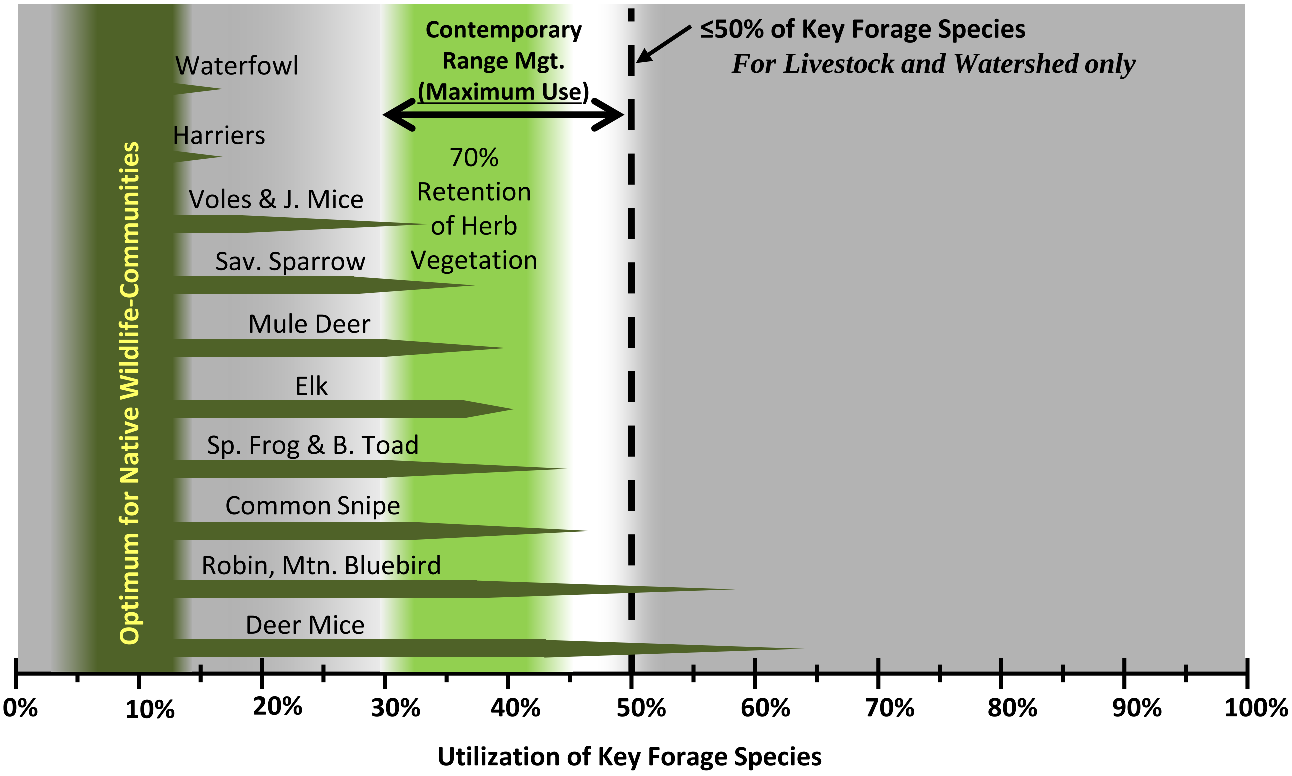


Figure C.4. Relationship of 70% retention of herbaceous vegetation to (1) contemporary range utilization limits and (2) the herbaceous retention needs of a range of other wildlife species that inhabit the BTNF (based on DeLong 2009b, DeLong 2012), indicated with pointed bars projecting from the "Optimum Conditions." The narrowing of the bars toward the left indicates either declining scientific information demonstrating suitable conditions or declining conditions.

Several points about the information in Figure C.4:

- During AMP revision, utilization limits will be prescribed that meet Forest Plan Objectives, e.g., 2.1(a), 3.3(a), 4.7(d).
- There is no need to evaluate whether utilization limits of more than 50% use of key forage species would adequately meet the needs of wildlife.
- Can we really expect there to be a such a large coincidence that a maximum of 50% use of key forage species would meet wildlife needs on BTNF when:
    - It was developed in the 1940s.
    - Wildlife needs not considered.
- Maximum 50% use level does not meet wildlife objectives 2.1(a), 3.3(a) and 4.7(d) of the Forest Plan (DeLong 2009b).

Appendix D

Responses to Comments

on the Draft Report: "Sensitive Species Objectives and Recommended Conservation Actions, and their Basis, for the Bridger-Teton National Forest"

(01-09-2013 version of the report)

Review by Amphibian Experts / Scientists

The 01-09-2013 version of the report was sent to three amphibian experts / scientists, and they all submitted review comments.

DOUG KEINATH, WYOMING NATURAL DIVERSITY DATABASE, UW

Cmt. No.	Page No.		Comment	Response
1	—		Though it can be somewhat lost in given the length and confusing organization of the documents, I think the approach that this effort takes to establishing objectives is excellent.	The report was completely reorganized based on this and similar comments from reviewers.
2	—		The section regarding dealing with limited definitive scientific data is spot on. Without spending hundreds of thousands of dollars on detailed, site specific research (which is clearly out of the question), there will never be sufficient quantitative data to set precise targets across the forest.	The section on dealing with limited scientific information was maintained in the revised report. A large amount of scientific information from a wide range of disciplines was synthesized for this report in part in recognition of the unlikelihood of several scientific studies each costing hundreds of thousands of dollars, the recognition that these projects would only provide additional information on a small number of issues, and the need to define suitable conditions now.
3	—		In this context, it is very reasonable to establish reference conditions based on what we know was appropriate habitat (i.e., natural conditions) and cautiously assess how much this can be altered before impact to amphibians might occur. In taking a precautionary view of wildlife management, I believe this is more defensible than the more common approach of basing objectives on current, often degraded, conditions. This is particularly true regarding amphibians, which are known to be highly sensitive to environmental conditions.	This provides additional support for using near-100% herbaceous retention as the starting point for the analysis of herbaceous retention levels, in particular as noted, given that amphibians are known to be "highly sensitive to environmental conditions."
4	—		On the whole, these documents do a good job of assessing the literature. In fact, this is one of the more thorough literature reviews I have ever seen on the subject of setting habitat goals for amphibian conservation. Therefore, I have very little additional information that could be used to adjust specific targets. (Dr. Estes-Zumpf has considered this and I believe is providing some comments under separate cover.)	Comment noted.
5	—		Within the framework established by this document, there can some debate on the exact levels of protection pertinent to key habitat elements, but I feel that the decisions presented are largely appropriate. Deviations from what these documents	This supports the approach used in the report (and in the new Appendix A).

			suggest would be largely based on speculation and therefore even less justified than what is presented.	
6	—		Since quantifying elements of habitat that are specifically important to amphibians can be difficult and time-consuming for land management agencies with many demands, I like the approach of tying management targets to things that are already recorded, such as retention levels of herbaceous vegetation. The target that this document recommends (70-100% retention) seems appropriate given the data at hand, which is presented throughout the report and supplementary material.	This provides additional support for using 70-100% herbaceous retention as both a habitat objective and as a proxy for protection against increased mortality due to livestock trampling, reduced water quality, accelerated desiccation of wetlands, and caving-in of shallow burrows.

DR. WENDY ESTES-ZUMPF, WYOMING NATURAL DIVERSITY DATABASE, UW

Wendy Estes-Zumpf works for the Wyoming Natural Diversity Database of the University of Wyoming.

Cmt. No.	Page No.		Comment	Response
1	—		Please commend Don for the tremendous effort he must have expended to pull this document together. This is one of the most detailed and comprehensive literature reviews of amphibians and potential threats to their populations I have ever seen. Don covers just about every threat I'm familiar with, even the ones that most people overlook because they might be controversial in light of other resources uses. The document is complete and unbiased. I really didn't have much to add in terms of scientific knowledge. Don nailed it. Actually, I'd like to keep a copy of this as a current comprehensive literature review. This document is priceless from that standpoint.	Comment noted.
2	—		Organization is the biggest challenge with this document. I feel like the objectives and suitable conditions that are of most use to USFS personnel are almost hidden in the wealth of background information. I haven't been able to find the best way to deal with this, I apologize. Reorganization is needed, but I strongly recommend retaining the background information presented in some way (even if it's as an appendix). The information is critical to understanding the objectives and suitable conditions, which I feel are very well supported by the background information.	The report was completely restructured, including putting the detailed basis of 70% was put in an appendix. The revised conservation assessment and plan will provide a summary.
3	—		My role is such that I can only comment on the strength of scientific support behind management recommendations. I do not make management recommendations. That said, given how few scientific studies have been done on amphibians due lack of financial support for these species, Don did an amazing job: 1) finding most of the literature available and 2) making logical recommendations with limited data.	Comment noted.
4	4-5		The section on "Dealing with Limited Definitive Scientific Information" is excellent and extremely relevant. There is little information on these species. They are declining all over the world, North America, and Wyoming. We are unlike to get more specific	This adds further support to the identified section.

			data in any timely manner. We need to make logical recommendations with the limited data we have. The objectives and suitable conditions are logical based on the information accumulated.	
5	3-4		The approach of assuming pre-European conditions as the baseline is also a good one, and probably the most defensible since all we really know now is that what we have now is not working. We can't work from the bottom up in a defensible manner in this system because we have no idea how much "better" we need to make the habitat to prevent further declines. Working from ideal pre-disturbance conditions is brilliant and is very defensible...since we know those conditions are good for amphibians. Well done, especially considering how difficult this task must have been.	This adds further support for the use of near-100% retention as a starting point for determining an herbaceous retention level that meets the needs of the species while also providing for some level of grazing.
6	—		Please thank Don for his tremendous effort and his innovative ideas for tackling such a difficult problem. I hope this can set a precedent for other forests trying to figure out how to manage amphibians and prevent further declines.	Comment noted.
			[[[*Start of comments and suggested changes within report.*]]]	
7	1		Reword? [in reference to "This not only requires objectives to be implemented, but it requires they be implemented."	The sentence was reworded.
8	3		Great source! Glad you used it! [in reference to the use of "Habitat Guidelines for Amphibians and Reptiles in the Northwestern United States."]	Comment noted.
9	4		This is an excellent section to state upfront since so few scientific studies have been done on amphibians. Well written and will hopefully head-off comments about "no evidence" and such. [In reference to the "Dealing with Limited Definitive Scientific Information" section.]	Agreed that this is an important section. This was addressed in Response to Comment 4, above.
10	5		Zack and I compiled years of data and extended the distribution of several Bighorn amphibians. Estes-Zumpf, W. A., Z. J. Walker, and D. A. Keinath. 2012. Status and Distribution of Amphibians in the Bighorn Mountains of Wyoming. Prepared for the Wyoming Game and Fish Department by the Wyoming Natural Diversity Database and Wyoming Game and Fish Department Aquatic Assessment Crew, WY.	The sentence was modified and the reference was cited.
11	6		Is it Species of Greatest Conservation Need (SGCN) in Wyoming? [in reference to use of the term "Species of Special Concern."]	The suggested term was used.
12	7		Excellent idea! [in reference to: "Additionally, locations of juvenile boreal toads can be treated as a proxy for 'breeding site' until a breeding site is found if there are no known existing or historic breeding sites within about 1/3 mile, and if there are no known existing or historic breeding sites within about 3 miles."]	Comment noted.
13	13		This is a great way to deal with this common problem. But this sentence is a bit confusing. It seems to be saying the same thing for both 1/3 and 3 miles. [in reference to: "Additionally, locations of juvenile boreal toads can be treated as a proxy for 'breeding site' until a breeding site is found if there are no known existing or historic breeding sites within about 1/3 mile, and if there are no known existing or historic breeding sites within about 3 miles."]	The sentence was reworded.
14	13		Agreed! Good! This is one of the biggest problems....so little work has been done in less accessible areas that the state has no idea where other breeding sites are or how rare or common they are. [in	Coming from an amphibian expert, this provides further support for the definitions.

			reference to: "If objectives were to only apply to known breeding sites and associated habitat, this could easily lead to continued declines in spotted frog and boreal toad distribution and abundance"]	
15	13		I did not review this section because I had reviewed an earlier version	Comments received from Wendy on an earlier version had been incorporated.
16	24		Yes. This is the biggest problem we face and I'm glad you point this out. Evidence suggests there are a suite of factors acting synergistically that impact amphibian populations. We are only just beginning to learn things like how the presence of small quantities of a particular herbicide or pesticide might have no discernible impact on its own, but when combined with increased stress from the presence of an invasive predator or disease…the combination is lethal. Based on this, to prevent amphibs from declining further, it might be safest to consider that all threats could be cumulative to some degree….sometimes additive, sometimes multiplicative, etc. Thus, minimizing EACH threat is essential. It's unfortunate, but it's where the data are starting to point. [All above comments are in reference to: "Some of the factors affecting habitat elements may independently have no more than negligible or minor effects, but together with a large number of risk factors have the potential to cumulatively have considerable impacts on these species. The number of factors affecting any given population of amphibians likely ranges from a small to large number and the set of factors affecting one population may be substantially different than the set affecting another population."]	This discussion was expanded by adding a section on multiple stressors and by discussion multiple stressors in different parts of the report, including the "Survival, as Affected by the Spread of Diseases" section. The importance of "minimizing EACH threat" is backed up by a large and growing body of literature.
17	25		Synergistic effects of stress from chemical and disease, as with fish and disease, or fish with chemicals…. [along with a recommendation to add "N" to the "Pesticides and Other Chemicals" column of Table 2, in row L ("Survival as Affected by Disease.]	"N" was added to this cell.
18	26		Also results in faster water flows, further reducing breeding habitat (quiet, calm waters).	The text was modified.
19	27		Agreed. Riparian habitat is critical to these species. Conserving as much as possible is probably one of the first and best things we can do for them. [in reference to discussion of suitable conditions for riparian areas.]	Comment noted.
20	29		I was confused with this. So is the Objective (A.1 in this case) the coarse-filter recommendation? [in reference to discussions of coarse-filter conditions and fine-filter adjustments.]	No. Coarse-filter conditions consist of the full extent of riparian habitat and other natural riparian conditions. Objective B.1 conditions consist of properly functioning conditions which are lower than natural conditions. The discussion of coarse-filter conditions and fine-filter adjustments was revamped to make it more clear.
21	29		I got confused. An adjustment is recommended right after you said "Therefore, there is no need to make any fine-filter adjustments…."	There is no need to make fine-filter adjustments based

			[in reference to: "A fine-filter adjustments of the approximation of natural conditions summarized above is to allow for existing legal roads and motorized trails and existing reservoirs, except where it is feasible to relocate roads and motorized trails outside of riparian areas where they currently are impacting spotted frogs or boreal toads, based on the Streamside Roads Standard."]	on the needs of spotted frogs and boreal toads. The referenced adjustment was to accommodate roads, trails, and motorized use.
22	30		Can you put page numbers next to these maybe? It took me a while to understand you were sending me to another formal objective. I thought these were sub-objectives under A.1. and was very confused. [in reference to the subsection "Other Related Objectives and their Relevance.]	Page numbers were not added. They can be found in the Table of Contents.
23	31		For both stubble height and streambank shearing you say they aren't good indicators, but have them under the section as possible recommended indicators. Confusing, and could be taken incorrectly if people just look at the underlined words and don't read the rest where it says NOT to use this method. [in reference to "should not be assessed based on stubble height" statement. [in reference to "should not be assessed based on stubble height" statement.]	They are not good indicators for frog and toad habitat, but they are good indicators of sustaining stable streambanks.
24	31		I would agree with this [in reference to: "The proportion of a streambank with signs of hoof action is directly related to the potential of streambank damage (e.g., collapsing streambanks) caused by livestock."]	Comment noted.
25	31		But you said stubble height was not a good indicator? [in reference to: "Implement minimum stubble height..."]	See response to comment 23.
26	32		This is logical, but you may want to use one of your buffer distances to make this more defensible. 200m seems too close, so maybe the 1/3mile? [in reference to: "Place all salt and mineral supplements at least ¼-mile from live streams, springs, and wetlands."]	Agreed. The mgt. action was changed to 200 yards from any stream, spring, wetland, or riparian habitat.
27	35		This could be a big help! [in reference to Objective A.2, specifically: "...all existing riparian habitat is maintained (not lost to these developments or activities) within 200 yards of existing breeding sites and known historic breeding sites having capable wetland habitat and within 1½ miles of these to the greatest extent possible."]	The suitable condition statement was revised somewhat. Other commenters recommended dropping the 200 yds.
28	35		This is logical, though will be difficult to enforce I imagine. A whole populations reproductive effort can sometimes be concentrated in one pool. If that goes dry too soon...it's a complete loss. This happens often as it is due to annual weather cycles. It would be nice to minimize any additional premature drying. Knowledge of which ponds are most important and trying to preserve at least those one would be an alternative if needed. [in reference to Objective A.2, specifically: "...and summertime declines in water levels in these breeding sites are not artificially accelerated by alterations in hydrology or direct water level reductions (e.g., due to water developments, drinking by livestock in small pools, water extraction for fire management."]	Yes, it would be difficult to enforce. This is now in "B.2. Surface-water Duration in Small Pools." Identification of wetlands susceptible to premature drying due to drinking by livestock was identified as a conservation action.
29	36		[Strikeout: "Consider closing and or re-routing roads and motorized trails currently within ~~100 feet of breeding sites, as well as those within~~ 200 yards of breeding sites."]	This change was made.
30	37		Which objective levels? [in reference to "...objective levels..." in a conservation action for livestock grazing.]	Additional detail was added.
31	46		This is possibly a big concern. See studies by Dr. Rick Relyea about	Additional material was

			impacts of Roundup and other chemicals on amphibs. He also has some scary and rather disheartening data on synergistic effects of pesticides when combined with other stressors on amphibians (particularly tadpoles). [in reference to: "Pesticide Spraying and Other Chemicals" subsection.	added, including a paper by Dr. Relyea. Even more work should go into this.
32	47		I worry a bit about this one. From my work with amphibs in the Powder River Basin, I believe WY WQ standards are only set for certain mineral and compounds, leaving a whole lot of other compounds that could impact amphibians unregulated. They also come up with standards based on lab work, completely excluding all synergistic effects of chemical stressors and ecological stressors….. Anyway, WY WQ standards should maybe be the bare minimum. You may want to add on for specific concerns. Is sedimentation regulated under this? [In reference to Objective A.3 (water quality).]	Additional scientific information was examined and a more detailed assessment was made pertaining to effects of changes in water quality on spotted frogs and boreal toads. The suitable condition statement was changed. Additional discussion was added about synergistic effects, etc.
33	48		Unless warranted? [in reference to a statement that "Water quality would not be directly monitored.]	Additional verbiage was added.
34	48		Are BMPs for herbicide/pesticide spraying in place and adequate or should they be revised based on this document? A little bit of Roundup in a pond could be devastating under certain conditions. [In reference to factors and actions that would be taken in lieu of monitoring water quality.]	Pesticides is one subject that may still be inadequately addressed.
35	50		This section is good. Beaver ponds are REALLY important for these species…for a lot of reasons. Vickie Zero, grad student at UW is researching the role of beaver ponds in maintain leopard frog populations. In drought years, the ponds become critical refugia. This could become essential under many climate change scenarios.	Comment noted.
36	53		This is a really excellent point and one not often stressed. [In reference to the following statement under Objective A.4: "To facilitate expansion of existing distribution and abundance, the objective cannot be limited to existing areas occupied by spotted frogs and boreal toads."]	This is maintained in the revised report.
37	53		Can hydrologists, fisheries, or range people record beaver activity or potential when doing site assessments? [In reference to the following in the monitoring section: "The distribution and abundance of beaver pond complexes would not be monitored."]	Additional potential monitoring was added.
38	54		Good! [In reference to conservation actions 3 and 4 in the "Occurrence and Extent of Beaver Pond Complexes" section.]	These conservation actions were maintained in the revised report.
39	129		This is an excellent statement that is backed up by the example below. [In reference to a sentence in the "Habitat Connectivity" section: "By acting as barriers to animal movements, roads reduce the amount of habitat available to some species, thereby shrinking available habitat more than the road base destroyed."]	This was maintained in the revised report.
40	129		You could even move this up so that it comes right after the statement about shrinking available habitat. [In reference to two paragraphs in the "Habitat Connectivity" section.	The suggested change was made.
41	130		This is great, and well supported by literature and examples given. [In reference to: "This highlights the importance of being certain that a new road is needed in the first place and, if it is determined to	This was maintained in the revised report.

			be worth the environmental effects, locating the road in ways that avoid barriers to amphibian movements.”]	
42	130		This is very true, but can you explain what might cause this on the forest. [In reference to: “Plant Communities with Depleted Species Composition” paragraph.]	This was maintained in the revised report. An example was added.
43	142		We may be able to help you out with planning this. WYNDD and UW just received another grant to help agencies across Wyoming develop workable and affordable monitoring plans. Zack and I will be working hard on this in 2013. So if you want to leave wording a little vague, we can work with you to get the most bang for your buck. Also...your wetland complexes might qualify as catchments, depending on how you look at it. On the MedBow NF, we use clusters of ~5 wetland sites within the same drainage as a “catchment” our catchments are only about 35ha rather than 200ha as in the Yellowstone model. [In reference to the “Population Level Monitoring” section.]	WNDD has, in fact, been taking the lead role in planning this.

ZACK WALKER, WYOMING GAME AND FISH DEPARTMENT

Zack Walker was the State Herpetologist for the Wyoming Game and Fish Department when the review was conducted.

Cmt. No.	Page No.		Comment	Response
1	—		I would first like to state that I think the document is really well done, and am impressed with all of the hard work put into this. It was long, but worth the read.	Comment noted.
2	7		Columbia Spotted Frogs in the BTNF have been shown to be infected with chytrid. I can provide infection locations if you are interested. [In reference to a sentence in the Range and Status subsection for Columbia Spotted Frogs.]	This information will be useful when compiling GIS layers for spotted frogs.
3	134		In most commenting, I am now stating that there be a 500 meter buffer applied to development. I think this has now been adopted to our standard commenting. [In reference to the “Oil, Gas, and Mineral Development” in the “Risk Factors” subsection of the Section on Reproduction and Survival as Affected by Lights and Noise.]	The subsection was modified accordingly.
4	139		New Literature is leaning that this is a natural disease, but has hybridized with exotic strains and become more virulent. I am pretty sure I have a reference for this if you are interested. [In reference to the sentence: “ ‘Little is known about the causes of the disease or the apparent inability of amphibian immune systems to respond successfully. Biologists hypothesize either that this is a new disease recently emerged (and possibly spread into new areas by human activities’.”]	Additional information was added to discussions of chitrid fungus, but references should be added on the specific topic identified in the comment.
5	139		Spotted Frogs have been found to be infected with	This information will be useful when

			chytrid within the BT. I can give you coordinates if you are interested. I think we only have a handful of records. [In reference to the sentence: " 'The disease status of Columbia spotted frogs in Wyoming needs to be determined'."]	compiling GIS layers for spotted frogs.
6	139		I think Deb Patla has records of ranavirus outbreaks in Boreal Toads along the snake river. [In reference to a sentence on ranavirus.]	This information should be obtained from Deb Patla.
7	140		It is my understanding that chytrid dies when desiccation occurs. I could look up references if needed. [In reference to: "However, it is not clear whether infection of uninfected wetlands could happen if the time span were days, weeks, or months."]	The sentence was deleted, as additional information was added to the next paragraph.
8	140		I would also state or suitable disinfectant. I have started moving from bleach to Virkon. [In reference to the identified management recommendation.]	Virkon was added as a solution for killing pathogens on equipment.

Review by the Forest Service

DALE DEITER, DISTRICT RANGER, JACKSON DISTRICT

Cmt. No.	Page No.		Comment	Response
1	cov.		Prefers a section at the front of the doc. that lists existing laws, policy, and FP requirements and how they protect against various risk factors so that we could then focus on only the significant concerns & risk factors that are not addressed --- I think this would be a good idea for all of the species.	A section was added up front that lists the main laws, executive orders, regulations, policies, and Forest Plan direction that provide direction for conserving spotted frogs and boreal toads. Instead of addressing "how they protect against various risk factors" in this up-front section, risk factors were addressed this by habitat/survival element so that they would be evaluated in the context of suitable and existing conditions.
2	cov.		Document uses too many glittering generalities, needs to be more specific to the B-T.	This appears to refer to the references to scientific literature, and it is a common critique of papers that incorporate scientific literature, especially when there is limited site-specific data available. A key role of scientific studies in natural resource management is that — even though they are conducted in a limited number of places — their results are extrapolated to other places with similar settings or settings in which results of parts of studies can be extrapolated. Science is conducted with the explicit understanding that it is far beyond reasonableness to carry out scientific research for every issue in every location where each issue occurs. That said, effort was made to explain more of what is happening on the BTNF and how scientific information applies to the situation on the BTNF. An assessment was made for each element as to the likely level to which each risk factor poses a threat

				to spotted frogs and boreal toads on the BTNF.
3	cov.		Personally I would rather commit a broad scale inventory and assessment of amphibian habitat on the B–T and compile the pop. data and risk factors from that.	A broad-scale inventory has been ongoing for the last several years by the BTNF, Wyoming Natural Diversity Database, and Wyoming Game and Fish Department, beyond the inventory completed by Patla (2000). This inventory will provide limited information on population levels and even less on risk factors. Monitoring and research to determine the relative degree to which activities pose risks to spotted frogs and boreal toads across the BTNF would cost many hundreds of thousands of dollars if not millions of dollars. And spotted frogs and boreal toads are only 2 of 18 sensitive wildlife species, along with 20 sensitive plant species and 10 MIS.
4	cov.		Wild & Scenic standards are in many cases more protective than this document and in others contradictory in recommendations in this doc. e.g., fencing not looked on favorably in W&S.	The *Snake River Headwaters Comprehensive River Management Plan* (USFS 2014) was reviewed, and few instances of standards or guidelines being more protective were found. This was mainly due to the standards and guidelines in the plan being qualitative and most of the direction being in the form of guidelines. Fencing to protect amphibians from livestock grazing would not be inconsistent with the plan's Fencing and Safe Road Crossing Guideline. Where recommended conservation actions in the revised report are less restrictive than direction in USFS (2014), direction in USFS (2014) will need to be used within Wild and Scenic areas.
5	cov.		Whole document needs soil & hydro peer review.	Getting this review would be good given the degree to which this document deals with hydrology, and soils to a more limited degree. Specialists would need to be informed that we would be looking for their review on whether all applicable laws, executive orders, and Forest Plan direction are identified; on ecological relationships (e.g., between water tables and stream channels); etc., and that we would not be looking for their review of suitable conditions for spotted frogs and boreal toads. The report as written summarizes widely published and well accepted principles of hydrology.
6	1		Without commenting on how this is written we should have only 1 intro for all species.	This is logical and there was much discussion about doing this, but it has not been done as yet.
7	2		Don is presenting his own framing of the Forest Plan, not sure whether or not he is presenting the original intent or not. [In reference to a sentence stating that Objective 3.3(a) is based on Forest Service policy requirements followed by a listing of quoted national objectives and policy for sensitive species (from FSM 2670.22.).]	Objectives and policy from FSM 2670.22 was quoted, with no interpretation provided. It is possible that Forest Plan objectives were not based on and were written to support national objectives and policy, but hopefully this is not the case. However, it is possible that current objectives and policy in FSM 2670 are outside the scope of objectives and policy that existed when the 1990 plan was completed. This section was restructured and rewritten.
8	3		We now have a planning rule.	This is correct, and language in the revised report has been changed to reflect this.

9	4		Does not appear to understand what the fine-filter approach is.	The comment did not specify why the write-up on fine-filter approach is erroneous. It appears that he thinks the fine-filter approach can be used as the “initial or overarching approach.” I used this phrase in my discussion, but the rest of the sentence explains that taking this approach — i.e., a single-species approach — “would be impractical.” This was written in trying to make a point of the impracticality of single-species management without using this term and instead referred to it as “using a fine-filter approach as the initial or overarching approach…” Changes were made to the write-up.
10	4		[Suggested deletion of entire section: “Dealing with Limited Scientific Information.”]	This section was not deleted. The two scientists that reviewed the report expressed their support for this section.
11	4		Some major concerns with some of the scientific & mathematical & policy assumptions and claims made.	No specific concerns were identified. See the next response for more.
12	5		Not so fast; this is not exactly correct on more than 1 statistical level.	The comment states that parts of paragraph 4 are incorrect, but no specifics were identified. I cited two sources, and I added additional sources. This is something we did not learn in college, and I can understand the initial concerns by someone who may not yet have been exposed to this. There have been many scientific papers and books published on this subject.
13	12		Why are existing sites identified as those that “exist during the period <u>1999</u>-present”? Why will the definition of existing sites shift in 2015 “when it will shift to a 10-year period”?	The intent was to give us time, with limited and somewhat scattered information from early in the inventory/survey period (i.e., 1999 through the early 2000s). There may be sites identified in 1999 or 2000 that wildlife crews or WNDD/WGFD have not revisited to determine whether breeding is presently occurring. By 2015 (one year was added), a 10-year period should be a wide enough window for wildlife crews to determine whether breeding is occurring at each site. This was further clarified in the definition.
14	13		Why the range? [in reference to a statement about “distances of 1/3 mile to 1½ miles will need to be evaluated”]	The discussion was revised somewhat to provide better clarification; 1/3 mile was used because large proportion of spotted frogs and boreal toads, especially juveniles, do not venture beyond 1/3 mile from breeding sites. However, they can venture beyond 1/3 mile and, where potential breeding sites are sparse, it is more important to err on the side of caution..
15	13		National Wetland Inventory should be included in this [as part of “Mapped Capable Habitat”.	“and National Wetland Inventory” was added.
16	13		Explain – aren’t you including plus ¼ mile as associated habitat? [In reference to: “If objectives were to only apply to known breeding sites and associated habitat, this could <u>easily</u> lead to continued declines in spotted frog and boreal toad distribution and abundance.”	The intent was that “associated habitat” did not include the ¼-mile buffer described in the “Mapped Capable Habitat” paragraph. Associated habitat only included habitat immediately surrounding known breeding sites (e.g., within 1/3 mile or 1½ mile, depending on the suitable condition statement). Mapped capable habitat is referenced in

				some suitable condition statements because there are many existing and historic breeding sites that are not “known” and, therefore, would otherwise not be protected. Additional explanation was added to the paragraph.
17	14		???? [in reference to the following sentence: “As a general rule, as the potential for adverse impacts increases and as the level of protection within a buffer zone declines, the width of the buffer zone must go up.”]	This sentence was somewhat redundant with the next paragraph and some of the material was added to this paragraph.
18	14		Awkward way to say this [in reference to “(1) the level of protection generally declines for many human-related activities.”]	The paragraph was reworded.
19	14		Good! Is more of a justifiable standard for aquatics, hydrology for several reasons. [*This comment refers to the entire first paragraph of “Why 100 Feet?”*]	Comment noted.
20	14		We can’t guarantee this with things like grazing esp. unless we can _____?______ [in reference to the sentence: “It is imperative to give full and complete protection to the wetland...”]	This sentence was reworded to: “Thus, of any part of their habitat, it is imperative to maintain breeding wetlands and maintain suitable conditions in breeding wetlands, which may require full and complete protection for many human-related activities.” The sentence was changed because complete and full protection may not be warranted for activities that do not alter habitat or otherwise negatively affect spotted frogs and boreal toads at breeding sites. However, Dale implied that, because we can’t guarantee complete protection from activities like grazing, complete protection is not a valid option. This is incorrect. If complete protection from activities like livestock grazing in particular situations is needed to achieve Objective 3.3(a), Objective 4.7(d), the Sensitive Species Management Standard, and higher-level direction for sensitive species, with respect to spotted frogs or boreal toads, then serious consideration would need to be given to complete protection from livestock grazing.
21	15		Missing creation of hazardous migration corridors & fragmentation.	It is agreed that these are problems created by roads, but this part of the report does not identify the actual problems caused by the listed activities and facilities.
22	16		At least on the NZ [north zone] of the B-T, I think I get decent compliance.	Comment noted. This is not true across the BTNF.
23	16		Should be clear on difference between cutting trees vs. mechanical removal.	This is a good distinction, and an attempt was made to address both throughout the report.
24	16		Depends on which habitat component you are talking about [in reference to “...habitat changes resulting from timber harvest last many decades”]	This is correct; the sentence was changed.
25	16		[Two typos on this page.]	Corrected.
26	16		Why is 600’ more practical than 100’?	The sentence was adjusted somewhat.
27	16		We have a lot of dispersed and developed site	Comment noted.

			use within 200 yards.	
28	19		The Fishlake had radio collar data for amphibs.	This is correct, and Brazier and Whelan (2004) and Goates et al. (2007) were cited in the draft report in the “Within 1½ Miles of Breeding Wetlands” section.
29	22		Wouldn’t drawing out habitat based on local site cond. be preferable to a blind buffer at this scale?	Yes in a perfect world where we have all the information we need at our fingertips for each breeding site and surrounding habitat. However, there are too many sites with differing sets of conditions. Different sites probably have different sets of conditions that interact in different ways to affect frog and toad movement patterns away from breeding sites. Additionally, for the same reasons, taking this approach would require differing widths around a given breeding site (i.e., a polygon rather than a circle). Use of standard widths for buffers is a common practice.
30	23		Why does this table only focus on allotments?	Because it was copied directly from USFS (2009). The intent is to complete a new GIS analysis for the entire forest, but this has not been done yet.
31	25		Biggest impact is from the road moreso than from the use. [In reference to Table 2.]	While habitat loss, reduced habitat connectivity, and impacts on hydrology can have substantive impacts on frogs and toads, the scientific and ecological literature also show that use of roads can add substantively to the negative effects of roads on frog and toad populations (see sections A.1, A.6, B.1, and C.1 in the new report).
32	25		[Several changes were suggested for Table 2, including adding “N” to row B under Roads/Trails, and Motorized Use, adding “n” to row B under Pesticides and Other Chemicals, adding “n/N” in row D under Reduced Distribution of Beaver Pond Complexes, and adding “n” to row F under Roads/Trails, and Motorized Use.]	These changes were made.
33	25		Based on quick review of the top third of the table, it needs interdisciplinary peer review, but otherwise I like the table.	See response to comment 5.
34	26		[suggestion to add “60-” to 65%.]	This addition was made.
35	26		They can also affect peak flows and routing of water and sediments.	A sentence was added: “Roads in riparian areas and adjacent to riparian areas can also affect peak flows and the routing of water and sediments (Satterlund and Adams 1992, Jones et al. 2000, Forman et al. 2003:177-195).”
36	26		North zone has lots [of beavers].	Other parts of the BTNF have “lots” of beavers as well.
37	27		Not always [in reference to the sentence: “The altered plant community is easy to see”].	The sentence was adjusted to reflect that altered plant communities are easy to see in many situations.
38	27		Not sure how common this is on B-T. Not much on NZ. Water tables are generally way below rutted trail [in reference to the sentence: “Down-cut trails in meadows, including horseback riding trails, hiking trails, cattle trails,	This sentence was adjusted to reflect that the identified effects only occur where down-cutting of trails is deep enough and where gradient is sufficient to facilitate water flow.

			and motorized trails have similar effects”].	
39	28		If the E’s are in the 75% column on the fish obj. that should be changed as well. E channels should be in the first column; 75% [~~un~~]stable on an E is getting trashed [in reference to Table 3].	This correction was made. The intent was for the table to match the table for the fish objective.
40	28		I believe the B-D data in addition to the B-T dataset is valuable for reference reaches.	Comment noted. No changes needed.
41	29		This is not really a fine filter [in reference to discussion under the heading “Approximation of Natural Conditions”].	This is correct. The intent of the “Approximation of Natural Conditions” subsection was to set the stage for fine-filter adjustments. The document was reorganized to make this more clear.
42	29		No FP amendment so no new standards [in reference to the phrase: “Based in part on the two standards...” “two standards” was circled].	The two standards quoted on pg. 29 were taken directly from the 1990 Forest Plan; i.e., they were not added through a Forest Plan amendment and there is no need for an amendment.
43	29		Strike “Standard” in the “Streamside Road Standard” and strike the entire Road Maintenance in Riparian Area Standard .	The Streamside Road Standard is a standard, not a guideline, or prescription, or recommendation. There is no justification for striking “standard.” No reasons were provided for striking the entire Road Maintenance in Riparian Area Standard. No changes were made to the document.
44	29		[Delete the Road Maintenance Standard]	No reasons were made for deleting this standard. It was not deleted.
45	30		Already provided elsewhere in FP and BMPs, etc. [in reference to Objective A.1, which he crossed out entirely].	There was considerable discussion, among biologists and with the Rangers, about whether objectives should or should not be included that have overlap with existing direction in the Forest Plan or with law, executive orders, regulation, or policy. Most biologists agreed that objectives were still needed if they overlapped with this direction. In fact, this falls directly in line with resource management principles. Higher-level direction in the form of laws, regulation, executive orders, regulations, and policy are stepped down to comprehensive plans like forest plans, and direct in these plans are stepped-down further to more specific direction (e.g., objectives for individual sensitive species). Objectives for sensitive species identify conditions on the ground that are needed to meet Objective 3.3(a) and other direction for sensitive species on the BTNF, regardless of whether these conditions would be produced or maintained by other management direction. Most biologists also felt that it was beneficial to have additional justification (expressed in terms of suitable conditions for sensitive species) for following existing Forest Plan direction and provisions of laws, executive orders, regulations, and policy. This would help in implementing existing direction.
46	30		Needs rewording, but this sounds perhaps more like a guide [in reference to Objective A.1, Extent of Riparian Vegetation]	This objective was reworded. Because it identifies conditions on the ground that contribute to riparian areas providing suitable habitat for spotted frogs

				and boreal toads, it fits the definition of an objective and suitable condition statement.
47	30		Varies by channel type [in reference to no. 2 in paragraph].	The wording of the sentence takes into account differences among channel types.
48	30		Natural erosion rates are not always consistent with human water quality standards [in reference to no. 3 in the paragraph].	The following phrase was added to the end of the sentence: “beyond the range of natural variability.”
49	30		“and aspen.”	No changes made since the scope of the paragraph is limited to riparian zones.
50	30		~~anyhow~~	N/A since this paragraph has been deleted.
51	30		I am not convinced this is pervasive on the B-T.	The sentence did not state that it is pervasive on the BTNF, but it recognizes that it occurs. Supporting citations were added.
52	30		Need work & not convinced all are needed given existing FP standards & guidelines.	“Objectives” were changed to “suitable conditions statements.” Suitable conditions need to be defined regardless of whether they are addressed in Forest Plan standards and guidelines. Also, by identifying suitable conditions (or objectives), it stresses the importance of attaining these conditions.
53	30		How measured, not convinced this is systemic [in reference to statement about some riparian zones being impacted by roads, parking areas, and dispersed camping areas].	The most simple unit of measure is acres, and this can readily measured on the ground and using GIS. Some narrow riparian zones on the BTNF are dominated by roads and even in wider riparian zones, roads have eliminated substantive proportions of riparian habitat and some have likely altered hydrology thereby causing further reductions. This is addressed, with supporting references, in the report.
54	30		How measured? [in reference to natural herbaceous species composition].	This is being measured on the BTNF using line point intercept to measure canopy cover, ocular estimations of canopy cover, among other methods.
55	30		Not necessarily – oversimplified; can also cause deposition & agrading [in reference to eroded sediment from upland areas contributing to scouring of stream channels].	The sentence was modified to reflect this.
56	30		How measured? [in reference to natural herbaceous species composition].	See responses to the two comments above.
57	30		Not sure this is limiting or needed for the B-T [in reference to the Forage Improvement Standard and Watershed Restoration Standard].	It is well recognized that a majority of rangeland acres on parts of the BTNF (e.g., forblands in the Wyoming Range) are in less-than-satisfactory condition (e.g., USFS 1997, USFS 2004a, USFS 2004b).
58	31		Not consistently [in reference to measuring streambank stability].	Although streambank stability is not being measured consistently, there is no reason to change the text. This can be said of most the monitoring that is done on the BTNF.
59	31		What are we measuring? [in reference to stream channel integrity].	Several “indicators” in multiple indicator monitoring (MIM) are used to assess stream channel integrity.
60	31		Not sure what saying here... or here [in reference to use of stubble heights as an indicator and use of streambank shearing as an indicator].	The discussion was expanded to help clarify.
61	31		When you have these conditions, you fix them	Yes, this would be preferable.

			and move on rather than __?__t back and monitor them [in reference to monitoring down-cut trails and head-cuts in meadows].	
62	31		Annual indicator – but why mention if already in Forest Plan? [in reference monitoring streambank shearing].	It is not in the Forest Plan. Even if it was in the Forest Plan, this is a component of managing livestock grazing in ways that allow Forest Plan objectives and standards for sensitive species to be achieved with respect to spotted frogs and boreal toads. Also, given the track record of implementing standards and guidelines in the Forest Plan dealing with livestock grazing, merely having requirements in the Forest Plan is not enough.
63	32		Rather than specify the actions specify the desired condition you would like mgt. to achieve [in reference to conservation actions related to controls over grazing management].	The section is titled “Conservation Actions,” the purpose of which is to outline management actions that can be implemented to achieve the objective (i.e. desired condition). Also, a comment on the objective (Objective A.1) was that it sounded more like a guide, and a guide is more of an action to achieve an objective (e.g., see discussion in the ROD for the Forest Plan EIS). In effect this comment is asking desired conditions to be defined rather than identifying management actions to meet them, but other comments question the identification of desired conditions.
64	32		Do we have much of this? First fix __?__s to stop causal mechanisms [in reference to erosion of cattle trails and head-cuts in meadows].	Yes, in places (e.g., quite a few on Little Greys allotment, also on Big Greys, Spring Creek; and I’ve seen some on the Kemmerer RD). Yes, the first action is to stop the causal mechanism. Additional information was added to the statement to clarify this.
65	32		Is this a fifth buffer area??? [in reference to “Wetland, Stream, and Riparian Habitat Retention].	No. The buffer zones in the “Buffer Zones and Levels of Protection” section can be variously applied to this section.
66	32		Maybe semantics -- might be on every district but don’t agree it is extensive [in reference to “wide range of locations” of roads being “placed over the top of a wetland or part of a riparian area”].	Roads constructed through wetlands may not be extensive, but the main place where roads have been constructed throughout the BTNF (where roads have been constructed) is in and adjacent to riparian areas. This has occurred “in a wide range of locations on the BTNF.”
67	32		Our roads budget doesn’t support much of this [in reference to effects of widening and straightening roads].	The relevance of this comment is unclear. If the point is that little widening and straightening of roads occurs on the BTNF due to limited budgets, this does not account for special funds that have resulted in major widening/straightening projects (e.g., 35 miles of the Greys River Road) and road-work associated with timber harvest (e.g., Hams Fork, LaBarge). Incremental increases can, over the long term, has the potential to cause major impacts.
68	32		Maybe it would be better to collapse all of these mgt. buffer areas in a “200 yard buffer of all riparian areas and wetlands” [in reference to the list of risk factors on pages 32-33]	The intent of the comment is unclear. The referenced section outlines risk factors that have the potential to cause the loss of wetland and riparian habitat, and does not address buffer zones.
69	33		On D4 [Jackson District], we have been actively relocating these trails some distance... have	Comment noted.

			more than others [in reference to braided ATV trails in wet areas].	
70	33		Not really building roads any more [in reference to discussion of altered hydrology resulting from placement of roads and other facilities].	Roads continue to be proposed with timber sales and mechanical treatment projects, including construction of roads on top of user-created two-track roads. Re-routing of sections of roads also is a possibility on the BTNF. Additional explanation was added.
71	33		How many on B-T & where? D4 [Jackson District] has none that I can think of [in reference to reservoirs on the BTNF].	There are at least 6 on the Pinedale RD (these are large reservoirs), 4 on the Greys River RD, and 1 on the Big Piney RD.
72	34		All of these needs hydro peer review [in reference to risk factors related to loss of habitat to reservoirs and sedimentation issues, as related to the loss and alteration of riparian and wetland habitat].	Input from hydrologists was not received, but the assessment was limited to documenting basic ecological principles and what was found in the literature.
73	34		GV [Gros Ventre watershed] has a lot of natural areas <60% cover due to soils [in reference to discussion on ground cover and effects on elevated sedimentation rates in wetlands].	And there are other parts of the BTNF in which ground cover is naturally <60%. The following sentence was added: “It is recognized that some sites naturally have <60% ground cover.”
74	34		This often is a natural impact I would not suggest interfering __?__ fire as a process [in reference to discussion of sedimentation of wetlands from burned and logged areas].	No reference was made to interfering with it; this paragraph merely identified the potential effects.
75	34		[Suggestion to replace “which this may have happened” with “this is occurring” on the BTNF.]	The sentence was adjusted.
76	34		Careful here, big supposition [in reference to statement about sedimentation from roads being the largest contributor of sedimentation on a given landscape].	The sentence begins with “It is not uncommon for…” and the following sentence reads “It is unclear the extent to which this may have happened on the BTNF.” The two cited references cite several supporting references.
77	34		[Suggestion to replace “may have happened” with “is occurring”].	This change was made.
78	34		Not really helpful, provided we follow State & National BMPs we are likely OK [in reference to fine-filter adjustments].	Yes, “provided we follow” them. Again, just because there are requirements for non-amphibian reasons does not mean we should not line out conservation actions that would contribute to restoring and/or maintaining amphibian habitat.
79	35		We already have plenty of laws and standards in FP that protect riparian and wetlands [in reference to Objective A.2 in the draft document].	No disagreements, but as with defining desired or suitable conditions for other resources (e.g., streambank stability in allotment management plans), having management direction in the Forest Plan does not provide a reason for desired or suitable conditions to be defined. Furthermore, it is this management direction (e.g., laws and Forest Plan standards) upon which desired conditions and suitable conditions are based.
80	35		Not doable [in reference to Objective A.2 calling for water level declines in breeding sites not be artificially accelerated].	The statement was modified to avoid an absolute statement about water-level declines not be artificially accelerated. This is now in suitable condition statement B.2.
81	35		[Suggestion to delete the entirety of Objective	This was not done, although it was rewritten.

			A.2.]	
82	35		Therefore no need for a new objective [in reference to the desired condition of retaining all capable wetlands being consistent with current laws, policy, and Forest Plan direction].	This comment is flawed because statements of desired and suitable conditions (including objectives) are founded upon laws, policy, and Forest Plan direction; i.e., desired or suitable conditions that are inconsistent with laws, policy, and Forest Plan direction are not supportable. A phrase was added to emphasize that consistency with laws, policy, and Forest Plan direction is a precursor to the definition of any statement of suitable conditions and habitat objectives.
83	35		Confusing; not clear [in reference to explanation under Objective A.2].	It is not clear which part(s) of the paragraph was not deemed clear.
84	35		Haven't read about B.2 yet so too early to relate -- should do it once as a summary for whole doc. and get rid of things that are overly redundant [in reference to the "Other Related Objectives and their Relevance" subsection].	Comment noted. This is a technical document; for readers that do not wish to read certain parts, they can go directly to the places that pertain to whatever it is they are dealing with at the time.
85	35		Many areas are not capable of having >60% herbaceous ground cover [in reference to discussion of excessive sediments going to wetlands, etc.].	No reference is made to "herbaceous" ground cover. Ground cover, in the context of the discussion includes all ground cover, including basal shrub cover, litter, and rocks. As pointed out in an earlier response, it is recognized there are other parts of the BTNF in which ground cover is naturally <60%.
86	36		We should shoot for 0 [zero] loss [in reference to acres of direct loss of riparian and wetland habitat].	This would be best for amphibians, but may not be practical.
87	36		[Suggestion to delete the two indicators for riparian habitat retention and loss.]	This suggestion was not taken.
88	37		Why in camping already above [in reference to a statement about "oil, gas, and mineral development" in the "Camping" subsection].	The statement was corrected by referring to camping.
89	37		Often occurs naturally [in reference to statement about objective levels of ground cover].	See three comments above. Also, a phrase was added: "…if it can be demonstrated that low ground cover levels are natural…"
90	37		Only loosely correlated [in reference to "70% of herbaceous vegetation" and "amount of drinking by livestock"].	This is correct. An alternative would be to monitor water levels in breeding wetlands.
91	37		We will never have sufficient spatially explicit data to do this [in reference to maintaining ≥70% herbaceous vegetation across ≥80% of the area in breeding sites].	Spatially explicit data (GIS data?) is not needed and would not be appropriate for this use since this is an annual, actual-use measure. An adjusted form of the landscape appearance method (BLM et al. 2008) would provide the needed information. This is described in the report.
92	37		Rx fire usually have more choices [in reference to "Avoid, to the greatest extent possible, drawing water from breeding sites..."].	This supports the recommended conservation action.
93	37		We only pull water for firefighting by definition when fighting fires -- if we know of a breeding site and have other options, we may use them, but this also has to be informed by safety and risk mgt. [in reference to "Avoid, to the greatest	This supports the recommended conservation action. Note the beginning of the sentence: "…to the greatest extent possible…"

			extent possible, drawing water from breeding sites...”].	
94	39		Not quite right... and... not sure of the difference here [in reference to “vertical down-cutting or lateral down-cutting of stream channels”]	The sentence was adjusted accordingly.
95	39		Depends on geology [in reference to discharge rates of springs being reduced by increases in conifer canopy cover].	The paragraph was modified to recognize this.
96	39		Volume more a function of total input -- do you mean peak flows? [in reference to “Conversion of late-seral forestland and disclimax rangelands to early-seral communities...” having the “...potential to increase the volume of water in streams...”].	While major reduction in conifer cover can — where conifer cover is reducing spring discharges — increase peak flows, it can also increase overall flow volumes at other times during summer and fall. The citations from the previous paragraph were added.
97	39		[Suggestion to replace “likely is” with “may be”; in reference to livestock drinking affecting water-level declines in small breeding pools on the BTNF].	There is sufficient information — presented in the report — demonstrating it “likely” happens on “some” of the “smaller” breeding pools on the BTNF.
98	39		__?__nocise of __?__cards with assumption on top of assumption [in response to calculations demonstrating that drinking by livestock has a likelihood of affecting water-level declines on the BTNF].	The paragraph presents a hypothetical example based on an aerial extent and depth in the ballpark of what can be found on the BTNF, along with published evapotranspiration rates and the amount of water typically used by cattle. The comment did not identify any specific concerns.
99	40		Are there more than 1 H_2O souirces in this area?... and ... Doesn’t’ help; characterize conditions on the Forest [in reference to descriptions of wetlands in the Little Greys watershed].	Yes, there are other water sources, including two small stream channels (about 0.25 miles or more away). A sentence was added (now in Appendix A).
100	40		[Suggestion to replace “means” with “could mean.”	The suggested change was made.
101	40		[addition of] “, elk, wolves,....” [in reference to drinking by native animals that hastened the decline of water in small pools].	Elk was not added because there likely are more elk today than prior to Euro-American settlement.
102	40		Seems like if the impacts from this are so great, the 100+ years of past grazing would have already “removed” breeding sites and that the pops today would be somewhat “normalized” with ongoing grazing, climate change excluded i.e., marginal impact ___?___.... [in reference to discussion of suitable conditions with respect to effects of water-level declines].	Nowhere in the discussion did it come close to concluding that breeding wetlands would be removed or eliminated. This comment appears to be the result of someone displeased with assessing a given factor with potential to impact frogs and toads and then carrying it to the extreme. This is like arguing that if livestock really had an impact on riparian areas in the West, we wouldn’t have any riparian areas left. This is not helpful. Effects of drinking by livestock grazing on water-level declines is not something that can be normalized because it does not result in permanent changes to wetlands and is not something to which populations can become accustomed.
103	41		Best defense against climate change as it maintains filter and sponge functionality [in reference to stream channels being at properly functioning condition].	It appears that the comments is stating that the “Best defense against climate change…” is maintaining “stream channels being at properly functioning condition,” but this is not clear.

104	41		How did you get to focusing on livestock only? [in reference to adjusting the coarse-filter approach to accommodate livestock grazing use].	The focus was not on livestock grazing, as the first of two factors involved stream channels being maintained at proper functioning condition. While this involves livestock grazing, it did not specify livestock in the paragraph and the report earlier identified other factors (e.g., roads) that affect this.
105	43		Water quality is dependent on a lot more than grazing [in reference to the water quality discussion under the subheading of “Livestock Grazing”].	This is correct, and this subsection is 1 of 8 subsections.
106	43		[Suggestion to replace “are” with “can be.”]	The change was made.
107	43		I believe most are not in terms of plurality [in reference to the statement that “Given the locations and conditions of roads on the BTNF, sedimentation from roads likely is an issue in some wetlands used by spotted frogs and boreal toads on the forest”].	The referenced sentence did not state that sediments is an issue for most roads.
108	43		North zone overall decline w/ travel plan implementation [in reference to sedimentation stemming from roads].	This was incorporated into the text.
109	44		I have done a lot of this type of WQ monitoring; it is less of a concern than you might think [in reference to reductions in water quality due to contaminants from vehicles].	This was incorporated into the text.
110	44		Not used any more [in reference to creosote].	A reference to this effect was added to the text.
111	45		Should reference the requirements of the Retardant EIS.	References were added to the revised report.
112	45		& national FS BMPs [in reference to best management practices for water quality and timber harvest].	This was added.
113	46		[Suggestion to replace “likely a” with “could be a,” and addition of “potential”.]	This change was made.
114	46		Should reference the Forest Weed EA/EIS.	Yes.
115	46		How often do we have breeding sites in or near feedgrounds – need to make sure Alkali effect analysis and this analysis are 1. correct and 2. consistent.[in reference to discussion of potential effects of elk feedgrounds on water quality] (pg. 46).	The referenced paragraph in the report only identified unnatural concentrations of elk at feedgrounds as potentially affecting water quality.
116	47		[Suggestion to strike Objective A.3 for water quality because it is...] redundant with existing laws and FP standards.	As explained elsewhere, this comment is flawed because statements of desired and suitable conditions (including objectives) are founded upon laws, policy, and Forest Plan direction; i.e., desired or suitable conditions that are inconsistent with laws, policy, and Forest Plan direction are not supportable. A phrase was added to emphasize that consistency with laws, policy, and Forest Plan direction is a precursor to the definition of any statement of suitable conditions and habitat objectives.
117	48		Which methodology? [in reference to “Stream Channel Integrity” as a currently monitored element].	MIM.

118	49		Can’t see these are mentioned in A.1 [in reference to stubble height standards].	With respect to Objective A.1, minimum stubble heights were discussed on page 31. The discussion in the conservation actions section was expanded.
119	49		Need to discuss [in reference to livestock grazing conservation actions].	No reason was given for additional discussion.
120	49		300 feet should be more than enough for WQ [with respect to livestock carcasses].	No rationale was provided for changing it to 300 feet.
121	49		Not used any more [in reference to conservation action for the use of creosote].	This was added to text.
122	49		[Suggestion to replace “Fire Fighting, Fire Use Fire, Prescribed Burning” with “Wildfire & Prescribed Fire Mgt.” in heading of subsection.]	No rationale was provided for this suggested change. No changes made.
123	49		National Retardant EIS requirements are more restrictive… under “Retardence Avoidance Areas” [in reference to discussion on avoiding aerial retardants within 100 feet of breeding wetlands].	The buffer was changed to reflect conservation measures in the Record of Decision.
124	50		Again, not sure all of these are useful given that many are already cover by law, policy, or other FP requirements [in reference to conservation actions relevant to protecting water quality].	As discussed previously, biologists discussed this several times and we feel it is important to identify them specific to the conservation of sensitive species.
125	50		Not sure it covers everywhere all the time, which order? [in refernce to special order prohibiting camping within 100 feet of streams].	This needs to be ascertained.
126	50		Can’t enforce [in reference to prohibiting human waste within 100 ft. of wetlands and streams].	While it may be difficult to enforce, there may different options to consider (e.g., it may be possible to place provisions in special-use permits).
127	50		Would rather not say it is something we even consider allowing and try to manage use at >100’ and NPDS permits [in reference to wastewater from kitchens and water facilities].	It’s not clear what is being recommended.
128	50		Coord w/ Counties & APHIS [in reference to conservation actions related to pesticide application].	A new conservation action was added.
129	52		We can also work with them and NGOs on reintroduction. D4 [Jackson District] works with Wyoming Wetland Society on reintroductions [in reference to current beaver trapping discussion].	A new conservation action was added.
130	52		Too subjective and supposition [in reference to assessment that beaver distribution has become more restrictive due to greatly expanded fire return intervals].	In restructuring the document, this discussion was removed. However, it is addressed elsewhere and is references are cited in support of it.
131	53		Awkward wording [in reference to Objective A.4, Occurrence and Extent of Beaver Ponds].	The wording was modified.
132	53		You can do comparisons with historical photographs [in reference to discussion monitoring elements with respect to beaver distribution].	This was added to the discussion.
133	53		Not necessarily, we have a say in reintroductions and if and how control actions are taken [in reference to managing beaver	The text was modified.

			trapping].	
134	54		Avoid overgrazing induced bathtub rings of willow/aspen in riparian [in reference to conservation actions].	This comment is unclear.
135	54		FP req. FS to work coop. w/ WGFD on quotas.	This was added to conservation actions.
136	54		[Recommend striking:] "~~The 70% retention of all herbaceous vegetation identified in Objectives B.1 and B.2 should readily provide for the needs of beavers, recognizing this high of retention levels in the vicinity of beaver pond complexes likely is not necessary~~."	The sentence was clarified.
137	54		These areas usually do not burn -- rather than specific # years for rest, specify desired condition such as terminal leader above the reach of moose [in reference to conservation action of at least two years of rest after fire].	While some of these do not tend to burn in most situations, post-fire rest is important. With respect to identifying desired conditions and not the action, this is in a "Conservation Actions" section. Also, in this case, desired conditions would not suffice because, by the time desired conditions are achieved or not achieved, the period when a burned area could be rested will have passed.
138	54		Already in FP [in reference to working with WGFD to keep elk from increasing beyond objective levels, etc.].	This has been addressed several times in response to previous comments.
139	54		2?s is stream in right place, is road in right place -- can engineering solutions be implemented that would reduce or prevent road conflict? Relocate roads and trails when within valley ?______.	This information was incorporated.
140	55		Not sure we want to adopt this concept -- not really in favor any more [in reference to range of natural variability].	This comment is not correct. The 2012 Planning Rule's focus on coarse-filter approach, which overlaps substantially with concept of range of natural variability, strongly indicates it is still in favor.
141	55		Talk to Kerry on this re: the owl work [in reference to figures in Table 4, mix of succession stages from Landfire].	Biologists on the BTNF have discussed this issue.
142	55		Kerry had a different conclusion possibly [in reference to "Late-seral communities are overrepresented in most parts of the BTNF (USFS 1997). For example, ≥90-95% of forestland on the Greys River Ranger District is in a late stage of succession (USFS 2004a, Loosen et al. 2009), compared to 65-70% for most forested biophysical settings (Table 4)."]	This general assessment is based on the cited information.
143	57		Not if it burns more extensively and severely on the landscape as a result [in reference to overrepresentation of late-seral forestland having positive effects on water quality].	Additional information was added.
144	63		With our spotting impact [of roads] likely is minor in the bigger scheme of things [in reference to roads providing a fire break].	The sentence was modified to incorporate this information.
145	65		10,000 years ago completely scoured by glaciers in many areas so HRV is 0% to 100% [in reference to conditions under which amphibian	This comment is inconsistent with assessing conditions under which native wildlife-communities developed, e.g., as per the 2012

			communities formed].	Planning Rule.
146	65		Not HRV for Teton NF based on 1896 survey that stated 20K acres of commercial timber on TNF (Forest Reserve) [in reference to 60-70% of forestland being in late succession when in relatively natural condition].	A footnote was added in recognition of this.
147	66		Too high if have fuels concerns [in reference to a minimum of 10-15 tons/acre of coarse woody material for amphibians].	Whether there are fuels concerns is separate and apart from identifying habitat needs of amphibians.
148	66		Many acres don't have this capability [in reference to 60-70% of forestland in late succession within 1.5 miles of breeding sites].	The basis for this is unclear. It is unclear how forestland does not have the capability for 60-70% of the acreage to be maintained in late succession.
149	66		See existing law, policy, FP req. [in reference to description of suitable conditions on page 66].	No inconsistencies with existing law, policy, and Forest Plan requirements were found.
150	67		Not implementable as written and not sure desirable given that Landfire is a fuzzy dataset w/ unproven assumptions [<u>and</u> the entire Objective A.5, mix of succession stages was struck out]. Need to talk to fire; silviculture for peer review.	No specifics were identified as to why the objective was thought to not be implementable and no reasons were given. No reasons were given to back up the opinion that Landfire is a "fuzzy" dataset, and no faulty assumptions were identified. A large number and variety of experts were involved in the process of developing Landfire estimates of fire return intervals and mix of succession stages. No other alternatives to Landfire were offered, and this appears to be the best available science for the BTNF. While some of the percentages of are somewhat different, they are very similar to published percentages (i.e., if other sources were used, the general theme would be the same. Thus far, fire and silviculturalists — on other projects — have not expressed any substantive concerns about using Landfire and the fire program on the BTNF is actively using Landfire.
151	68		Allow for nat. dist. processes to occur as unimpeded as possible as poss. incl. wind, fire, flood... [in reference to conservation actions to limit fire, timber harvest, and mechanical treatment near breeding sites].	While there is some support for allowing fire near breeding sites, as outlined in the report, concern has been expressed by some experts and the conservation actions deferred to a cautious approach. No scientific or technical support was identified for the comment. The highlighted conservation actions in the report did not address wind or flooding.
152	69		If they even exist to that degree [in reference to retaining a minimum of 20 live and/or standing dead trees].	A qualifier was added to this effect.
153	69		Would like a broader Forest perspective since this is a Forest-wide doc. [in reference to findings from Yellowstone National Park (that sedges are prevalent in breeding wetlands) being consistent with findings on the Greys River and Kemmerer Ranger Districts].	Attempts will be made to track down information from other parts of the BTNF.
154	70		How much of this is really happening on the B-T? [in reference to impacts of recreation on vegetation in riparian areas].	In some places, impacts of dispersed camping and associated motorized-vehicle use can be a substantive contributor to vegetation impacts in riparian zones.

155	71		Bode needs to review. We have two local studies of veg. impacts from feedgrounds. would be better to use those than import literature from elsewhere as primary source [in reference to discussion of impacts of concentrated elk on vegetation]	None of the cited material was “imported.” All are from the Jackson area. The two referenced studies were added.
156	72		Need recreation to peer review. Not convinced use is expanding. Most suitable sites occupied and used for decades [in reference to statement about continual expansion of dispersed camping sites].	This may be the case on the Jackson Ranger District, but at recreation has continued to expand on some of the other districts. Signs include new camping sites being established and established sites growing in size.
157	75		I don’t think you can make the argument they are directly proportional in every case [in reference to mortality of frogs/toads being proportional to the level of use by livestock].	Additional scientific information was added to this discussion (now in Appendix A).
158	79		Not clear what the table is showing [in reference to Table 5].	Additional explanation was added to the text.
159	84		You are assuming 100% is natural [in reference to habitat needs of frogs/toads being best met by approximating natural vegetation conditions].	This is not correct; it was not assumed that 100% is natural. Additional information was added to Appendix A on this topic.
160	85		Natural conditions are 0 to 100% [in reference to a paragraph supporting the assessment that there is no scientific information showing that approximation of natural conditions would not adequately meet the needs of frogs and toads].	Yes, but this sidesteps the reality that very, very little spotted frog and boreal toad habitat on the BTNF was close to 0% retention and most was close to 100% (as measured by standard techniques).
161	86		It is my understanding there were fewer moose [in reference to discussion of grazing by native ungulates in most amphibian habitat not being substantively higher than it was prior to Euro-American settlement].	This is consistent with the cited report (DeLong 2009b), and additional information was added from the cited report.
162	87		Stubble heights are simpler [in reference to the inference that minimum percent retention is simpler than using minimum stubble height].	This is correct. The text was revised.
163	87		70% retention is absolute # even though is relative f__?__ ____?___ growth.	It is not an absolute measure in the context of the discussion since it is a proportion of what is produced. It is more forgiving in that it allows a proportion to be removed regardless of how little is produced in a given year, which can be to the detriment to amphibians and other wildlife.
164	88		The Fishlake maintained amphibians even though utilization was 70-95% so grazing doesn’t lead to full extinction of amphibs [in reference to “≥70% Retention of Total Herbaceous Vegetation” section].	Comment noted.
165	110		Not implementable [in reference to Objective B.1, …≥70% retention…]	No reasons were provided as to why it would not be implementable. It appears the difficulties with the objective are the provisions to allow for some of the realities of livestock grazing. These could easily be removed, which would make it easier to implement, but would result in less grazing use by livestock.
166	110		“>4-5 years” in place of “≥4-5 years.”	The reference to 4-5 years was removed because the insertion of this had been done prior to assessing scientific information.

167	110		This reads like a standard, which is no-no for this assignment [in reference to “must be met” in the second sentence of Objective B.1].	No, because the second sentence merely identifies the years in which it is most important to meet suitable conditions identified in the objective.
168	111		Even less implementable [in reference to Objective B.2].	No reasons were provided as to why it would not be implementable. It appears the difficulties with the objective are the provisions to allow for some of the realities of livestock grazing. These could easily be removed, which would make it easier to implement, but would result in less grazing use by livestock.
169	111		Reads like a standard [in reference to Objective B. 2].	This has been discussed at length in many meetings, etc. There is a difference of opinion. It reads like many wildlife habitat objectives (e.g., Adamcik et al. 2004, Lauhban et al. 2012).
170	111		???	Unclear what the comment is.
171	111		??? [in reference to “approximating plant species”].	It should be “approximating plant species composition.” This was corrected.
172	111		So why not stay w/ utilization terminology to avoid confusion? [in reference to utilization being the flip-side of retention].	Because Objective 4.7(d) calls for retention, and because retention is what is meaningful for wildlife --- herbaceous vegetation that is retained is what remains as habitat.
173	112		Awk. [in reference to paragraph explaining “that suitable condition statements 2-4 are expressed as minimum percent retention, not as minimum average percent retention”].	Attempts were made to clarify this.
174	112		Extremely unimplementable.	No reasons were provided as to why it would not be implementable. Again, the stumbling block in the objectives appears to be the provisions to allow for some of the realities of livestock grazing, primarily over-use. Allowing for 20% of areas to be over-used easily be removed, making it easier to implement, but would result in less grazing use by livestock.
175	113-115		See previous concerns and too prescriptive [in reference to conservation actions identified for meeting objectives for herbaceous species composition and retention].	Previous concerns were addressed previously. Regarding being too prescriptive, this is the purpose of identifying potential management actions.
176	116		Depends on soils and moisture conditions [in reference to a statement: “The total amount of walking/running that is done by livestock, which directly affects soil compaction and extent of burrow collapsing, is proportional to the intensity of grazing”].	A qualifier was added to the sentence.
177	116		This disagrees with the table earlier in the document, but is correct #s for E channels [in reference to 85-100% of E channels being stable under desired conditions].	Table 3 was changed based on an earlier comment.
178	120		Timing of use can be used to mitigate will use as well.	Good point and this is supported by literature. The addition was made.
179	121		Map these segments before saying many [in reference to statement that many roads on the BTNF follow stream courses and are located within riparian zones]	It does not take a mapping exercise to make this statement. This is easy to see on the ground and on existing maps. A GIS analysis to assess roads in relation to streams and riparian areas exercise would be to put numbers to this statement.

180	121		Repeat [in relation to a statement about Bartelt's findings].	The second (repeated) sentence was removed.
181	121		Is mortality for amphibians compensatory? If so, how does that affect the conclusion one should draw from this analysis?	In the studies and scientific papers, conservation assessments, and plans that were reviewed, there was little discussion of compensatory versus additive mortality. Mortality caused by vehicles and livestock likely can be either additive or compensatory depending on the situation, and where many individuals are killed it may be possible for a percentage of the mortality to be compensatory and then after some point, additive. Determining which it is in any particular situation takes intensive research. Given the importance of adult survival (e.g., do not being reproducing until 4-6 years of age, low natural mortality, chitrid fungus that is eating into survival, a number of other human-related factors that elevate mortality rates) and their status of sensitive species, a cautious approach should be taken, for example by not erring on assuming mortality caused by vehicles and livestock is compensatory. While a portion of metamorphs killed by vehicles and livestock is likely compensatory, for example when large numbers are killed, there also is a potential for a portion of the mortality to be additive. Given the large number and variety of factors impacting boreal toads and spotted frogs, mortality by vehicles and livestock can be important mortality factors. This is backed up by many scientific studies.
182	124		See ? on compensatory [in reference to a statement that optimum conditions would be no additive mortality caused by vehicles, livestock, or other human-related factor.]	See response to the previous comment.
183	125		See previous concerns [in response to adjustments to accommodate recreation and commercial activities].	This section was revised.
184	125		April-Aug as below? Not doable [in reference to minimizing roads and motorized trails to the greatest extent possible].	No reasons were given as to why this would no be doable. While it may be highly controversial in some situations and while it may be difficult to enforce, this does not make it undoable.
185	126		[Suggestion to strike-out Objective C.1 and] see previous.	No reasons were provided for deleting the objective.
186	127		Need parallel construction — too controversial.	It is not clear which conservation action this applies to. Regardless, while the level of controversy is a factors, other factors weigh in as well.
187	127-128		See previous [in reference to conservation actions].	See previous response.
188	128		Why would we ever do this? [in reference to permitting larger-than-permitted numbers of livestock].	This appears to be done on at least some districts on the BTNF, so long as permitted AUMs are not exceeded.
189	128		Rest rotation, other options? [in reference to conservation action of deferred rotation].	Rest rotation was added as another option to consider.
190	128		I don't think we have one [in reference to	This needs to be ascertained.

			special order prohibiting dispersed camping within 100 feet of streams].	
191	131		[Suggestion to replace “possible” with “practical”.]	These have similar meanings. It’s not clear why the change should be made.
192	131		Best worded objective in doc.	Comment noted.
193	131		Not really building new roads except oil & gas, but it should provide for passage from the get go [in reference to movements that may be blocked by a road in Objective C.2].	The suggested change is not clear.
194	132-133		See previous [in reference to Measures and Indicators and Conservation Actions]	See previous response.
195	136		We shouldn’t be putting facilities close enough for to wetlands for this to be an issue in the first place [in reference to Objective C.3].	Exactly! And the objective calls for this.
196	136		Awk.[in reference to Objective C.3].	The wording has been modified.
197	136		[Suggestion to delete the entirety of Objective C.3.]	The objective was retained, although it was incorporated into suitable condition statements.
198	137		See previous [in reference to conservation actions].	See previous response.
199	138		Awk. [in reference to Objective C.4].	It is stated as a desired condition. Yes, this is a little awkward, but this is a common style for objectives.
200	138		Or stream & lake? [in reference to trout inhabiting waters they previously did not in Objective C.4].	Lakes and streams was added.
201	138		Need to coordinate with WGFD to not stock any currently fishless streams & lakes [in reference to Objective C.4].	This is correct, and verbiage was added to conservation actions.
202	140		This seems like fertile sea to explore for management implications and BMPs [in reference to discussion of potential for equipment to contribute to the spread of amphibian diseases].	Comment noted.
203	140		Wish this were possible, but probably not. I would like to get ANS prevention in existing O&G permits though, where appropriate [in reference to cleaning <u>all</u> equipment].	This was added to conservation actions.
204	141		Why 2017?	It was 5 years from when this was first added.
205	141		Simply state that we would like to create monitoring network capable of establishing trend.	The objective provides a target for this.
206	141		Seems like this could be reworded and combined [in reference to monitoring objectives].	Each of these addresses distinct components.
207	142		Each of these addresses distinct components.	See previous response.
208	142		Not necessarily [in reference to determining cause-and-effect relationships requiring intensive research].	The sentence was modified.
209	142		Cites [in reference to some experts recommending more than 10-15 tons/acre].	This was addressed in the Mix of Succession Stages section.
210	142		This would be more powerful and paletable if we, the refuge, BLM, and the Parks agreed to a sampling protocol for the GYE.	Wendy is working to do this and it looks like it will work out this way (generally).

211	143		At some point, this could get cost prohibitive as database increases so would not want to commit ad infinitem [in reference to statement that all boreal toad breeding sites should be monitored].	There is no requirement. The statement says “should.”

TYLER JOHNSON, ENVIRONMENTAL COORDINATOR, NORTH ZONE BTNF

Cmt. No.	Page No.		Comment	Response
1	—		Way too long, 164 pages for 2 species creates essentially an unreadable document, this is essentially a literature review on par with that required for a Master’s thesis and I am sure that the information in it has been thoroughly synthesized to come up with these objectives. However, this level of synthesis is not useful for the majority of FS folks that will deal with the implications of these objectives. I understand that the synthesis is needed to show that we used the ‘best available science’, but a 5-6 page summary of the synthesis with a table of the objectives, the species they will be applicable to, and the conservation measures and monitoring needed to meet them would make a much more useful document. The synthesis could be appended to that summary. The GAO does this kind of thing all the time, where they simultaneously release an entire analysis of say, information regarding ESA species, as well as a Highlights paper. They all reference each other and are part of any record, the Highlights paper just provides the needed information without pages and pages of literature review	The purpose of this type of document is not to be read cover-to-cover; it documents the information synthesized in defining suitable conditions, identifying threats, and developing conservation actions. It is a review and analysis of the scientific literature, and technical documents of this length are not unusual. It is not the conservation assessment. Given the range of habitats used by amphibians in both aquatic and terrestrial systems, the range of human activities that affect amphibians, the amount of scientific information on amphibians and on pertinent ecological relationships, and the level of scrutiny, 5-6 pages would be wholly inadequate. There are few if any species in which 5-6 pages would suffice even for a conservation assessment. For amphibians, the a list of habitat and survival elements and risk factors, and one or two sentences for each (without any citations) would span 5-6 pages. The conservation assessment provides a summary of the information synthesized in the literature review and analysis, and it is hoped this can be kept within 50 pages.
2	—		All of these quantifiable objectives write-ups need an executive summary for the entire document and an abstract for each species (think bullet points for each species and a brief description of the objectives that relate to the species and the conservation measures and monitoring	Comment noted. This is a good consideration.
3	—		Put all objectives in 1 table so they can be analyzed as a whole and compared	Comment noted. This is a good consideration for the conservation assessment and plan.
4	—		At the beginning of a document of this size there needs to be a list of tables and figures, I spent 5 minutes leafing through just to find Table 3	A table of tables and figures was added.
5	3-4		The discussion of coarse and fine filters needs to be much more clear, I read those 6 paragraphs almost a dozen times and got more	This material was re-written in hopes that it is more clear.

			confused every time I read them. I still cannot tell you what a coarse and fine filter is in this context. I think that I have it as the coarse filter is the habitats that a species can occupy and the fine filter is what we do to those habitats, but I am still unsure of my own interpretation of that. Since this is the framework on which the entire objectives write-up hangs this needs to be put into plain language.	
6	1		The 3rd paragraph of the Introduction mentions that Patla and Keinathe and Keinath and McGee have presented detailed illustrations of the factors that affect these two species. Since these factors are the sort of outline for the entire write-up they should be briefly summarized and listed so that they are out in the open. In the document as it stands now they are discussed on pp24 and are in Table 2, but it's buried behind 24 pages of dense text. I would suggest putting these factors in a bulleted table right up front	A section was added on multiple stressors. While factors that affect spotted frogs and boreal toads are very important, the emphasis of this report was (and continues to be) on the development of objectives, which involves habitat and other environmental elements. This focus is critical since (1) Forest Plan and higher-level direction require that suitable conditions be maintained for sensitive species, and (2) to be able to identify threats/risks, suitable conditions must be known (a threat is identified by comparing suitable/desired conditions with existing conditions). The focus of the revised report is on the development of suitable conditions statement (which is nearly the same as a focus on developing objectives). Part II of the report is organized around "habitat and other environmental elements," and threats/risks are addressed within this context.
			I was confused about some of the definitions about Breeding Sites:	(See next three rows)
7	12		1. It appears that the definition of a Breeding Site hinges on the fact that things are *observed* and *documented* (presence of eggs, presence of tadpoles, etc.) and thus the site must be known about to be a breeding site	No, this is incorrect. An existing breeding site is a breeding site whether we know about it or not. A known existing breeding site is one that both exists and that we know about.
8	12		2. The definition of an Existing Breeding Site speaks about breeding sites being present whether their use is known or not. My issue arises from the fact that a breeding site must be known to be a breeding site, but several places in the document the caveat '...breeding sites... if known' is used (pp 14 last sentence of the 2nd paragraph).	The definitions have been clarified.
9			3. This needs to be cleared up because so many of the objectives hinge on the presence of breeding sites, which implies that we have documented the things necessary to call some place a Breeding Site. This entails a lot of monitoring and the objectives can't be applied unless the monitoring takes place. By using this definition we are essentially committing ourselves to monitor at a very fine scale.	
10	App. B		Appendix B - I understand what the numbers correspond to in the x and y axes of this table, I cannot comprehend what the numbers within	Additional explanation has been added.

			the matrix are. Just to take the top left cell as an example. I understand that if the utilization rate for key species is 10% and the utilization rate of non-key plant species approximates 0% and if the composition of the total herbaceous veg is 10% of the key species, what does the 1% stand for? Is this the site-wide utilization rate?	
11	—		As I said earlier, some of the objectives commit us to quite a bit of monitoring. For example objective A.5 commits the timber folks to assessing the successional status of an entire 5th and 6th level HUC as well as measuring the tons of large woody debris in every project area and counting live and dead trees.	Regardless of amphibians, successional status will need to be determined and tracked in watersheds in which timber is planning to be harvested, mechanical treatments, and/or prescribed burns are being planned. This is fundamental to all wildlife species associated with forestland and to tracking forest health. Snags and large woody material is also already being determined and tracked for harvest and mechanical treatment projects, as this can be substantially altered and is central to the needs of a wide range of wildlife, forest health, and fuels.
12	30		Objective B.1 states that certain criteria must be met every year in certain cases. However, there are going to be years where things entirely outside our control will make it such that we won't meet this objective. Maybe need to revisit the idea of having absolutes in objectives for things as variable as water levels, hopping things that move around, and a complex landscape of ownerships and priorities.	This true of managing almost any resource toward objectives. The specific elements in Objective B.1 are long-developing attributes and, therefore, it is not an objective that is achieved based on attributes that change seasonally or in the short term (e.g., stubble height, streambank alteration, percent retention). The Sensitive Species Management Standard requires objectives for sensitive species to be numeric and numbers are absolute. This is consistent with the treatment of objectives in the discipline of wildlife habitat management.

CYNTHIA TATE, REGIONAL AQUATIC BIOLOGIST, REGION 4 OFFICE

Cmt. No.	Page No.		Comment	Response
1	30		Maintain at PFC? [In reference to Objective A.1."]	The revised report was changed to explain that the lower end of PFC is outside the range of suitable conditions for spotted frogs and boreal toads.
2	35		what does this mean? [In reference to Objective A.2, specifically "...within 1½ mile of these..."	The suitable condition statement in the revised report is worded differently.
3	47		Don't understand a buffer for WQ . Is it needed? [In reference to Objective A.3, specifically: "...within 1/3 mile of known existing breeding sites..."]	The question is unclear. Yes, it is important to maintain suitable water quality in wetlands used by spotted frogs and boreal toads.
4	47		Meet State water quality standards?	Yes, at a bare minimum. The wording was changed in the revised report.
5	52		Manage for beaver ponds? [In reference to Objective A.4.]	Yes, as outlined in the conservation actions section.
6	67		I am unable to understand what is being said here	The wording was revised somewhat.

			[In reference to Objective A.5.]	
7	110		Same as comment [6]. [In reference to Objective B.1.]	See response to comment 6.
8	110		Same as comment [6]. [In reference to Objective B.2.]	See response to comment 6.
9	126		There are 3 different buffers here, and their application and relevance is confusing. [In reference to Objective C.1.]	The wording was revised.
10	136		Good, but how do you measure 'no more than minimally'? [In reference to Objective C.3.]	The suitable condition statement was revised.
11	138		Good. [In reference to Objective C.4.]	Comment noted.
12	141		Good. [In reference to monitoring objectives.]	Comment noted.

PINEDALE RANGER DISTRICT REVIEWERS (COMBINED)

Range management specialists and others on the Pinedale Ranger District provided several comments.

Cmt. No.	Page No.		Comment	Response
1	—		[For all sensitive species.] Staff on the district were concerned about the fact that the Forest Plan calls for quantifiable objectives and these documents include many objectives that are not, or are not directly quantifiable. What are the implications of having objectives that are not quantifiable enough? Potential solutions include rewriting the objectives to make them more quantifiable or amending the forest plan to remove the term 'quantifiable'.	With respect to the sensitive amphibian report, objectives were defined numerically to the extent practical.
2	—		[For all sensitive species.] Is the monitoring too much? We understand the desire and need for additional monitoring, but it is very important that we don't promise more than we will be able to deliver. Monitoring should be discussed for all species at the same time to make sure that what sounds **achievable** for each species is in context of the entire additional effort required. The papers should avoid prescribing specific methodologies or definitive frequency of monitoring unless there is no alternative and it is absolutely necessary for the species. The monitoring should consider monitoring already described in the Forest Plan.	This was brought up specifically for amphibians; see comment 9, below. As far as methodologies, many times it is important to identify methodologies and frequency of monitoring. If it is left open and methods change over time, we lose the ability to track populations or habitat over time, thereby defeating the purpose of monitoring.
3	—		[For all sensitive species.] To clarify, we already have LRMP standards and guides, plus additional monitoring we are doing for various resources (manual direction, accepted protocols like MIM, etc). If we are managing within LRMP and manual sideboards, is this sufficient given limited budgets? For example, streambank stability is important to hydrologic function, native trout, and rangeland management. We should highlight this existing monitoring as of particular importance to species A,	For the question of whether it is sufficient if we are already managing within LRMP and manual sideboards, the answer for sensitive amphibians is no if current management is reflective of this. As an example, Forest Plan Objective 4.7(d) call for an adequate amount of suitable forage and cover to be retained for wildlife on allotments and this is not being done as part of current management for sensitive amphibians or for other wildlife.

			B, C. See also suggestion below about ranking species.	
4	—		The document could be vastly improved by following the same format as the other papers. Like the other papers, a good approach would be to start with a review of existing conservation plans and then tie the objectives to the specific conditions on the BT. Hanvey already has an amphib draft in the same format as swans and trout.	The document reviewed by the Pinedale Ranger District was not the conservation assessment. The draft conservation assessment for spotted frogs and boreal toads is in a similar format to the other sensitive species.
5	—		Generally, the document needs to be condensed considerably and revise for clarity. Currently, the document rivals the forest plan in length, and the volume detracts from the utility of the document. The objectives are overly broad and could result in the unintended consequences that few projects could stand up to the scrutiny under this plan. The document is not clearly written or to-the-point.	The purpose of the document reviewed by the Pinedale Ranger District is to document the information synthesized in defining suitable conditions, identifying threats, and developing conservation actions. It is a review and analysis of the scientific literature. It is not the conservation assessment. The utility of this document is different than the utility of the conservation assessments.
6	—		The objective statements are not clearly written or to-the-point. For example, objective A.1 – includes provisions for riparian vegetation, water level fluctuations, and bank stability. As a result, it will be very difficult to have a consistent interpretation of the intent of the objectives.	Objectives have been separated into discrete suitable condition statements and they have otherwise been reworded to be more clear.
7	—		The document comes across with a tone that the primary solution is to substantially limit or remove livestock; however, the primary literature citations indicate that disease (chytrid fungus) and climate change are likely the primary drivers in amphibians in the region.	Nowhere in the document does it state or imply that the primary solution is to limit or remove livestock. The number of pages devoted to livestock grazing relative to pages on other threats, as explained in the report, has more to do with the specificity of scientific information available and the number of different ways that a given threat can impact the species. The detailed examination of retaining suitable habitat and protecting frogs and toads in allotments was moved to an appendix. The review of scientific literature in the report culminates in the identification of 70% retention of herbaceous veg. as the low end of suitable conditions for 12 habitat/survival elements affected by livestock use, despite some studies showing that adverse impacts begin at an estimated 80% retention. 70% herbaceous is general equivalent to 30-60% utilization of key forage species, which means it is within the range of utilization limits identified in contemporary range texts. This contrasts with recommendations by amphibian experts to completely exclude livestock from breeding areas and other amphibian habitat. The report recognizes the major role that chitrid fungus has played and additional information was added to the revised report on the multiple stressor concept and implications to

				livestock grazing.
8			While disease and climate change, and connected elements such as altered wildfire regime, are largely dismissed by the document, the document focuses on habitat impacts that may not even be a concern in most parts of the Forest. The document tries to ensure that every element of habitat for every stage of the life history is protected. However, there is no recognition of, and in many cases scientific information is lacking to know, which elements are truly relevant to the conservation of these species.	Disease, climate change, and altered fire regime were not dismissed in the report. Altered fire regime was addressed very extensively in the "Mix of Succession Stages in Forests" section, as altered fire regime is the main reason for the overrepresentation of late-seral forestland. Disease was also addressed, but (1) there is little that can be done to reduce the prevalence of chitrid fungus, and (2) numerous papers identify the importance of minimizing the effects of other stressors when dealing with diseases like chitrid fungus. The discussion of disease and multiple stressors was expanded in the revised report. The preponderance of scientific information supports the approach taken in the report.
9			We feel that citations have been taken out of context to make the science connecting resource use activities to impacts to amphibians stronger than the original researchers stated.	No examples were provided and, therefore, the accuracy of this comment cannot be assessed, nor can any corrections be made even if it were accurate.
10			The monitoring recommendations would result in a huge workload for the forest. We do not feel that it is practical or possible to monitor every breeding site every year. In some cases there are specific methodologies and timelines for monitoring that would likely not be attainable with the current budget and workforce.	Little additional monitoring was recommended. Every breeding site would not be monitored every year. No examples were provided of monitoring, or methodologies or timelines that would not be attainable.
11			In other cases there are objectives and conservation actions that are basically unmeasureable (e.g. are watering livestock increasing the rate of water loss in seasonally wet habitats?)	This is true. Some objectives were not stated numerically. For the example provided, however, the objective was measurable as it was tied to a minimum retention level of 70% of herbaceous vegetation.
12			[For all sensitive species.] Go with minimum necessary to meet LRMP requirement. Information already compiled can be utilized later for projects and/or overall monitoring strategies.	With respect to sensitive amphibians, the "minimum necessary to meet LRMP requirements" forms a major premise of defining objectives, identifying threats, and developing conservation actions in the report. As an example, 70% retention of herbaceous vegetation represents the bare minimum that can be supported to meet Forest Plan and higher level requirements pertinent to spotted frogs and boreal toads. Some information shows that 70% retention is not high enough to meet some habitat/survival elements.
13			[For all sensitive species.] Our sensitive species list is a Regional list. I'd suggest a more focused approach on the Bridger-Teton. The first step is the QO's by species. The next step is to rate species relative to each other considering (not in any order): 1) Distribution across Region, State, Forest. Our trumpeter swans are confined to the tri state area – BTNF is particularly	Most of this comment is beyond the scope of the sensitive amphibian report. Maps with location data were added to the revised report. Yes, habitat for spotted frogs and boreal toads can be mapped, and plans are to do so.

			important regionally to this population. 2) How much do we know about the species occurrence on the BTNF? We know little about amphibian presence or absence; we know a fair amount about cutthroat trout and sage grouse 3) Can we model habitat and then determine how much potential habitat we may have and where it occurs? Right now we have thousands of acres of snag habitat (unmapped) for dependent woodpeckers (ie maybe we don't need to be worried about lack of woodpecker habitat). Habitat is already mapped for trout and swans.	
14			[For all sensitive species.] These are just examples of how we could look at the overall importance of the BTNF and the extent of our knowledge. We could then rate each species as high, medium, low, or unknown risk and then focus our budget and attention where most beneficial. ("risk" meaning risk of trending towards listing due to management activities on the BTNF)	This is beyond the scope of the sensitive amphibian report.
15			Amphibians would rate "unknown risk" since we have little to no information on their presence/absence, distribution, or how much potential habitat we have. State-wide there is little information. Nation-wide they are in decline. Thus these species might be high priority for monitoring/survey and modeling potential habitat.	An assessment of unknown risk is unsupportable given inventory and monitoring data that is available and the large amount of scientific information on effects of disease and human activities on spotted frogs, boreal toads, and related species. The monitoring program that has been developed for the BTNF will provide minimal information on risk. The grazing-effects study being discussed will also provide a relatively small amount of information on risk. However, combining the small amount of information available specifically for the BTNF with scientific information, a substantial amount can be said about risk. Synopses were added to the revised report on risk based on this information.
16			We need standardized/accepted protocols for survey work.	A standardized protocol for monitoring amphibians has been adopted and began to be implemented in the 2014 season.
17			[For all sensitive species.] I agree with the above synopsis: too much information and too many management requirements (with unknown or unintended consequences) for species we know little about.	Comment noted.
18			[For all sensitive species.] A suggested way forward would be to model potential habitat and then focus survey/monitoring efforts where we have the highest potential of finding specific amphibians. Modeling habitat and survey work would be the QO. Current LRMP standards and guides, plus additional monitoring we are doing for	In regard to the first sentence, this is similar to the approach being used to locate existing amphibian breeding sites, except sites with highest potential for occupancy were not selected. Modeling habitat and survey work is not a quantifiable objective. Healthy, functioning riparian, wetland, and terrestrial habitat is central to amphibian conservation;

			various resources (manual direction, accepted protocols like MIM, etc) should be supporting healthy functioning riparians/wetlands and thus supporting amphibians.	however, activities that can reduce water quality, increase mortality (e.g., crushing by vehicles and livestock), altering behavior (e.g., artificial lights), fragmenting habitat (e.g., roads), etc. also are critical to conserving amphibians.
19			If we have a lot of potential habitat distributed across the Forest and we find amphibs where predicted, their rating could change from “unknown” to “low” after 5-10 years once we have data (or not!). We also have the unique opportunity to compare findings on the BTNF with Patlas work in the Parks. We can utilize the Park data as a control....ie if populations and distribution is changing in the Park, and if the BTNF is experiencing similar changes, changes may have nothing to do with Forest management.	This simplistic approach is not consistent with the scientific literature. Level of occupancy/ distribution and comparing it with capable habitat would only be a first tier of determining the degree to which amphibian population have been altered and the potential for future risk. It may not fully account for historic distribution and occupancy and does not account for habitat already lost, changes in reproduction rates, and survival rates. Data from National Parks would not suffice as controls, as there are many human-related activities occurring there.

Review by Others

ERIC PETERSON, MANAGER, SUBLETTE COUNTY CONSERVATION DISTRICT

Comments from Eric Peterson were in the form of an email “cover letter” for the detailed comments from the Sublette County Conservation District.

Cmt. No.	Page No.		Comment	Response
1	—		Staff from the Sublette County Conservation District recently completed a review of the document, “Sensitive Species Objectives and Recommended Conservation Actions, and their Basis — Bridger Teton National Forest — Don DeLong, District Biologist, Greys River Ranger District, Draft — 01-09-2013”.	No response necessary.
2	—		We initiated this review because of suspicion regarding the conclusions which the paper works so very hard to support.	If the author of the draft report “worked hard” at anything, it was trying to defend the assessment that a 70% retention threshold is *high enough* to sufficiently provide for habitat needs of spotted frogs and boreal toads, to sufficiently protect them against direct and indirect negative effects of livestock (e.g., reduced water quality, increased mortality due to trampling, accelerated declines in water levels), and ultimately to meet Forest Plan objectives and standards and higher-level direction, particularly in light of effects of chitrid fungus, climate change, rising UV radiation, and a multitude of other stressors. This was difficult for some elements (e.g., water quality, mortality from trampling, water level declines) since (1) some scientific studies

				showed there to be negative effects of livestock grazing use at 20% use of total herbaceous vegetation (80% retention), (2) other scientific information shows a substantive potential for negative effects at 30% use of herbaceous vegetation, and (3) only low to moderate scientific support for the assessment that a maximum of 30% use would protect against trampling by livestock and reduced water quality. Some of the scientific and ecological information shows that the threshold ought to be higher than 70%, and reviewers with science background asked us why we did not identify 80% retention of herbaceous vegetation as the threshold, given what the scientific information shows. The original report only peripherally considered the cumulative effects of chitrid fungus, climate change, rising UV radiation, and other multiple stressors; consideration of these stressors made it more difficult to demonstrate that 70% retention of herbaceous vegetation is high enough.
3.a			In our review we have found that the science used to develop a foundation for the argument is often misapplied,...	• Of the 539 comments provided by the Conservation District, several identifying what the commenters believed were misinterpretations or misapplications of scientific information in the report, and none ended up having any bearing on whether 70% retention is an appropriate threshold for suitable habitat conditions. Corrections were made to the report as needed. In one case, there was a question about applying lab results to the field, and a response was provided. In some cases, what were perceived as misinterpretation actually were not misinterpretations of the science (in some cases the commenter had a misinterpretation of the science); in more than one case, the commenters misinterpreted the report and the report was adjusted to be more clear. • E. Peterson did not provide any examples of science being misapplied.
3.b			... non-supportive,	• Of the 539 comments, commenters identified several situations in which they felt scientific citations did not support accompanying statements in the report. Corrections were made to the report in a small number of cases. In several cases, there was a question about applying results from other areas to the BTNF, and responses were provided. None of the comments ended up having any bearing on whether 70% retention is an appropriate threshold. • E. Peterson did not provide any examples of science being supportive.
3.c			...missing, or	• Of the 539 comments, many did identify places in the report where commenters felt statements needed to be backed up with supportive scientific literature (i.e., “missing” scientific information). In many cases, supportive literature was provided in the report but in a different location. In other cases, citations were added as requested. In other cases, citations were not needed. • Also, many comments were made about references not being included in the Literature Cited section (another aspect of “missing” science). Missing references in the literature cited section have been added.

3.d			...untraceable.	• None of the 539 comments indicated that cited scientific material was untraceable. While many comments were made about references not being included in the Literature Cited section, this is an issue about missing references, not about science not being traceable. • E. Peterson did not provide any examples of science being discounted.
4.a			In other cases, science which does not support the argument is discounted,	• None of the 539 comments identified any instances of science that was discounted. • E. Peterson did not provide any examples of science being discounted.
4.b			...disregarded or	• None of the 539 comments identified any instances of science that was disregarded. • E. Peterson did not provide any examples of science being disregarded.
4.c			...ignored.	• None of the 539 comments identified any instances of science that was ignored. • E. Peterson did not provide any examples of science being ignored.
5			It is apparent that the real intent of the paper is to support an opinion or assumption and does not adequately present a solid foundation for the conclusions advanced.	No support was provided for this comment, either in the comments from E. Peterson or in the comments attached to his comments (i.e., the 539 comments from Sublette County Conservation District, outlined below). The large volume of scientific information outlined in the report, in the context of requirements for conserving sensitive species, demonstrates otherwise.
6	—		In our opinion, the paper is critically flawed in its fundamental assertions and/or conclusions. It should NOT be used to inform management of the Bridger-Teton National Forest. Prior to employing the paper, we believe the United States Forest Service should take the time to have a thorough scientific review done on the paper. Otherwise, the use of the paper's bad science to inform management decisions exposes those decisions to constant challenge, friction, and debate.	This comment needs to be considered by line authority.
7	—		Accompanying this letter, we have attached a pdf of the document in question. The document contains sticky-note comments made by District staff, pointing out the problems found in our review of the document.	The 539 comments in the pdf document were reviewed, changes were made to the report, and responses to the comments are included in separate document. See Response to Comment 2 for a summary. None of the comments or comments as a whole provided a basis for adjusting the 70% herbaceous retention threshold.
8	—		We recognize that reading and evaluating the document is challenging. Critically reviewing the document is not an option for most. We have made those	Each of the 539 comments were read, evaluated, and addressed. Changes were made to the report where changes were needed. Numerous comments were made in the pdf document, but it is unclear why any alarm should be expressed based on them. The comments identified few

			investments and request Forest decision-makers to spend 15 minutes with the attachment, perusing the comments affixed within the document and evaluating the veracity of the document's conclusions. We believe that 15 minutes should alarm Forest decision-makers as to the wisdom of employing the document as a fundamental information source.	instances in which the interpretation of scientific information was changed in the report based on comments provided and, in the few cases where the draft report misinterpreted scientific findings (1) they were relatively minor issues, and (2) the change had no bearing on the appropriateness of 70% retention as a threshold. No scientific information was provided by the Conservation District that refutes any of the assessments or conclusions supporting a 70% retention threshold. No scientific information was presented by the Conservation District demonstrating that a threshold of 60% or 50% retention of herbaceous vegetation would maintain suitable habitat conditions for spotted frogs and boreal toads and would minimize direct and indirect negative effects of livestock grazing use (e.g., reduced water quality, reduced survival due to trampling, accelerated water-level declines) in order to meet Forest Plan Objectives 3.3(a) and 4.7(d) and the Sensitive Species Management Standard with respect to spotted frogs and boreal toads. As a whole, available scientific information shows that thresholds of 60% and 50% retention of herbaceous vegetation would not retain suitable habitat conditions for these species and would not sufficiently limit direct and indirect negative effects of livestock grazing use and, therefore, there is little or no scientific information showing Forest Plan Objectives 3.3(a) and 4.7(d) and Sensitive Species Management Standard could be met with respect to spotted frogs and boreal toads by applying these thresholds. The Conservation District did not provide any scientific information showing otherwise.

SUBLETTE COUNTY CONSERVATION DISTRICT

Cmt. No.	Page No.		Comment	Response
1	1		The forest plan is vaguely referenced but not cited.	One of the specific requirements of the Sensitive Species Management Standard is for quantifiable objectives to be developed. The reference is provided in a more detailed discussion of the standard later in the report.
2	1		The author cites Patla and Keinath (2005:38,39) in regard to their description of factors affecting adult and tadpole spotted frogs. Adult frog ecological relationships are presented on page 40, not 38 or 39.	This comment is incorrect. Patla and Keinath (2005) was double checked, and the illustration referenced in the report is on page 39.
3	2		Without using quotation marks on the policy statement it is not clear that the bracketed comments are those of the author, not the policy document.	Comment noted. The material in the report was quoted directly from the manual.
4	2		This bracketed statement is unnecessary, as the title of FSM 2670.32 is "Sensitive Species".	Comment noted.

5	2		This item is indeed applicable and should be included. From FSM document: "4. Analyze, if impacts cannot be avoided, the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole. (The line officer, with project approval authority, makes the decision to allow or disallow impact, but the decision must not result in loss of species viability or create significant trends toward federal listing.)"	Policy item number 4 was not deemed applicable because it deals with effects analyses, and the report addresses the development of objectives. The preceding sentence in the report set the context: “Forest Plan Objective 3.3(a) is based on Forest Service policy requirements, including those listed below, and meeting these are required to meet wildlife requirements of the Multiple-Use Sustained Yield Act” (pg. 2 of report). No changes were made to the report.
6	2		No description of why the third element may or may not apply.	Crucial likely applies because the Forest Plan provides direction to protect and maintain crucial habitat for sensitive species.
7	3		What evidence exists that supports this statement?	The assessment in the report was based on a conversation with Regis Terney (referenced in the proceeding paragraph). The final planning rule has been approved and the language is similar.
8	4		Only one publication is from the past 13 years, and most are not peer reviewed. Conservation biology has since evolved to include discussion of mesofilters and species-energy theory along with the concepts described.	The coarse-filter / fine-filter approach is identified in the 2012 Planning Rule as a key part of the framework for conservation planning on national forests. Concerns about the lack of support for the coarse-filter /fine-filter approach should be directed to the Washington Office. On page 21212 of the *Federal Register* (68, vol. 77), the Dept. of Agriculture made the assessment that the coarse-filter / fine-filter concept “is a well-developed concept in the scientific literature and has broad support from the scientific community…” Yes, identifying mesofilters in ecosystems has potential to complement the coarse-filter / fine-filter approach in conserving biological diversity, and this should be explored further in conserving biological diversity on the BTNF. It is unclear how species-energy theory applies to setting habitat objectives for two species of amphibians.
9	4		This (these) area(s) should be specified. "DFC" should be defined for the reader.	This is a general statement. Page numbers in the Forest Plan were provided for readers to read more about DFCs.
10	4		This statement is not in the forest plan, nor is it apparently inferred.	On pages 93, the Forest Plan states “…some objectives conflict with others. Consequently, some objectives will not be met on all areas of the Bridger-Teton National Forest… The conflicts are resolved by application of the different Desired Future Conditions to different areas of the National Forest.” On page 145, it states notes “That the DFCs exist at all is recognition that not all the Goals and Objectives can be achieved at the same time from the same land areas.” This clarification was added to the final report.
11	5		Amphibian conservation literature from other study locations is used extensively throughout this document. This paragraph argues that only treatment-effect studies conducted on the BTNF are valid for consideration. This is a double standard.	Paragraph 3 does not address the use or non-use of amphibian conservation literature from other areas. The paragraph only clarifies that “…the argument that no changes are needed in current herbaceous retention levels because no adverse effects of current retention levels have been identified is baseless…” e.g., when no information exists on impacts.
12	5		What studies? It is clear that the author	No, this was just pointing out that one or two studies with

			has specific research in mind, therefore it must be cited.	no effects detected only provides weak evidence of no effects of the treatment.
13	5		The primary way to decrease type II error is to increase alpha. Little, if any, scientific research will get published when alpha values are inflated over .05. In addition, type II error is not measurable unless an alternative hypothesis is proven correct.	Comment noted. Additional references were added, including recognition that alpha values over 0.05 can be perfectly valid depending on the intended use of the information.
14	5		If a statistical test is applied and results in a failure to reject the null hypothesis, a researcher cannot conclude otherwise without changing the test. We trust that the peer review process is sufficient to authenticate this process. The credibility of the author is called into question by doubting this process without citing any reasons or supporting literature.	The first two sentences are correct and not inconsistent with the statement referenced in the report. First, there was no intention for the highlighted statement to imply that a researcher can make a different conclusion. The highlighted statement in the report merely characterizes a byproduct of the statistical process in many published studies. The highlighted statement just reiterates what happens with a Type II error, which is discussed in most statistics textbooks. Additional explanation was added in an attempt to clarify the key points. Therefore, the third sentence has no merit. D. Keinath (Univ. Wyo., Wyo. Nat. Div. Database; email dated 2/8/2013) made the comment that “The section regarding dealing with limited definitive scientific data is spot on.”
15	5		These are books about the cautionary principle, not statistical literature or biometric texts.	The books discuss statistics in relation to resource conservation. References for statistics literature were added.
16	5		The information referenced is not in the cited document.	The reference was added.
17	5		The information referenced is not in the cited document.	The reference was added.
18	6		Not in bibliography.	The reference was added.
19	6		Keinath and McGee 2005 is about boreal toads, not Columbia spotted frogs.	The citation was changed to Patla and Keinath 2005.
20	6		The information referenced is not in the cited document.	The reference was added.
21	7		These are not in the bibliography.	The references were added.
22	7		There is a new version (2010) of this document that should be used.	The report was changed to reflect the new version.
23	7		Outdated reference. There are multiple current sources of wetland definition.	Comment noted. No alternative definitions were offered and no references were identified. In one of the most recent definitive discussions of wetlands from the standpoint of wildlife conservation, Laubhan et al. (2012:98) — in *The Wildlife Techniques Manual* published by the society of professional wildlife biologists, managers, and researchers — used this definition: “In this chapter, we use the definition of wetlands provided by Cowardin et al. (1979)…” As such, the reference is sufficient for the purposes of the report.
24	7		Citation needed.	Citations are not needed for laws.
25	7		Citations needed for the last several sentences.	The sentences are general characterizations of habitat and citations are not needed. Nonetheless, citations were added. This definition was moved to the “Definitions” section.

26	7		Patla and Keinath (2005) reports the findings of Pilliod et al., not their own research on the topic.	This is correct. The reference to Patla and Keinath was removed.
27	7		Every possible condition meets these criteria.	Comment noted.
28	8		Citation needed.	The sentence is a continuation of the previous.
29	8		Dumas (1964) is the primary literature and should be cited by itself.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
30	8		This is possible but cannot be inferred from Dumas (1964). There is no indication whether the temperature/humidy/time tests in the study were conducted in the wild or a lab. The purpose was to examine differences in how species respond to their environment.	Other parts of the report, including Appendix A discuss this in more detail. This part of the report only presents a general discussion.
31	8		This is the paper cited, and should not be recorded as "in" another document.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
32	8		Information referenced is not in the cited document.	Already discussed.
33	8		This citation is not in the bibliography. Presumably it is primary literature and should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
34	9		There is no indication of what this might mean.	“Ibid” is a standard way of referring to the previous citation.
35	9		This citation is not in the bibliography. Presumably it is primary literature and should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
36	9		This is a book about Wyoming fish. It contains no mention of boreal toads or spotted frogs.	This sentence came from another biologist working on the project. The citation was replaced.
37	9		Outdated reference, the 2010 version is readily available.	Correct. The reference had been changed.
38	9		Information referenced does not pertain to this document.	This is incorrect since abundance is characterized in WGFD (2010) as “extremely rare.”
39	10		Not in bibliography.	This reference was deleted.
40	10		The information referenced is not in the cited document.	The reference was added.
41	10		The author probably means 2005 based on prior citations.	No, this is the correct citation, except the page number was removed.
42	10		The information referenced is not in the cited document.	The reference was added.
43	11		Outdated source. The 2010 version is readily accessible. Also, this is a policy document, not a biological reference.	The 2010 version is now cited.
44	11		According to the cited document, "within 6m of shore, in marshy areas with emergent sedges or shrubby willows, or even bare substrate."	This quote was added to the report, as well as the primary source of the information (Patla 2001).
45	11		While cited in Keinath and McGee (2005), the information is from Patla (2001).	This is correct.

46	11		This is an oversimplification of Bartelt et al. (2004). They did not use a "moist" or "dry" metric, and found complex patterns in microsite and microhabitat selection.	It is unclear how this is an oversimplification. The text was adjusted by adding “and microsites.” The following is a quote from their paper: An analysis of microsite conditions showed that toads in terrestrial habitats used microsites that had similar T_as to randomly selected sites (21.6 ± 0.7 C versus 21.7 ± 0.8 C; t_{16} = 0.017, P = 0.494), but which were significantly more humid (84.2 ± 0.9% versus 74.5 ± 2.9%; t_{16} = 2.255, P = 0.02).”
47	11		Bartelt is the primary literature and should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not evaluated.
48	11		This is a recovery plan, not a biological information source. The authors cited by Pierce (2006) for the information are as follows: Degenhardt et al. 1996, Loeffler 2001.	The primary authors for this information were added.
49	12		These statements require citation.	This portion of the report provides general discussions. Many of the sources were identified. The more detailed discussions later in the report provide citations for this information.
50	12		Not in the bibliography.	The reference was added.
51	12		Bartelt (2000) should stand alone.	This is a standard way of citing primary literature sources when the primary literature source was not evaluated.
52	12		Bartelt (2000) should stand alone.	This is a standard way of citing primary literature sources when the primary literature source was not evaluated.
53	12		This publication is unrelated to the feeding habits of tadpoles.	Schmutzer et al. (2008) provided references for tadpole food.
54	12		Not in the bibliography.	The reference was added.
55	12		Loeffler (1998) is a management and recovery plan. None of these citations are research based biological literature.	The citations provide information on general biology of boreal toads. The sentence begins “In Colorado, toads are reported to…” This appears to be an accurate depiction of the information provided.
56	12		This needs a citation, whether policy or literature based.	“for the purposes of this report” was added.
57	12		If these definitions are from the literature, a biology text, or USFS policy that needs to be cited. If they are the author's own definitions that should be specified.	These are definitions for the report.
58	13		We need to know if these are criteria specified by policy, literature, or created by the author.	These criteria were identified by the author based on information summarized earlier.
59	13		Why 3'-10"? Where did this number come from?	The text was adjusted to indicate shallow water.
60	13		The reason for choosing 1/4 mile must be specified. This is a different value than anything in the buffer discussion.	This was from a previous effort. The mapping effort will be redone using buffers identified in the report.
61	13		This says 1/4 mile buffer, but the rest of the document uses different buffer values.	See above.
62	13		Is there literature or in-house research to support this statement?	Yes, including Marsh and Trenham 2001.
63	14		The author lists three rules, not two.	The text had been changed.

64	14		This is a recovery policy document for New Mexico, not a study about frog and toad movements.	The document provides biological information.
65	14		If a statement needs support, the appropriate literature must be cited.	Adequate reference is made as to where some of the supporting literature can be found.
66	14		Many riparian systems of interest on the BTNF are not forested.	This is correct. The relevance of the comment is unclear.
67	15		An absolute statement of this gravity must be accompanied by scientific literature. We can assume this is the authors opinion, but without citation it carries no weight.	Support for the beginning of the sentence is found in the previous sentence (“Thus,” was added to more clearly connect it to the preceding sentence. Support for the second part of the sentence is in the proceeding sentence.
68	15		Goates et al. (2007) did not recommend this. They recommended ground truthing proposed buffers to see if an extension of the distance was appropriate or beneficial. In some cases it was, in some it was not.	It is correct that Goates et al. (2007) did not recommend extending buffer zones to something greater than 100 ft., but they did conclude that implementation of a 100 ft. buffer was not sufficient in their study and that 100 ft. buffers would not necessarily include all habitat used by boreal toads in other places. Comment 68 also misinterpreted recommendations of the study. The recommendation by Goates et al. (2007) to ground truth prior to establishing buffers did not have to do with buffer widths or distances; they recommended ground truthing to make sure that all perennial streams and seeps are included in maps prior to the application of buffers. They did not identify any situations in which a 100 ft. buffer was appropriate. The text in the report was revised to read as follows: “Goates et al. (2007:480) found that ‘The standard method of creating 30.5m [100 ft.] buffers [around all aquatic habitat, not just breeding sites] does not protect all critical habitats for boreal toads… Toads moved up to 100 m into upland areas, more commonly in late July and August.’ Goates et al. (2007:478, 481) also found that ‘…important portions of breeding sites, overland dispersal routes, upland habitats frequented by toads, and small unmapped streams and seeps used for hibernation were still not covered by the current [100 ft.] buffer zones at six of the seven sites,’ and that ‘…ground truthing and implementation of a 30.5m buffer will not necessarily include all habitats used.’ Their results indicate that buffers larger than 100 ft. are needed for boreal toads. Goates et al. (2007) stressed the importance of ground-truthing to make sure all breeding wetlands, perennial streams, and seeps are taken into account when setting buffers for particular activities since they found that seeps and some perennial streams did not show up on GIS layers.”
69	15		Citations needed.	The statement is of general nature, is supported by literature cited in other parts of the document (e.g., “Status and Natural History Information” section).
70	15		The following does exactly this. Reasons for restriction are given, and recommendations for restriction follow.	Yes, reasons for restrictions are outlined, but as the highlighted sentence states, the basis for each reason is found later in the report (in respective sections).
71	15		Statements are not supported with literature.	As explained in the paragraph above the list, the basis for each reason is found later in the report (in respective

				sections). Repeating all information from later in the report would be redundant.
72	15		Statements are not supported with literature.	See above.
73	15		Statements are not supported with literature.	See above.
74	15		Statements are not supported with literature.	See above.
75	16		Statements are not supported with literature.	See above.
76	16		Statements are not supported with literature.	See above.
77	16		This is in opposition to reason "(2)".	Reason no. 2 does not identify the frequency of fire in breeding wetlands. The text was revised somewhat.
78	17		Bartelt et al. (2004) write that their proposed buffer would protect "a large percentage" of movements. They neither say directly or imply anything about 75% of movements.	The 75% figure was derived from data presented in their paper (see the “Buffer Zones and Levels of Protection” section).
79	17		There is no literature cited in support of the statements in this section.	A statement was added — similar to the statement in the 100 ft. section — to let readers know that the supporting literature is found later in the report (in respective sections).
80	18		They need to be listed.	The highlighted statement, “consistent among studies” is followed directly by “(see the “Spotted Frogs” and “Boreal Toads” subsections, below).” Supporting science is provided in these two subsections.
81	18		This was a recommendation, not a hypothesis that was tested. We cannot know what is needed based on an untested recommendation.	The comment that “we cannot know what is needed based on an untested recommendation” is erroneous. Recommendations by Semlitsch and Bodie (2003) were based on a review of scientific literature (comprised of individual studies in which hypotheses were tested).
82	18		Dumas (1964) is the primary literature and should stand alone.	This comment was already addressed.
83	19		This was almost certainly under lab conditions and tells us little about naturally occurring populations.	Opinion noted.
84	19		The study should be cited, not Hammerson (1982).	This has been addressed several times.
85	20		This is a recovery plan, not a biological information source. The authors cited by Pierce (2006) for the information are as follows: Degenhardt et al. 1996, Loeffler 2001.	This was addressed previously.
86	20		Citations needed for these statements.	Citations are provided elsewhere in the report. A statement identifying the location of the citations was added.
87	20		This statement is misleading. The authors recommend identifying important riparian habitat components withing 1.5 miles (2.5km) of breeding sites, and protecting as the managing agency sees fit.	Keinath and McGee (2005) clearly identified 2.5 km. as a distance within which important habitat components exist for boreal toads. The authors both (1) recommended that land managers should assign priorities for protecting boreal toad habitat within this distance, and (2) provide all components of habitat within 2.5 km of breeding habitat (pg. 30), and (3) limit timber harvest within 2.5 km of known breeding sites during and immediately following the

				breeding season." (pg. 43). Patla (2001:10) recommended 2.5 km as a buffer for timber harvest and for roads and motorized use.
88	20		First mention of this--needs description.	Explanation was added to the text.
89	20		The statements in this section are not supported with literature.	Citations are provided elsewhere in the report, as explained in the opening paragraph.
90	22		This statement is misleading. The authors recommend identifying important riparian habitat components withing 1.5 miles (2.5km) of breeding sites, and protecting as the managing agency sees fit.	See response to Comment 87.
91	22		The author should report on what the research (Goates et al. 2007) indicated, not the opinion of the Dixie National Forest.	Opinion noted.
92	22		No citations are provided in support of the statements made.	Citations are provided elsewhere in the report, as explained in the opening paragraph.
93	24		These factors were mentioned, but none were explicitly studied in the literature that is cited.	This is correct, as the cited literature are not scientific studies. The authors are subject-matter experts and they present reviews of scientific literature in their assessments.
94	24		None of these are hydrology or geomorphology texts. Youngblood et al. (1985) is a riparian community type document, the other two sources are books about grazing/wildlife management.	Additional citations were added. Youngblood et al. (1985) is pertinent to the statements made.
95	25		This table is a summary of the author's opinion. With the amount of applicable literature available, it should be included in support of these assignments.	A sentence was added noting that assessments are based on reviews of information examined in pertinent sections of the report.
96	25		There is often a major water use component associated with oil/gas/mineral development.	An "N" was added to the table.
97	25		There is no indication of what the superscripts mean.	Subscripts were removed.
98	25		Motorized use at stream crossings has a large effect on this.	Yes, and soil is compacted along roads and trails.
99	25		There is no indication of what the superscripts mean.	Subscripts were removed.
100	25		There is no indication of what this means.	"Wetland, Stream, and Riparian Habitat Retention" was rephrased to "Retention of Wetland, Stream, and Riparian Habitat."
101	25		There is often a major water use component associated with oil/gas/mineral development.	It is unclear how small pools would be affected.
102	25		Many willows were sprayed in the 1950's, and 1960's on the BTNF.	An "n" was added to the table.
103	25		Changes in forest canopy influence ground vegetation.	Yes, a "P" was added to this cell, which is supported by text in the Herbaceous Species Composition section.
104	25		Significant effects.	A "n" was added, and discussion was added to the section on height and structure of herbaceous vegetation.

105	25		The bottom of this phrase is cut off.	This was corrected.
106	25		Streamside camping and recreation does affect habitat.	Yes, an “N” was added to match discussion in the text.
107	25		[blank]	No response needed.
108	25		This gives the illusion of quantitative information. The N/n P/p assignments are completely subjective and unsupported by scientific data as presented.	A statement was added to the table informing readers that the numbers at the bottom of the table were not based on weighted figures. Information in the table is based on reviews of scientific information outlined in pertinent sections of the report, and a statement to this effect was added to the table.
109	25		This gives the illusion of quantitative information. The N/n P/p assignments are completely subjective and unsupported by scientific data as presented.	Same as above.
110	26		This is a book about rangeland wildlife, not a hydrologic or geologic text.	Ohmart (1996) cites relevant literature.
111	26		Clary and Webster (1989) and Hall and Bryant (1995) are not in the bibliography.	They were added.
112	26		Not in bibliography.	References were added.
113	26		Not in bibliography.	References were added.
114	26		This is an epa document, not scientific literature.	Chaney et al. (1991) includes discussions of pertinent information and cites supportive scientific literature.
115	26		It is questionable that this point was only worthy of one sentence, while all others were described in depth. Are road effects that minimal?	Additional information had been added, including in response to input from Dale Deter.
116	26		This is about soil erosion, not reduced stream flow.	This reference was deleted.
117	27		This section needs citations to support the statements made.	Citations were added.
118	27		These are field notes, not a scientific study.	Yes, and they were identified as such in the literature cited.
119	27		There is no indication that the conglomerate of information is accurate or has been tested. If it has been tested for accuracy those results should be included.	Comment noted. There is no requirement that such testing is needed before application in management.
120	28		These values have not been tested for accuracy. Citing drafts and specialist reports as supporting documentation is questionable.	The opening sentence of the paragraph states that the figures in Table 3 “are similar to” draft streambank objectives… Nothing in the paragraph stated the figures in Table 3 were based solely or in large part on these draft objectives.
121	28		These values have not been tested for accuracy. Citing drafts and specialist reports as supporting documentation is questionable.	There are no requirements for completing a scientific research project to ascertain accuracy. See also response to Comment 122.
122	28		The accuracy of these assumptions has not been tested on the BTNF.	Hydrologists are collecting data to assess this for the BTNF. <u>Note</u>: applying the level of rigor identified in this and previous comments on the BTNF would likely result in major changes to livestock grazing management on the

				BTNF. As an example, there currently is very little (if any) scientifically-valid information on the BTNF showing that a maximum of 50% utilization would allow healthy plant communities across all vegetation types to remain in healthy condition, much less allow less-than-healthy communities to recover.
123	28		Not in the bibliography.	Platts and Meehan (1977) was cited in Leffert (2005), as noted in the text.
124	29		This is an absolute statement, requiring scientific support.	The "Therefore" at the beginning of the sentence indicates the statement is based on preceding information, including documents that were cited.
125	29		This is an absolute statement, requiring scientific support.	The report was restructured and this sentence no longer exists.
126	29		The last sentence said there was no need to make fine-filter adjustments.	This is correct; no fine-filter adjustments were needed to meet the needs of amphibians. The sentence with highlighting refers to adjustments to accommodate roads and associated activities. The report was restructured in part to help alleviate this confusion.
127	31		These only address two of the many impacts listed in Table 2.	The revised report includes a more extensive list.
128	31		Many of these are not peer reviewed literature.	There is no requirement to limit the range of management actions of consideration to those identified and supported by peer-reviewed literature. If this were a requirement, few decisions would be able to be made on National Forest System lands. The cited documents are conservation assessments and plans produced by experts.
129	31		This value requires a citation and reasoning.	Citations were added.
130	31		This value requires a citation and reasoning.	Citations were added.
131	31		If it's an assumption, then reasoning and supporting literature must be provided at the very least. Using assumptions in support of management actions leaves the agency open to litigation.	Supportive literature is found in Simon (2008); this citation was added.
132	31		The way in which this adjustment would achieve the objective must be specified and supported with literature.	Additional citations were added to the opening paragraph. Also, the identified action to consider is something that can be considered in working toward meeting the objective. The objective is the central issue. If this action were implemented and it was not effective, another measure would need to be implemented.
133	32		The way in which this adjustment would achieve the objective must be specified and supported with literature.	See above.
134	32		The way in which this adjustment would achieve the objective must be specified and supported with literature.	See above.
135	32		The way in which this adjustment would achieve the objective must be specified and supported with literature.	See above.
136	34		What evidence is there for or against this stance?	Additional explanation was included.
137	37		There is no scientific literature that	Objective B.1 was referenced ("as outlined in Objective

			supports this.	B.1”). A large amount of scientific information was presented in the discussion of Objective b.1.
138	38		Citation and discussion of IPCC's findings would be appropriate here.	Additional information on climate change was added to the report.
139	38		These should be in the bibliography and cited directly.	These references are cited in Patla and Keinath (2005) on page 44, as noted in the text.
140	38		...?	The highlighted words (incomplete sentence) were deleted.
141	39		Water level is not a metric assessed in the PFC protocol.	While the elevation of the water table in relation to the elevation of the meadow/floodplain is not a metic used in assessing PFC, it is recognized that it varies according to whether a riparian area is at proper functioning condition (and whether it is at the high end or low end of this), functioning at risk, or non-functioning, depending on stream type (e.g., Prichard et al. 1998).
142	39		Patla and Keinath (2005) did not study this phenomenon, they reported findings of others. The primary literature should be cited.	The primary literature was added.
143	39		Water level is not a metric assessed by the PFC protocol.	See response to Comment 141.
144	39		This not a hydrology document or text.	Ohmart (1996) addresses the topic and provides supporting references.
145	39		None of these are peer reviewed literature, Wyman et al. (2006) being the only appropriate listed source for this information.	All of the main authors are subject experts and provide reviews of pertinent literature.
146	39		Not in bibliography.	The reference has been added.
147	39		Not in bibliography.	The reference has been added.
148	39		This is typically the result of increased stream energy (i.e. straightening, new culvert, etc.) or a downstream drop in stream bed elevation. Movement associated with bank erosion is usually lateral.	The discussion was more about water tables than bank movement.
149	39		Citation needed.	Citations are provided in the referenced section.
150	39		In some cases water developments allow moisture to persist where it would not otherwise.	This is likely correct, but no citations were provided to support this.
151	39		This phenomenon has not been quantified or tested.	Although accelerations in the decline of water levels due to drinking by livestock has not been scientifically tested, (1) concern has been expressed by amphibian experts, (2) available scientific information demonstrates drinking by livestock can accelerate declines in water levels, and (3) the absence of scientific studies does not excuse ignoring a threat to a sensitive species. Also, if scientific testing is needed before applying to livestock grazing management, this would mean that livestock grazing would need to cease until we have definitive results of several scientific studies, given the higher priority of protecting sensitive species. Additional information is presented in Appendix A of the revised report.
152	39		How do we know this?	See above and further discussion in Appendix A.
153	39		This is not in the bibliography.	This has been added.

154	39		The basis for this statement should be provided.	A citation has been added.
155	39		This has not been quantified or tested in the field. There is no research that supports this statement.	See response to comment 151.
156	39		This has not been quantified or tested.	See response to comment 151.
157	40		This has not been quantified or tested.	See response to comment 151.
158	40		This has not been quantified or tested. There is no research supporting this statement.	See response to comment 151.
159	41		There is no way to know if the following points will result in meeting objectives.	If there is no way of knowing if the listed points will result in objectives being met, declines in water levels may need to be directly monitored, which would add further burden to the livestock grazing program.
160	42		This is the only reference that is research based, re: water quality.	While Burton et al. (2009) is the only paper presenting results of research, the other citations are experts that have reviewed pertinent scientific literature.
161	42		How does light use differ from conservative use?	Holechek et al. (2004) identified differentiated light and conservative use of key forage species at 30%, but as stated, this is for key forage species and not total herbaceous vegetation.
162	43		This reference does not address intensity of use.	This is incorrect. Burton et al. (2009) monthly measured vegetation height and percent vertical structural (i.e., they measured changes in these metrics relative to grazing pressure).
163	43		How does low use differ from conservative use?	See response to comment 161.
164	43		This critique should be supported by more specific description of the issues and supporting literature.	Explanations were provided in the paragraph.
165	43		USFS (1997) is a PFC assessment, not a quantitative representation of vegetation/cover conditions.	This is correct.
166	43		"Proportionate" will represent a specific value, for which no scientific data has been collected or analyzed.	Proportionate does not necessarily require the use of numbers. A general principle was identified in the highlighted sentence.
167	43		Not in bibliography.	Anderson et al. (1976) is the primary source of information cited by DeManadier and Hunter (1995), as pointed out in the text.
168	44		Citation needed.	A citation was provided for this (Pilliod et al. 2003).
169	45		They should be included here.	Pilliod et al. (2003) can be consulted for this.
170	45		Citation needed.	The reference is Pilliod (2003).
171	45		Pilliod et al. (2003) did not study and analyze this phenomenon, this information is from an entirely different research paper.	This is correct. Pilliod eta l. (2003) provides a review of the scientific literature pertinent to the highlighted statement.
172	45		Citation needed for this statement.	A reference was added to another part of the report that addresses this in detail.
173	45		This insinuates that the authors are reporting their research findings on the matter, which is not the case.	No, the reference to Patla and Keinath (2005) insinuates they provide support for the statement.
174	46		Citation needed for this statement.	A reference was added to another part of the report that addresses this in detail.

175	46		There should be a description of what led the author to this conclusion.	A short explanation was added.
176	46		This citation should be for the WY state standard.	No, because Patla and Keinath (2005) interpreted the Wyoming State water quality standard to amphibians.
177	46		This may be true, but is an assumption. If this is explicitly specified by DEQ documents then that reference should be provided.	This is not explicitly specified by DEQ.
178	46		There should be a discussion of what led the author to this conclusion.	Further explanation has been provided.
179	48		How do we know this will result in meeting the objective? The following two criteria are mandated by policy, but this one has no basis in literature or policy documents.	The basis is explained in detail in Appendix A of the revised report. If retaining ≥70% of the total annual production of herbaceous vegetation does not result in suitable water quality being maintained (an implied implication of the comment), (1) either a higher retention level will need to be implemented or (2) water quality will need to be monitored at breeding sites, which would add further burden to the livestock grazing program.
180	49		Or maintain current conditions, as per forest plan.	This is incorrect because, if existing ground cover and/or plant species composition is below objective levels, there is no direction to maintain current conditions.
181	51		These are not in the bibiliography, and should be cited independent of Keinath and McGee (2005).	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
182	51		This is a draft conservation assessment, not a credible source of scienctific information.	The conservation assessment was authored by experts and apparently provided supporting literature.
183	53		A discussion of how this objective fits in with DFC classes would be useful.	Desired condition statements and objectives are independent of DFC direction. The degree to which any particular objective is emphasized may be influenced by DFC direction, except that for sensitive species, it may not be possible for the Forest Service to deemphasize objectives for sensitive species in non-wildlife emphasis DFC areas.
184	53		There is no way to know if an objective has been met if nothing is monitored.	This is correct, and this is a weakness of only monitoring a small proportion of factors that impact or potentially impact sensitive species that are affected by such a large range of stressors.
185	54		They need to be cited here too.	Publications cited earlier are cited in the conservation actions as necessary.
186	54		This should be directed by DFC classes and forest plan.	Any conservation action can be applied in any DFC area, but the degree of applicability or the degree to which it should be considered will depend on DFC direction.
187	54		This is a draft conservation assessment, not a scientific document.	The conservation assessment was authored by experts and they provided management recommendations that were incorporated into the report as considerations. The highlighted statement is not a matter of science.
188	54		Citation needed.	A citation was added.
189	54		This is a draft conservation assessment not a scientific document.	See response to comment 187.
190	54		Rationale for this number must be provided.	A citation was added.
191	54		The specific rationale for this action must be provided.	The comment is unclear. The conservation action does not involve a rotation, only a rest for at least two years after a

				fire.
192	56		This is not related to the bullet title: "Increased Evapotranspiration and Reduced Water Flows".	Additional explanation was added.
193	56		What constitutes a major effect and what has led the author to conclude this?	A reference to the "A.3. Occurrence and Extent of Beaver Pond Complexes" section which identifies the basis for this assessment. In situations where beaver ponds had been used by spotted frogs or boreal toads and where no other wetlands exist in drainages, the disappearance of beaver ponds can result in the disappearance of these species.
194	56		Earlier in the document the author suggested that this shading was essential to prevent over-warming of water bodies. A discussion of site specific conditions and habitat needs would be useful.	An earlier reference to shading being essential to prevent over-warming was not found, and such a statement likely was made erroneously since it is not likely that ponds would become too warm for tadpoles. A reference was found about shading contributed to lower evapotranspiration rates.
195	57		References need to be recited.	Where the same material is being covered as was discussed (with supporting citations) in the previous subsection, there is no need to repeat citations, especially when the introduction to a list specifically identifies where citations can be found.
196	58		Cite the sources here.	The text identifies where citations can be found.
197	59		Not in the bibliography.	Reference was added to the report.
198	59		This should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
199	60		The rationale for this statement must be provided.	Additional explanation was added.
200	60		The rationale for this statement must be provided.	Additional explanation was added.
201	61		This will be drastically different in our ecosystem compared to Oregon and Washington (see cited document).	Yes, and a qualifier was added to the text.
202	61		Depending on DFC class.	Yes, this is correct. The text was adjusted.
203	61		It requires an average of 2/ac., not minimum. Also, this text is only included in DFC 12.	Yes, this is correct. The text was modified.
204	61		This is not specified in a DFC class or elsewhere in the forest plan.	The highlighted sentence is not specified in the Forest Plan, but to provide a minimum of 10-15 tons of large woody material per acre into the future, there will need to be enough snags periodically to maintain this amount of large woody material.
205	62		They should be listed here.	Maxell (2000) could have been cited without stating he had based his assessment on several papers. The reference to several papers cited by Maxell (2000) was included to note that he based his assessment on several sources of information.
206	62		List them here.	Similar to response to comment 205.
207	63		This is implausible. Risk of the fire getting out of control is too high during the natural fire season.	This is incorrect because prescribed burning that is done during late summer and fall is done within the natural fire season, recognizing that the prescribed-burning season does not encompass the entire natural fire season.
208	63		Has this actually been observed or quantified? If so, references should be	References are included at the end of the sentence.

			included here.	
209	64		This is not a standard range management term, and should be explained or otherwise defined.	The term “retention” comes directly from the Forest Plan (Objective 4.7(d)). A definition was added to the definitions section of the report.
210	65		If this is supported by literature references should be provided.	Table 4 is referenced and this has a citation.
211	66		If this value is supported by literature it should be cited here.	The 60-70% minimum applies figures in Table 4 to the area within 1.5 miles of breeding sites. A reference was added for Table 4.
212	66		This has not been evaluated for the BTNF ecosystem.	No studies are known for the BTNF, but sufficient literature was available to estimate the weight of large woody material that would meet the Dead and Down Large Woody Material Standard in the Forest Plan. This is covered earlier in the “Mix of Succession Stages in Forests” section.
213	66		This is based on the Columbia River Basin.	This is correct, but the same principles apply in forest types where large woody material naturally accumulates.
214	67		There has been no discussion of Ecological Site Descriptions in regard to plant community dynamics. Successional stages are a coarse way to represent what current science indicates in regard to state and transition models in plant communities.	Ecological site descriptions are currently not available for forest types on the BTNF. While it is recognized that the path of succession after a fire or other major disturbance in forestland on the BTNF is not fully predictable, it can be predicted in many forestlands at a coarse scale, realizing that trajectories may be different than anticipated in places. However, a coarse-scale assessment is sufficient for the purposes at hand.
215	68		The forest plan prohibits this in riparian areas.	The exception is consistent with the Forest Plan; see the Logging in Riparian Areas Standard, pg. 133 of the Forest Plan.
216	69		What are these valus based on?	Additional explanation was added. No scientific studies are cited, but the intent of the value is described.
217	69		The following includes basically every ecosite that exists on the BTNF.	Observation noted.
218	69		Citations needed for these statements.	Pertinent sections of the report were referenced.
219	69		It is likely that forbs would be a large component at some sites.	This is possible, but has not been observed on the BTNF. No scientific studies supporting inclusion of this statement into the report were included in the comment.
220	69		These are not in the bibliography.	References were added to the Literature Cited section.
221	70		Citation needed.	Supporting citations were found later in the section; they were added to this sentence.
222	70		It is primarily driven by soils, precipitation, and aspect. It can be modified by grazing, rodent activity, etc.	The sentence was modified to make it clear that the intent was that, of human-related factors, herbaceous species composition is mainly affected by livestock grazing…
223	70		This is sensible, but references must be provided.	The highlighted sentence is the topic sentence, and it is supported by the remainder of the paragraphs and paragraphs that follow.
224	70		The information provided is about plant community ecology. This paper is not related to plant community ecology.	Patla and Keinath (2005) supports the statement that broad-level changes in plant species composition are important to spotted frogs. The citation had been changed to “Appendix A”, which contains numerous citations.
225	70		These are not scientific findings.	The citations do not reference peer-reviewed published papers, but they reference pertinent information. If only peer-reviewed, published scientific information could be used in resource management, data from rangeland monitoring would not be sufficient to guide management.
226	70		The citations provided are not tests or	While Youngblood et al. (1985) and Padgett et al. (1989) are

			studies of the concept described.	not tests, they provide pertinent information and there is no requirement for scientific information to meet this criteria in order to be used in resource management.
227	70		There is literature that describes this; it should be cited here.	Correct; a reference was added to the “A.1. Distribution and Amount of Wetland and Wet/Moist Riparian Habitat” section which discusses this in detail with supporting citations.
228	70		There is literature that addresses this; it should be included here.	Same as response to comment 227.
229	70		The authors did not measure changes in plant species composition.	The authors measured changes in bare ground and basal vegetation cover. They observed an increase in bare ground and reduction in basal cover after less than 1 day of grazing by horses and concluded, in part, that “…picketed horses could cause some changes on grazed areas depending on season and duration of grazing.” Longer durations of grazing would have greater impacts.
230	71		If they are referenced then they must be included here.	As pointed out in the highlighted sentence, the citations can be found in Boyce (1989).
231	71		They should be provided.	Same as response to comment 230.
232	71		This is the opinion of the author. If supported by literature, then it must be included.	The highlighted sentence is an observation regarding the previous sentence and does not require a citation.
233	71		This information should be supported by literature.	A citation was added.
234	71		The author should describe what has led him to this conclusion, or cite relevant reports by agency personnel.	Further explanation was added.
235	71		There is primary literature that addresses the statements in in this section. It should be included.	Riggs et al. (1996) was included in the draft report, and additional citations were added.
236	71		Not in bibliography.	References have been added.
237	71		That depends on the interpretation of the forest plan by the line officer, and the DFC class in question.	No, the conditions needed to meet Forest Plan Objective 3.3(a) and the Sensitive Species Management Standard is not dependent on the interpretation of the Forest Plan by the line officer and is not dependent on the DFC class in question. The conditions needed to meet Forest Plan Objective 3.3(a) and Sensitive Species Management Standard, with respect to spotted frogs and boreal toads, are based on the ecological needs of these species. Direction in the Forest Plan on DFCs affects the degree to which objectives need to be met in any given DFC area, but does not affect the development of objectives for sensitive species.
238	72		Plant species composition is not the only factor at play in meeting PFC criteria in many streams.	The statement was modified based on this comment.
239	72		This may be true in some cases, but is a severe oversimplification.	The statement was modified, but it involves a very basic tenet of riparian ecology and management.
240	72		There should be a description of what this concept is and where it came from.	The report was modified and this sentence no longer exists in the “Herbaceous Species Composition” section.
241	73		Thus far it is not a metric that science has adopted as viable or useful.	No supporting science or amphibian-management documents were cited in support of this. Herbaceous retention as a metric is important, and this is borne out by

				(1) the large number of studies that have compared ungrazed and grazed heights, visual obstruction, or structure, or have assessed utilization in assessing the effects of livestock grazing on amphibians; i.e., the difference being some expression of retention (e.g., Munger et al. 1994, Munger et al. 1994, Bull and Hayes 2000, Shovlaine 2006, Schmutzer et al. 2008, Adams et al. 2009, Burton et al. 2009, Roche et al. 2012a, Roche et al. 2012b, McIlroy et al. 2013); and (2) amphibian conservation documents that have addressed retention of herbaceous vegetation (e.g., Keinath and McGee 2005, Patla and Keinath 2005, Loeffler et al. 2001). The lack of *minimum* herbaceous retention levels for amphibian conservation in areas grazed by livestock is a short-coming, and this is evidenced by material in the "Height and Structure of Herbaceous Vegetation, Thatch, and Litter" section and Appendix A of the revised report.
242	74		Not in bibliography.	The reference was added to the Literature Cited.
243	74		Wrong citation, not listed this way in the bibliography.	The reference was added to the Literature Cited.
244	74		Not in bibliography.	The reference can be found in Heitschmidt et al. (1998), as indicated in the highlighted text.
245	74		Height is not an appropriate objective. It is primarily a function of yearly precipitation.	No supporting science or amphibian-management documents were cited in support of this opinion. There are many examples in the wildlife literature support the use of vegetation height as the subject of objectives, including those cited in the report.
246	74		This is written directly for management of wildlife refuge systems, not multiple use lands.	The subject of the document is the development of goals and objectives on national wildlife refuges, but the process of developing objectives for wildlife on national forests is similar.
247	74		This is a bird conservation plan, not a scientific document about stream ecology or similar.	The cited document supports the statement made in the report. Stream ecology is outside the scope of what is addressed in the sentence.
248	74		Height is a poor indicator of this. It fluctuates dramatically based on precipitation.	No supporting science or amphibian-management documents were cited in support of this opinion, and it counters a large volume of wildlife ecology literature. Wildlife habitat in herbaceous communities is a function of plant species composition, vegetation height, and density.
249	74		This has no basis in literature, and is a mis-representation of the referenced quote. The is the authors assumption and not supported by science. If use levels make poor objectives, then retention levels also make poor objectives by the same logic. They are measured in the same way, and in homogeneous carex communities use and retention levels will be the same. Later in the document the author suggests that retention and utilization are simply the inverse of one another.	As stated in the sentence immediately before the highlighted material, "Sanders' words from the previous paragraph can be modified somewhat <u>to put it in the context of wildlife habitat management</u>" (emphasis added). The distinction between what Sanders wrote and the modified sentence has nothing to do with retention versus utilization (since, as stated, they are the inverse of one another). The distinction is that, for rangeland soil and vegetation health, maintaining minimum herbaceous retention levels is a means to an end and, for applicable wildlife habitat, maintaining minimum herbaceous retention levels is the end (i.e., herbaceous vegetation provides habitat and is not just an intermediary as it is in range management).
250	74		Citations needed to support this statement.	This is covered extensively in the report, with numerous citations, and many more citations have been added since the draft report.

251	74		In what way is it an indicator? Its relationship to the metrics listed is unknown.	This is a general statement and it is covered thoroughly, with numerous citations, in the “Other Factors Directly Related to Grazing Intensity” subsections within the “Risk Factors and Restoration Factors” section.
252	74		This has not been tested or quantified in scientific literature.	This is supported by many pages of discussion, including numerous citations, following this statement. This and other paragraphs are setting the stage for the upcoming detailed discussion.
253	74		There is not literature indicating how and to what extent these elements are related to retention.	Same as response to comment 252.
254	74		Limited information is a reason to apply the scientific method, not to prescribe management without knowing the result.	Opinion noted. No supporting scientific literature accompanied this statement.
255	74		None of these were studies addressing frog/toad preference for vegetation height classes.	This is correct. But the statement in the report did not imply that any of the citations were of such studies.
256	74		Vegetation height was not a significant predictor of frog preference in this study.	The sentence supported in part by Shovlain (2006) addresses vegetation structure, not just height. On page 10 of Shovlain (2006), it states “A 10-pin point intercept frame adapted from Sharrow and Tober (1979) was used as an index of the difference of the removed vegetation cover between plots (Poissonet et al. 1973) and an estimate of grazing pressure in the riparian zone at individual treatment sites. The purpose of this sampling method is to estimate relative differences in grazing pressure between treatment plots and does not allow exact removed biomass estimates.” Many studies have demonstrated strong correlations between grazing pressure and vegetation height, and this is consistent with common sense. Also Shovlain (2006:11) stated that “The difference of vegetative height between the exclosure and control was considered to be another indicator of relative grazing pressure at each treatment plot.” It is recognized that Shovlain’s measures were more directly tied to vegetation structure.
257	75		"Proportional" is a specific term that is not appropriately used here.	It is unclear why the use of “proportional” is not appropriate. No literature supporting the comment was referenced in the comment.
258	75		It is not readily measured with appropriate sample sizes, as required by interagency manual protocol.	The basis of this comment is unclear, and no supporting literature was referenced and no explanation was provided. If sample size is an issue, it will be an issue for other measures used. Also, if it is infeasible to attain a high enough sample size of herbaceous retention for the purposes of meeting objectives for spotted frogs and toads, how will it be possible to attain sufficient sample size in livestock grazing management that covers many more acres and a greater diversity of situations? The same can be said of rangeland monitoring.
259	75		There is no indication in scientific literature that retention levels "...sufficiently account for all these factors." It has not been tested or quantified.	Correct. There are no comprehensive assessments in the current scientific literature, and this is the basis for examining this issue in detail in the report (and in Appendix A in the revised report). With the absence of a comprehensive assessment of livestock grazing effects on

				spotted frogs and boreal toads in the scientific literature does not provide justification for the Forest Service not making attempts to complete such an assessment in order to meet Forest Plan and higher-level direction for these species.
260	75		Plant vigor has little use in rangeland management and is virtually impossible to quantify.	The comment does not contain any scientific studies that demonstrate that livestock grazing does not affect plant vigor and that plant vigor does not affect the sustainability of healthy plant communities, and this counters available scientific information on the subject. Just because it is difficult to quantify does not provide reason to ignore it as a factor. Plant vigor is defined in the *Wyoming Rangeland Monitoring Guide* (BLM et al. 2008).
261	76		This should be cited alone, not "in...".	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
262	76		This was under laboratory conditions. The purpose of the study was to quantify how two different frog species responded to different inputs.	Results of studies conducted under laboratory conditions are routinely applied to wildlife conservation. Many times, it is much more feasible to test hypotheses under controlled conditions than in field conditions.
263	76		This study was in an oak-hickory woodland and has limited application to the BTNF.	This is not correct. Since desiccation was an issue for frogs in this part of Missouri where ambient humidity and spring-time rain was greater than on the BTNF, the capability for desiccation on the BTNF is higher. Additional explanation was added.
264	76		What places? Evidence supporting this statement should be cited.	Places where habitat is not wet or humid. The term “Thus” indicates that the basis for the statement rests in a previous explanation, which includes citations.
265	76		Not in the bibliography.	The reference is contained in Engle (2001) as indicated in the report.
266	77		This paper should be cited.	The reference is in Keinath and McGee (2005), as indicated in the report.
267	77		If the information in Appendix A is supported by scientific information, it must be included. If it is from another document, that document must be cited.	Supporting literature was added to the appendix; it was added as a figure to the new Appendix A (Figure A.3). Additional explanation was added to the text.
268	77		The applicability of soybean and ceral crop studies to native plant communities is questionable.	It is unclear how the basic results of this research (e.g., increasing capability of vegetation to retain humidity and moderate temperatures near ground level with higher levels of canopy cover) would not apply to native herbaceous communities. Figure 1.e on page 78 of the report (based on scientific study) provide one indication of the similarity in leaf surface area (the major influence on humidity retention and temperature moderation) between a meadow community and a soybean field. No studies showing otherwise were referenced in the comment, and no specifics were identified about the applicability being questionable. Parallel information was not available for meadows, silver sagebrush communities, etc.
269	77		This should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
270	77		How does solar radiation decline due to transmission?	Transmission would appear to be similar to absorbtion.
271	78		This is not supported by literature.	The highlighted sentence explains the likely range of herbaceous retention levels within which humidity retention

				and temperature moderation declines rapidly based on information derived from scientific studies. No scientific information was presented in the comment and no explanation was provided showing that humidity would be retained and temperatures would be moderated near ground level when herbaceous retention levels have dropped to 50% (associated with major reductions in canopy cover of relatively-intact vegetation), or even 60% herb retention.
272	79		There is no scientific evidence to support this table.	Citations were added to the table to show where information was obtained.
273	79		Further explanation is needed on how these numbers where calculated. McKinney (1997) is not in the bibliography. Kinney and Clary (1994) is not a commonly accepted method of realistic utilization monitoring. BLM et al. (1999) does not reference	McKinney (1997) was added to the Literature Cited section. Kinney and Clary (1994) was not identified as an accepted method of "realistic utilization monitoring." They provide height:weight curves for several native plant species.
274	79		Canopy cover, basal cover, and height are not comparable.	Canopy cover and basal cover are directly related (as one goes up / down, the other goes up /down), but they are different measures. No information was provided demonstrating that canopy cover and basal area are not related. Height is an independent measure and footnote "B" does not apply to height.
275	79		These are different because they measured in different ways, and mean different things.	Yes, and the sentence prior to the sentence with highlighter provides one reason why percent retention of canopy cover differs from percent retention of biomass. While canopy cover and biomass for any given plant community are two different measures, they are related.
276	79		What scientific information supports this assumption?	No search was conducted to determine whether any scientific information exists on this topic.
277	79		This assumption is not true at many riparian sites.	Presumably, the comment refers to sedge communities in which composition of key forage species can approach 100%, but this is not clear from the comment. A mid rage was used in the table.
278	81		The study was in Tennessee, where wetland ecology is much different than the BTNF.	While wetland ecology likely is different, effects of a major reduction in emergent vegetation on tadpoles has application to other areas. Emergent vegetation in the study ponds (cattails, rushes, and sedges) are similar to emergent vegetation in wetlands on the BTNF, except that cattail typically is a minor component or absent.
279	81		Not in the bibliography.	The reference was added to the Literature Cited section.
280	81		Not in the bibliography.	The reference was added to the Literature Cited section.
281	81		Not in the bibliography.	The reference was added to the Literature Cited section.
282	82		There is no literature indicating that this relationship is inversely proportional.	The explanation for the relationship is provided in the sentence, based on other information in the section… and based on some basic principles: Much of what tadpoles eat in herbaceous-dominated wetlands originates from herbaceous vegetation; livestock eat herbaceous vegetation; and as more herbaceous vegetation is eaten, less herbaceous vegetation remains available. Schmutzer et al. (2008) is one reference provided in support of the statement. The statement was qualified with "has the potential to be," but there is enough indication that it is inversely related for there to be no need for the qualifier.

283	82		Specificall,y wetlands in Tennessee.	See response to comment 278.
284	82		This specific value has not been scientifically tested.	This sentence did not focus on a specific value; it presented a general rule.
285	82		The scientific method has not been applied to this concept. There are a myriad of variables at play which are not addressed here. In addition, the Robel pole can be used to measure height and canopy density, not canopy cover. Canopy cover must be measured on a different dimension.	The scientific method (research) is not needed to apply ecological information to management. There is no inference in the highlighted sentence that Robel poles can be used to measure canopy cover. On any given site, a general rule is that, as canopy cover of relatively-intact herbaceous vegetation declines, Robel pole readings decline. It is common sense that as more vegetation is removed, visual obstruction of herbaceous vegetation declines, and research backs this up. Canopy cover "of relatively-intact vegetation" was added to provide clarity.
286	82		These are entirely different concepts, and are measured in different ways. They are not comparable.	The comment is not clear.
287	82		Retention, canopy cover, and weight of plant material above 2 inches are three different metrics.	Yes, this is correct, and this is why all three are listed and why no attempt was made to use one term to encompass all of them.
288	83		This has not been quantified or tested.	This is incorrect. Numerous studies have demonstrated this, and additional information has been added to the revised report, including references to some of the scientific literature.
289	83		This is not known. The term "proportional" implies that a confirmed and quantified x:y relationship exists.	The comment is incorrect. There are many studies that show this relationship and additional scientific information demonstrates other relationships where studies have not specifically been conducted. This information is detailed in the report. See also response to comment 166.
290	83		Retention/utilization would be very time consuming if appropriate sample sizes are used.	This is correct, and this applies to monitoring of retention / utilization in general (not just for assessing whether suitable conditions are retained for amphibians). However, as yet there has not been any effort to determine and apply statistically rigorous sample sizes to utilization / retention monitoring. No reasons were provided as to why monitoring related to amphibians should be held to a higher standard than range management.
291	83		This was not measured in the study and cannot be assumed. The authors measured vegetation height.	Differences in height between excluded and non-excluded areas was converted to percent retention outside of exclosures using height:weight curves. A more detailed explanation has been provided in the revised report.
292	83		The concepts in this bullet have not been quantified or tested. No literature indicates that this is a factor directly impacting tadpole recruitment.	See response to comment 151.
293	83		This is a hypothesis. We cannot make assumptions without testing it.	This is incorrect. Although the effects of trampling by livestock on survival of eggs, tadpoles, metamorphs, and adults has not been scientifically tested, (1) concern has been expressed by amphibian experts, (2) available scientific information demonstrates the potential for mortality increases with increasing levels of livestock grazing use, and (3) the absence of scientific studies on a specific aspect of the effects of livestock grazing use on amphibians does not excuse ignoring a threat to a sensitive species. Additional information is presented in Appendix A

				of the revised report.
294	83		These are not studies that addressed the information in this sentence.	These and other subject matter experts have documented cases of increased mortality. The sentence in the report did not indicate this was based on any specific research.
295	83		This has not been quantified or tested.	This is addressed in greater detail in the revised report.
296	84		They should be cited here.	The point is that several studies have shown the relationship identified in the sentence. References can be found in the cited document.
297	84		They should be cited here.	The sentence was modified.
298	84		Scientists cannot report results that they do not find.	This is correct, and the sentence in the report does not imply that they can. However, in contrast to "Results" sections of scientific papers, authors routinely have discussions that go beyond their results. The point is that no information was found indicating that soil compaction would not increase with increasing livestock grazing intensity.
299	84		This has not been quantified or tested.	There may be results of research in the published literature, but a concerted effort was not made to locate it. The statement is supported by the identified citation.
300	84		This has not been quantified or tested to my knowledge. If so, a citation is needed here.	Citations and references to sections with citations were added.
301	84		A citation is needed for this statement. Time is much more important than numbers in this case.	See above.
302	84		There is no scientific literature that supports the retention values specified in this paragraph.	There is a large body of scientific literature that went into identifying the minimum retention level identified in the paragraph.
303	84		What information? No study has tested the influence of specific retention levels.	The information is in the "≥60% Retention of Total Herbaceous Vegetation" subsection.
304	84		This varies greatly by site. We cannot assume 70% (or any other value) retention will result in natural veg. conditions for every area on the BTNF.	The highlighted sentence does not indicate or imply that 70% retention would result in natural vegetation conditions. It is not clear what if any change was desired.
305	84		What information? Retention levels have not been tested to determine their influence on response variables.	Introductory information is found on pages 75-87, and more specific information pertinent to the 70% figure is found on pages 88-98. There are no requirements to limit the development of objectives and desired condition statements to elements for which specific studies have been conducted.
306	85		The relationship between retention percentages and natural condition is unknown. Ecological site descriptions are a valid, applicable, and widely accepted way to address this.	The relationship between herbaceous retention and natural conditions was examined in the report, and was addressed in more detail in the revised report (Appendix A). No scientific citations were provided to support the second sentence. I am unaware of any ecological site descriptions that identify herbaceous retention levels that contribute to maintaining native wildlife-communities.
306	85		Not in bibliography.	The referenced document is cited in Patla and Keinath (2005) on page 47, as specified in the sentence.
307	85		These are not peer reviewed literature reviews.	There is no requirement for literature reviews to be peer-reviewed. Nonetheless, it is likely that some were peer reviewed.
308	86		They did not identify a detrimental effect on frogs.	This is incorrect. The authors did find detrimental effects on frogs. For example, on page 211, they reported: "Frog communities differed significantly between wetlands with different levels of grazing intensity (ANOSIM: Global

				R=0.13, P=0.006), and between years (ANOSIM: Global R=0.24, P=0.002). Species richness was significantly higher in wetlands grazed at low intensity (Mean 3.31, S.D. 1.58) than in those grazed at high intensity… Three taxa [of frogs] showed differences in their likelihood of occurrence according to levels of grazing intensity…” Also, on page 213, they assessed that “Frog communities changed significantly under different grazing regimes. In part, this was due to a decline in species richness with increased grazing intensity…” and “Thus, it seems clear that wetland frog communities on the Murrumbidgee River floodplain are significantly influenced by grazing by domestic livestock, and that this is caused by the impacts of those livestock on wetland habitat quality, particularly the vegetation.”
309	86		If they did not specify it and test its inlfuence on response variables, assumptions cannot be made about it as a predictor.	No assumptions were made in the highlighted sentence about 100% or near-100% as a predictor. The sentenced merely implied that near 100% retention is a reasonable expectation inside of an exclosure.
310	86		They specify this would apply until eggs hatch.	This is incorrect. Two of the recommendations on page 44 are to “Locate toad movement corridors and protect them from the impacts of livestock grazing” and “Minimize incidences of trampling by livestock by fencing critical habitat areas.” The authors stated, on page 38, that “Riparian areas provide critical breeding, foraging, and over-wintering habitats for boreal toads, and they are used as dispersal corridors for juvenile toads…” The authors also stated that “reducing interaction between livestock and boreal toads during critical periods **(**Table 3**)** is important to minimizing the effects of livestock grazing on boreal toads…” Page 38 identified critical periods as the breeding period, hatching of eggs, metamorphosis, toadlet dispersal, and overwintering.”
311	86		If there is literature supporting this absolute statement it should be included here.	The same citations as provided in the previous paragraph apply; if there are already openings in the vegetation that allow frogs and toads to sun themselves, additional openings would not be needed. With the restructuring of the document, the paragraph had been modified. Not noted in the comment is that there are no studies demonstrating that creation of small openings in extensive stands of tall, dense vegetation are needed.
312	86		BLM manuals do not use retention as a monitoring tool. Also, this reference is missing from the bibliography.	The first sentence is incorrect. The landscape appearance method outlined in BLM et al. (2008:27) specifically involves estimating what is left after the grazing season, recognizing the results are actually expressed in terms of utilization (but percent utilization estimates are derived from estimating percent retention). Regardless, the referenced “6-20% use” in the highlighted sentence is expressed in terms of utilization, not retention. BLM et al. (2008) was added to the Literature Cited section.
313	86		Use and retention could be close to the inverse of each other in a homogeneous carex community. This would not be true in other plant communities when key species are monitored for utilization	This is correct when percent use is expressed in terms of key forage species and percent retention is expressed in terms of total herbaceous species. If they are both expressed in terms of total herbaceous vegetation, they would always be the exact inverse of each other. The landscape appearance method in BLM et al. (2008) — and the “6-20% use” that is

			(which is typically the case).	highlighted by the comment — is based on percent use of total herbaceous vegetation, not percent use of key forage species like it originally did in BLM et al. (1984), as explained in DeLong (2009).
314	87		This whole paragraph is a mis-application of the landscape appearance monitoring method. It was not meant to translate into specific values and has no direct relationship to retention, real or implied.	This is incorrect, and no supporting documents regarding this assertion were cited. First, the purpose of the landscape appearance method is to arrive at estimates of percent utilization (BLM et al. 1999, BLM et al. 2008:27). Second, estimates of percent utilization using the landscape appearance method are arrived at through assessing characteristics of retained vegetation (i.e., the direct produce is an estimate of percent retention and this is converted to percent utilization, although this is not presented in BLM et al. 2008).
315	87		How do we know this? If there is literature that reports this finding it should be cited here. If frogs and toads are at ground level, the lower 2" of vegetation should be very important for microsite conditions like humidity.	This is explained further in DeLong (2009). References to pertinent sections of the report (where scientific literature was cited) were added to this section. Since it is the canopy of herbaceous vegetation that contributes to humidity retention near the ground level (see literature cited in the Humidity Retention and Temperature Moderation section of the report), a site having all vegetation at a 2” stubble height would be expected to retain little or no humidity compared to the pre-grazed community. No scientific information was presented that would counter this basic principle.
316	87		Stubble heights were intended to apply to the greenline. Utilization/retention cannot reasonably be measured on the greenline.	Yes, minimum stubble heights are most often applied to the green-line. The relevance of the second sentence is unclear, as there are no recommendations in the report for monitoring utilization/retention on green-lines.
317	87		Variability in a handful of clipped utilization cages for retention monitoring is also very high. Power analysis must be conducted to ensure proper sample sizes, as per the interagency monitoring manual (BLM 1999).	Comment noted, but the variability discussed in the highlighted statement pertains to variability in the height from plant to plant post grazing. The BTNF has not begun conducting power analyses to actual use monitoring.
318	87		This is why we use ecological site descriptions to incorporate site specific information to our understanding of systems.	The highlighted statement (and remainder of number 2) is outside the scope of ecological site descriptions. No scientific information was cited as to the applicability of the comment.
319	87		Retention is not a measure of canopy cover.	This is correct, and the statement does not imply that it is. In fact, the statement highlights the difference between the two with respect to importance to wildlife.
320	88		This is not quantifiable and must be explained.	Descriptions were added to the revised report for low, moderate, and strong support. The level of evidence is based on the scientific information presented for that section (in this case “≥70% Retention of Herbaceous Vegetation.”
321	88		This assumption has not been peer reviewed, quantified, or tested.	It is not an assumption, and there are no requirements for peer review or for scientific research to be performed. The desired condition identified in the sentence is based on an extensive literature review and analysis, which is provided in the forthcoming pages of the report (and in Appendix A of the revised report). See the highlighted text related to comment 329: “The basis for this is outlined in the following 10 pages,” which is found on at the end of the paragraph in the report. It has been “quantified.”

322	88		This value is not based in literature. If it has scientific support, references must be provided.	This is incorrect. It is based on an extensive literature review and analysis, which is provided in the forthcoming pages of the report (and in Appendix A of the revised report).
323	88		This assumption has not been peer reviewed or tested, and is not supported by scientific research.	Same as response to comment 322.
324	88		This is not known and is an untested assumption.	Percent use of key forage species can be derived from percent retention of total herbaceous vegetation based on three variables that affect the relationship between percent retention of total herbaceous vegetation and percent use of key forage species: (1) percent retention / utilization of total herbaceous vegetation, (2) percent composition of key forage species in relation to the total, and (3) percent utilization (or retention) of non-key species. There are no other variables. Comment 313 gets at this.
325	88		Range textbooks recommend adjusting use levels to meet objectives.	While this may be the case, they identified a maximum of 30% use of key forage species during the growing season and maximum of 40% use of key forage species during the dormant season for several intermountain West plant communities.
326	88		This is not quantifiable and must be explained.	See response to comment 320.
327	88		This is not quantifiable and must be explained.	See response to comment 320.
328	88		This is not known. No scientific study has quantified the influence of retention on the attributes described here.	See response to comments 321 and 322, and see the highlighted text related to comment 329.
329	88		The basis for a conclusion should be provided before the conclusion.	Opinion noted. By having the conclusion up front, immediately under the pertinent heading, this alleviates people having to search for it.
330	88		This is not known and has not been the subject of scientific study.	For the purposes of meeting Objectives 3.3(a) and 4.7(d) and the Sensitive Species Management Standard, it can no longer be stated that “This is not known,” as estimates are provided in the report and they have a logical and reasonable basis. There is no requirement for this to be the subject of scientific study before applying it in a management setting.
331	88		Robel poles are not appropriate for measuring canopy cover.	This is correct. Robel poles were not designed for measuring canopy cover and the report does not indicate or imply this.
331b	88		The 2" height cutoff has no apparent basis in literature. If it does, it should be listed here.	See response to comment 337.
332	88		Those are general height-weight curves. Height-weight curves differ greatly between species.	Both statements are correct, and this is the reason for expressing percentages in ranges. Note how large the range is, primarily due to differences between plant species as noted in the comment.
333	89		This implies precision in the landscape appearance method that does not exist. Also, BLM (2008) is not in the bibliography.	This is incorrect. The quoted material refers to 21-40% use of herbaceous vegetation, and 70% retention (30% use) fits in the middle of this range. “21-40% utilization class” was added to the sentence for clarity. BLM et al. (2008) was added to the Literature Cited section.
334	89		This assumes that retention is the	Percent retention is the exact opposite of percent utilization

			inverse of landscape appearance use estimates. This may or may not be the case, it has not been tested.	in the landscape appearance method since most criteria used in the method (e.g., percent of seedheads remaining, patchiness, vegetation appearing entirely covered) do not distinguish between key forage species and non-key species (see DeLong 2009b). Even if it were not exact, it would be close, and the statement in the report would still apply.
335	89		This cannot be quantified and must be explained.	See response to comment 320.
336	89		No scientifically accepted definition of canopy cover excludes the bottom 2" of vegetation.	Canopy cover of vegetation taller than 2 inches has been changed to canopy cover of relatively intact vegetation. The purpose of this is to distinguish between vegetation canopy cover that contributes to humidity retention, hiding cover, etc., and grazed plants that contribute little or nothing to them. Additional explanation has been added to the “Plant Material Above a 2-inch Height and Canopy Cover of Relatively Intact Vegetation” subsection in Appendix A of the revised report. No specific wildlife-related concerns were identified in the comment. By the time stubble height in a community declines to 2 inches, Robel pole readings are at 0 (zero).
337	89		Why did the author exclude the lowest 2" of vegetation if "near ground level" metrics are of interest?	In short, it is because live plant material nearest the ground contributes very little to retaining humidity near the ground, moderating temperatures near the ground, providing hiding cover, and providing insect habitat relative to the major contribution of the above plant material. This is especially important when (1) the unit of measure is biomass and (2) plant material closest to the ground contains a disproportionate amount of the weight. This is explained further in the “Plant Material Above a 2-inch Height and Canopy Cover of Relatively Intact Vegetation” subsection in Appendix A of the revised report. No specific wildlife-related concerns were identified in the comment.
338	89		The landscape appearance method does not measure or indicate a percentage of canopy cover.	This is correct, and the highlighted sentence does not indicate that it does. “Patchiness” is a criteria of the landscape appearance method (BLM et al. 2008:27), which involves canopy cover of ungrazed vegetation, but the method does not provide a measure of canopy cover.
339	89		This study was conducted with row crops planted at varying spacings in New Jersey, not under natural vegetative conditions.	The study examined the effects of row spacing and percent canopy cover of vegetation on humidity and temperature near ground level among other variables. Since this information is not available for herbaceous communities occurring on the BTNF, information from other sources was obtained. The report only addressed the basic principles involved (e.g., no effect vs. direct relationship vs. inverse relationship) and did not apply specific values (e.g., a specific range of humidity levels at a given canopy cover at specific ambient temperatures, etc.) Note the unquantified graphs in Figure 1 (pg. 78) to convey the basic principles. There is no indication that the basic principles involved (e.g., declining humidity retention near ground level with declining amounts of plant material having the capability to “trap” humidity below its canopy) would be different in these communities, recognizing that the rate of change would be different with different plant structures (e.g., soybean plants vs. tufted hairgrass plants). However, the

				report did not get into this level of specificity. Additional explanation was added to the revised report (in Appendix A). See also response to comment 268 and 345.
340	89		These studies were conducted on cereal crops.	See response to 339.
341	89		These were not the conclusions of Marlatt (1966). Marlatt (1966) was strictly intended to inform the most efficient spacing of row crops.	The assessment made in the highlighted statement draw from results of Marlatt (1966) and the other cited material. There is no reason why results of studies cannot be applied to purposes other than the purposes of the study, and it would be incomprehensible to forego the use of such information just because the intended use does not match the purposes of conducting the research.
342	89		The results of Marlatt (1966) were intended to apply to row crop spacing in the study environment (New Jersey).	See response to comments 339, 343, and 345.
343	90		It does not apply, it was intended for row crop farmers in the Northeast US.	To say the results of Marlatt (1966) have absolutely no application has no basis in the application of scientific information to resource management, and taking such a hard line foregoes the use of a very large amount of information that can be used in addressing resource issues. See also responses to comments 339 and 345.
344	90		If the author did not create this drawing, the reference should be cited.	The illustration was created by the author.
345	91		This is true of row crops in New Jersey. It's relationship to rangelands in Wyoming is unknown. Air movement is surely different in row crops and native range.	See response to comments 339 and 341. Yes, there is no doubt that air movement is different in row crops in New Jersey than in native meadows in Wyoming. Note the different, unquantified lines in graph "b" in Figure 1 (pg. 78), using information from cited studies. Rangelands in Wyoming may have lines outside the scope of what is shown, but the basic principles would be the same, including higher wind speed above the canopy and declining wind speed as the height above the ground (below the canopy) declines. The denser the vegetation the steeper the line.
346	91		There is no scientific explanation of why we should exclude the lowest 2" of vegetation.	See response to comment 337.
347	91		They did not study or reference the influence of retention. Researchers cannot report on results that were not measured.	The first sentence is incorrect since the researchers did evaluate the effects on response variables against cattle grazing utilization (utilization of total herbaceous vegetation). The text in the report does not state or imply that researchers reported on results that were not measured. As such, the point of this comment is unclear.
348	92		The author previously equated retention to the inverse of utilization. If this were the case, Allen-Diaz et al. (2010) would show retention values of 51%-96%. The author of this document should indicate why Allen-Diaz et al. (2010) and Roche et al. (2012) cannot be used.	Additional details are provided in the highlighted section and in a new section of Appendix A of the revised report ("Information on Several Amphibian Studies Cited in this Report"). This new section summarizes research by Roche et al. (2012a), Roche et al. (2012b), and McIlory et al. (2013), and other research projects. Among other things, it explains how retention levels were estimated based on results of their studies. One important point is that retention levels were lower where (e.g., in and next to wetlands) and when (May-July) response variables were measured as

				compared to where (meadows) and when (June-September) livestock utilization was measured.
349	92		This is not quantifiable and must be described.	See response to comment 320.
350	92		There is no literature or scientific study that supports 70% retention as a threshold as it relates to shading.	There was little scientific information to draw from for this element, but the proportion of intact and relatively-intact vegetation provides a good indication of available shading.. At near-100% canopy cover of intact and relatively-intact herbaceous vegetation, it is clear that sufficient shading is provided. There appears to be sufficient information (including in the "Humidity Retention, Temperature Moderation, and Protection from the Sun" subsection earlier in the report) showing 70% retention of herbaceous vegetation likely retains sufficient shading. By 40% retention, there is virtually no shading and radiant heat from exposed ground and basal vegetation would likely offset any effects of the minimal shading provided at this retention level. Additional information was added to the revised report.
351	92		That is because they did not study the affects shading.	Also because retention levels were different.
352	92		Researchers cannot report on results that were not measured.	See response to comment 347.
353	92		This is not quantifiable and must be explained.	See response to comment 320.
354	92		Canopy cover and height occur on two different dimensions.	This is correct. The text does not state or imply that canopy cover and height are on the same dimension. Height was not covered in the sentence, except in the context of referring to a height category, but this in no way inferred any relationship between canopy cover and height.
355	92		There is no indication of what "low to moderately-high" means in this case.	See response to comment 320.
356	93		No relationship between retention and canopy cover has been quantified or tested.	The relationship is covered in Table 5 (and supporting documentation) and is illustrated in Figure 2. Additional information on the analysis is included in the revised report.
357	93		This assumption has not been studied scientifically or tested. There is no support in the literature for these values.	The statement is based on figures in Table 5 and the basis of the table has been explained in more detail in the revised report. The estimates are based on published scientific information and basic principles.
358	93		There is no reason that the lowest two inches of vegetation should not apply to hiding cover for amphibians.	See response to comments 336 and 337.
359	93		The authors did not come to this specific conclusion, and how it is derived from those studies must be explained. Neither Roche et al. (2012) or Allen-Diaz et al. (2010) contain the term "retention".	See response to comment 348. The explanation of how percent retention was estimated based on results of the studies and other published literature.
360	93		They did not evaluate utilization levels as a treatment.	This is correct because they did not evaluate the effects of utilization levels, but they did more generally evaluate the effects of cattle utilization as a treatment. Roche et al. (2012) clearly and repeatedly stated that cattle exclusion, partial exclusion, and non-exclusion were the main treatments. Exclosures were used to assess the effects of

				allowing utilization by cattle.
361	93		This was true of early season use, but not annual use. Annual values were available in Figure 13 (Allen-Diaz et al. 2010).	Exactly! Utilization continued to be measured after the measurement of Yosemite toad response variables ceased, meaning that later utilization levels cannot be evaluated against toad response variables. More detail was added to the revised report (the "Information on Several Amphibian Studies Cited in the Report"). See also response to comment 348.
362	94		This is circumstantial, and may be true or not true, but was not the intent of the study.	Additional qualifiers have been added to the highlighted statement. Results of the study lend some support to the highlighted assessment, with the recognition that hiding cover was not specifically sampled.
363	94		This is an assumption.	This was based on information in the published papers and report and based on a conversation with one of the authors.
364	94		This is not quantifiable and must be explained. Is it different than "moderate to moderately-high"? If so, in what way?	See response to comment 320.
365	94		Schmutzer et al. (2008) did not measure utilization by livestock. The livestock treatment was presence or absence.	They used the same study wetlands as Burton et al. (2009) in which emergent vegetation height, percent horizontal cover, and percent vertical structure were measured before and after grazing. Additional detail was added to the revised report.
366	94		This is not quantifiable and must be explained.	See response to comment 320.
367	95		This is not quantifiable and must be explained.	See response to comment 320.
368	95		This is an extreme generalization. Height-weight relationships vary greatly between plant species.	Height was changed to Robel pole readings in the revised report since Foote and Hornung Rice (2005) measured structure using a Robel pole. Yes, height-weight relationships vary by species, and this was the reason for only using sedge height-weight information for sedges. See also response to comments 332 and 371.
369	95		The author's method is not precise enough to detect a change of 5%. The threshold in question is perceived and assumed by the author; it is not apparent.	No effort was made in the highlighted section to detect a change of 5%. I erred on the side of concluding that 70% retention was probably still okay even though it was below the apparent threshold of 75%. I did not attempt to conclude that, because 70% falls below the apparent threshold of 75%, 70% is too low to provide for the needs of dragonflies and damselflies… This would have involved attempting to "detect a change of 5%."
370	95		Citation needed for this statement.	A citation is found in the next sentence.
371	95		General height-weight curves developed for rapid assessment (BLM et al. 1999) are not appropriate for defining a specific value (retention) that has no basis in the literature.	BLM et al. (1999) and Kinney and Clary (1994) provide height-weight curves for a range of plant species. Specific values were not derived from this information; typically, numeric figures have been expressed as ranges. The data available in these two sources allow percent retention of herbaceous vegetation to be calculated (within ranges) without any assumptions. The purpose of developing these curves is immaterial.
372	95		Roche et al. (2012) did not evaluate the influences of livestock on retention levels. Utilization levels were not evaluated as a treatment.	See response to comment 360.

373	95		This study cannot be used to evaluate the effects of retention because utilization level was not tested as a factor.	See response to comment 360. Regardless, the comment is consistent with the sentence.
374	95		Citation needed for this statement.	This is addressed in more detail in Appendix A of the revised report.
375	96		These references must be cited.	The two references are cite in Maxell (2000).
376	96		These should be cited here.	This is a valid point, as “other authors” were generally referenced and they should be identified. Because these references were not found, the sentence was changed. Also, it did not require referencing other authors to point out that the direct support for the livestock-created openings is incidental observations.
377	96		What does the science say?	Two points. First, there are no known studies demonstrating a benefit of livestock-created opening to either spotted frogs or boreal toads. Second, there is sufficient ecological and behavioral information on both species indicating that livestock-created openings in otherwise extensive stands of tall, dense herbaceous vegetation is beneficial to these species. The discussion on this topic was expanded in the revised report.
378	96		This assumption has not been quantified or tested.	It is a conclusion based on an extensive review of scientific literature. And, as acknowledge in the report, a minimum of 70% retention may not be a high enough threshold to sufficiently conserve suitable water quality, protect against accelerated declines in water levels, sufficiently protect against mortality caused by trampling, etc.
379	96		This assumption has not been quantified or tested.	Same as response to comment 179. Scientific information was reviewed in the “Water Quality” section earlier in the report (beginning on page 42), and the water quality section in Appendix A of the revised report was greatly expanded to provide more clarity to the science. Available scientific information indicates that water quality should be sufficient in many breeding wetlands where 70% of herbaceous vegetation is retained, but that water quality will be impacted in a portion of breeding wetlands at this herbaceous retention level. Variability from wetland to wetland is an important issue. A definitive, strong conclusion that ≥70% retention will sufficiently protect water quality is not possible.
380	96		The three studies need to be cited here.	They are. This highlighted phrase is the opening to the paragraph.
381	96		This is not quantifiable and must be explained.	See response to comment 320.
382	96		This has not been quantified or tested.	One of the purposes of the report was to examine a wide range of available scientific literature and ascertain a threshold. This was done.
383	96		General height-weight curves developed for rapid assessment (BLM et al. 1999) are not appropriate for defining a specific value (retention) that has no basis in the literature.	See response to comments 332 and 371.
384	96		Single species biomass, height, and retention are three distinct vegetation	Yes, biomass, height, and retention are distinct attributes and there are no statements in the report that say otherwise.

			attributes. Height-weight curves vary among sedge species and ecosites.	The response to the second sentence is the same as the response to comment 368.
385	97		Use levels were not evaluated as a treatment, therefore retention cannot be used as a surrogate predictor for any of the results.	Same as response to comment 360. Also, even though Roche et al. (2012) did not collect and evaluate specific utilization data, utilization in the study area was measured by Allen-Diaz et al. (2010), Roche et al. (2012b), and McIlroy et al. (2013) and sufficient information exists to make the conclusion in the highlighted section. This includes correspondence with one of the authors. Additional details on applying their results to the BTNF are provided in the revised report ("Information on Several Amphibian Studies Cited in this Report" in Appendix A).
386	97		If there is scientific support for this statement it should be cited here.	The highlighted statement is part of the opening sentence for the subsection. Scientific support was provided in earlier sections of the report. In the revised report, scientific support is found in the "Surface Water Duration in Small Pools" subsection in the "Roles of Herbaceous Retention and Openings" section of Appendix A and in the 70% retention subsection of the "Suitable Conditions with Respect to Herbaceous Retention" section in Appendix A.
387	97		There is no scientific support for this assumption. The influence of a 70% retention standard on small breeding wetland persistence has not be quantified.	Most of the science reviewed for this report is outlined in the "Surface Water Duration in Small Pools (Retention of Water into Mid and Late Summer)" section earlier in the report, and additional science was added to the revised report. In regard to the second sentence, this was one of the purposes of this report, and it was based on a review of scientific information.
388	97		This assumed phenomenon has not been quantified or tested for the area in question.	This is not an assumed phenomenon. It has been identified as a concern by several amphibian experts, and there is no arguing that extraction of water results in accelerated declines in water levels when drinking by livestock occurs in wetlands where water outputs are already exceeding water inputs. Even though it should have to be demonstrated (it's just common sense) the report demonstrates scientifically that it is a real threat. Additional scientific information was added to the discussion in Appendix A of the revised report.
389	97		The landscape appearance method is not applicable to homogeneous wetland plant communities.	There is no mention of this in BLM et al. (2008) or other document and no scientific support was provided in the comment, but it does bring up a valid point. And this is the main reason for providing information on vegetation height in Table 5 and Figure 2. Additional information was added to address this issue, including further discussion of "even" grazing as described in BLM et al. (2008) and presentation of expected stubble heights at each retention level that was evaluated and effects thereof.
390	98		If this is supported by literature it must be cited here.	This topic was covered in more detail in the "Survival, as Affected by Vehicles, Heavy Equipment, and Livestock" section later in the report (starting on page 120). The revised report was restructured and more scientific information was added on this topic (Appendix A).
391	98		This assumption has not been quantified or tested.	Yes, it has and the scientific information is summarized after the statement.
392	98		This assumption is impossible to know.	This comment does not make any sense.

393	98		This is an assumption that is not supported by scientific literature.	A crosswalk table is provided in the back of the report (Appendix B). Scientific information is not needed for such simple, mathematical calculations. Additional information was added on the procedures of the crosswalks.
394	98		The cannot be quantified and must be explained.	See response to comment 320.
395	98		This cannot be quantified and must be explained.	See response to comment 320.
396	98		There is no scientific information that evaluates the influence of retention levels on spotted frog and boreal toad success or viability.	The purpose of this portion of the report was to examine available scientific information to come up with a reasonably defensible herbaceous retention threshold for ensuring that Forest Plan Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and higher-level requirements will be met with respect to spotted frogs and boreal toads on the BTNF. The analysis included the examination of a large volume of scientific information.
397	98		We cannot know this because no study has quantified the influence of varying retention levels on a response variable.	This is incorrect, an extensive analysis was completed (this portion of the report), which included an examination of a large volume of scientific information. Also, several of the studies addressed response variables of spotted frogs, boreal toads, and other amphibians in response to livestock utilization.
398	99		This cannot be quantified and must be explained.	See response to comment 320.
399	99		The relationship between canopy cover and retention is unkown.	This is incorrect. See response to comment 356.
400	99		General height-weight curves developed for rapid assessment (BLM et al. 1999) are not appropriate for defining a specific value (retention) that has no basis in the literature.	See response to comments 332 and 371.
401	99		What values does this statement represent?	See response to comment 320.
402	99		This cannot be quantified and must be explained.	See response to comment 320.
403	99		This assumption is unknown and has not been addressed in scientific literature.	See response to comment 322.
404	99		List citations supporting this statement.	Pertinent literature is provided later in the paragraph and in the “Humidity Retention, Temperature Moderation, and Protection from the Sun” subsection earlier in the report (pg. 76).
405	99		This study is not applicable to native plant communities in WY. It is directed toward row crop producers in the NE US.	See response to comments 339, 343, and 345.
406	101		This study was based on row crops in New Jersey. It's relationship to rangelands in Wyoming is unknown.	See response to comments 339, 343, and 345.
407	101		This citation should stand alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
408	101		This assumption has not been quantified or tested. Retention and cover relationships will vary greatly depending on the vegetation type.	The percentages are based on figures in Table 5 and the basis of the table has been explained in more detail in the revised report. The estimates are based on published scientific information and basic principles.

409	101		This assumption is unknown and has not been tested or quantified.	The highlighted assessment is based on a review and synthesis of scientific information, which is provided in the “Humidity Retention, Temperature Moderation, and Protection from the Sun” subsection earlier in the report (pg. 76), and the estimated amount of vegetation remaining that has the capacity to reduce wind speeds.
410	101		This was true for row crops in New Jersey. Its relationship to native Wyoming rangelands is unknown.	See response to comments 339, 343, and 345.
411	101		They should be cited here.	Supporting references can be found in Burton et al. (2009), as indicated in the text.
412	101		This cannot be quantified and must be explained.	See response to comment 320.
413	101		They did not address retention.	Same as response to comments 360 and 385.
414	101		What does this mean and how did the author come to that conclusion?	See response to comment 320. While Roche et al. (2012) “found no evidence of improved toad breeding pool habitat conditions following fencing compared to standard US Forest Service grazing management” (i.e., ≤40% use of total herbaceous vegetation), utilization was substantially lower where and when response variables were measured; see also response to comment 348.
415	101		This is an assumption that has not been quantified or tested.	See response to comments 336 and 337.
416	101		This cannot be quantified and must be explained.	See response to comment 320.
417	102		This should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
418	102		This cannot be quantified and must be explained.	See response to comment 320.
419	102		There is no literature support for this specific value. There also is no reason that vegetation below 2" shouldn't be considered hiding and escape cover.	See response to comments 409, 336, and 337.
420	102		They should be listed here.	See response to comment 411.
421	102		They did not address retention.	Same as response to comments 360 and 385.
422	102		This cannot be quantified and must be explained.	See response to comment 320.
423	103		This is an assumption that has not been scientifically tested.	See response to comments 336 and 337.
424	103		This doesn't mean anything about predation risk.	Additional information has been added to the revised report that indicates boreal toads have a substantial number of predators (e.g., the list of known predators is equally long).
425	103		This is circumstantial, as the authors did not test level effects of utilization as a factor	No, this assessment was based on data presented in Allen-Diaz (2010), as noted immediately after the highlighted statement, as well as communication with one of the authors.
426	103		The study area was in TN; the relationship of results to WY rangelands is unknown.	See response to comment 278.
427	103		No relationship between retention and detritus biomass has been established. Retention was not analyzed by Schmutzer et al. (2008). The	While no exact formula has been developed, there obviously is a relationship between percent retention of herbaceous vegetation and herbaceous-based detritus. The amount of detritus on a given site will be higher with increasing

			treatments were cattle use and no cattle use, not utilization levels.	percent retention of herbaceous vegetation. See also response to comment 365 regarding whether retention ws analyzed by Schmutzer et al. (2008).
428	103		This is impossible to know since they didn't measure retention or analyze its effects.	See response to comment 365.
429	103		This relationship has not been quantified or tested.	Numerous scientific studies have been conducted on the effects of livestock grazing on a wide range of invertebrate taxa, and none of these studies support the assessment that herbaceous communities with 60% or 50% retention approximate pre-grazed diversity and abundance. The preponderance of information shows that diversity and abundance in post-grazed communities do not approximate pre-grazed communities. This topic is addressed in more detail, including additional scientific information, in the revised report.
430	104		Figure 1.e doesn't say if it applies to forbs, grasses, or grass-likes. It is a conceptual figure and has no specific values associated with it.	This is incorrect. The caption on page 78 of the report states that Figure 1.e is for a mixed legume pasture and for a soybean cultivar, respectively, for the two graphs. It is a conceptual figure based on data from the identified sources.
431	104		This was not expressed in Black et al. (2007).	The citation should have been Black et al. (2011). Warren (1993) is another citation.
432	104		They should be cited here.	See response to comment 431.
433	104		Utilization/retention was not measured used as a treatment in Foote and Rice-Hornung (2005).	This is incorrect. Foote and Hornung Rice (2005) measured structure using a Robel pole at 2-week intervals in season-long, deferred, and no grazing treatment areas. Percent change in robel pole readings was crosswalked to percent retention.
434	104		This is not in the bibliography. Perhaps the author is referring to Foote and Hornung (2005), which should actually be Foote and Rice-Hornung (2005).	This is correct. The correction has been made.
435	104		This cannot be quantified and must be explained.	See response to comment 320.
436	104		They did not analyze the effects of retention.	Same as response to comments 360 and 385.
437	105		No study has tested the influence of retention on the variables listed in this paragraph.	This is incorrect. Studies exist on the effects of livestock grazing at different levels on some of the elements (e.g., water quality, soil compaction). Results of pertinent studies were made more prevalent in water quality discussions. A large amount of literature was examined to assess the effects of different retention levels on these and other elements. This was the purpose of this part of the report, which is now in Appendix A. See also response to comments 179 and 379.
438	105		No study has quantified the influence of retention levels on water quality.	This is incorrect. Several studies are cited in the report, including the paragraphs that follow the highlighted text. See also the "Water Quality" section of the report. The water quality part of the report was expanded in the revised report to include additional scientific information that addresses the effects of livestock grazing intensity.
439	105		They measured plant heights, not utilization or retention.	See response to comment 433.
440	105		This is not a viable assumption.	No reasons were provided as to why the author of the

				comment felt the conversion from changes in Robel pole readings to percent retention was not valid.
441	105		The results of Schmutzer et al. (2008) are not related to the effects of different utilization levels. Retention was not referenced by the authors.	See response to comment 365.
442	105		Their treatments were use and no use, not levels of grazing intensity.	See response to comment 365.
443	105		The authors did not address retention or utilization.	See response to comment 365.
444	106		No scientific studies assess retention level effects.	This is incorrect as has been addressed in responses to several comments.
445	106		There is no indication that this metric is tied to utilization levels or retention.	There is a clear connection as was described in the report. Percent retention is inversely related to livestock grazing intensity, and livestock grazing intensity is inversely related to reductions in water available in small pools where surface water and/or groundwater inflows do not offset the removal of water by livestock. The basis of this is outlined in the report.
446	106		The relationship between retention and this metric have not been studied or quantified.	There is a clear connection as was described in the report. Percent retention is inversely related to livestock grazing intensity, and livestock grazing intensity is directly related to the potential for increased mortality of frogs and toads. The sections in the revised report on the effects of trampling on frog and toad survival were expanded, including the incorporation of additional scientific information.
447	106		If this has been expressly studied or analyzed in any peer reviewed document it should be included here.	See response to comment 446.
448	106		Stubble height in meadows and uplands is not an accepted standard for monitoring. It was intended to address greenline vegetation only.	This section was included because some people feel that a stubble height of 4 inches in frog and toad habitat would be sufficient to meet their needs.
449	107		This is because no manual or primary literature is suggesting a 4" stubble height standard for these ecosites.	See response to comment 448.
450	107		No document that I'm aware of suggests this as a standard for anything outside of the greenline.	See response to comment 448.
451	107		This cannot be assumed; each site is different.	The reason for giving a range of heights, as an example, is that each site is different. A different way of stating of phrasing the sentence is… "for sedge communities having heights of 14-28 inches…"
452	107		That picture only applies to conditions at that site. Plant communities vary too much to extrapolate this to all wet meadows.	There was no intent stated or implied that conditions shown in Figure 6 apply to all wet meadows.
453	107		This reference does not support the statement.	See response to comments 268, 339, 343, and 345.
454	107		This study was conducted on cereal grain fields, not native rangelands.	See response to comments 268, 339, 343, and 345.
455	107		This study was conducted on crops, not native rangelands.	See response to comments 268, 339, 343, and 345.

456	107		This is possible, but unsubstantiated by scientific information.	The "Survival, as Affected by Vehicles, Heavy Equipment, and Livestock" section provided the information that had been compiled for the report. Additional scientific information has been added to the revised report (in Appendix A), and the potential for trampling at given livestock grazing use intensities is greater than what was first assessed.
457	107		There is only one way to calculate an average. No manual or scientific document that I'm aware of suggests applying a 4" stubble height to anything outside of the greenline.	The point of the first sentence is not clear; it did not identify a perceived error in the report. See response to comments 316 and 448 regarding the second sentence.
458	107		This is an assumption and not substantiated by literature.	This is not a scientific issue. It can readily be assessed by using math to calculate averages using different extremes of individual plant heights (see first sentence of comment 457), and assessing the heights of the majority of plants.
459	107		What scientific literature has led the author to this conclusion.	If, in the example provided, 70% of the sedge plants in a community are 2 inches tall, the structure of the community is driven by these short plants with tufts of taller vegetation (i.e., 30% of plants at 8-10 inches tall). This is substantially different than an ungrazed sedge community. Additional explanation was added.
460	107		This is subjective.	See response to comment 320.
461	108		The information to support this statement should be included.	This sentence was deleted.
462	108		No single condition favors all species.	This is correct, and the highlighted statement does not state or imply otherwise.
463	108		This has not been quantified or analyzed scientifically in regard to retention.	This was thoroughly examined, including an in-depth analysis of scientific information, in previous sections.
464	108		This is not known.	See response to comment 463. If we can't demonstrate that 70% retention "would still retain suitable habitat conditions," we certainly would not be able to demonstrate that 60% is sufficient. A range of information presented in the report indicates there to be some question on the ability of a70% herbaceous retention to provide suitable habitat and provide suitable protection from trampling, reductions in water quality, and accelerated declines in water levels, but it is felt there is sufficient information on balance to support 70% retention as a threshold with the important caveat that substantive areas of ≥80% remain.
465	108		This depends entirely on the specific site in question and a single value is not to be applied across landscapes.	The cited authors identified a maximum of 30% utilization of key forage species during the growing season and a maximum of 40% during the dormant season for intermountain west vegetation types typically grazed by cattle. The crosswalks (Appendix B) recognize that percent retention of total herbaceous vegetation and percent retention of key forage species do not match in most situations.
466	108		This suggestion has not been scientifically tested.	This is not a suggestion. It is based on a crosswalk from percent retention of total herbaceous vegetation to percent utilization of key forage species. Additional explanation was added on the crosswalk.
467	108		These grasses are not often preferred species.	These are the sites that are consistently grazed first and are grazed heaviest.

468	109		This is the author's extrapolation, range science has not made this assumption. Utilization studies are available for many native range grasses.	No, the highlighted section was in reference to the results being extrapolated in livestock grazing management; this has been used to support a maximum of 50% utilization. The text in the revised report was adjusted. Yes, effects of utilization vary from plant species to plant species. Because Kentucky bluegrass is able to withstand higher levels of grazing than many native grasses, 50% defoliation likely is beyond the level whereby root mass can be maintained. As an example, results from Heady (1950) demonstrate that bluebunch wheatgrass declines in vigor and survival when plants are defoliated by 50%. Further explanation was added to the revised report.
469	109		There is no scientific literature that supports this statement.	This is correct. This had been inserted to be able to allow for over-use by livestock in some years (up to 1 in 5 years), but it had not been analyzed with respect to scientific literature. The sentence was deleted.
470	110		This is not known and has not been scientifically tested.	If the comment is correct, this means there is insufficient information to support a retention level as low as 70% and it would mean that 75% or 80% retention would be needed. Given additional information added to the revised report, this may not be too far off the mark. As stated in the highlighted statement, there is a “reasonably high” probability that livestock use would be low enough to meet management direction for spotted frogs and boreal toads, and this is based on a thorough review of a large volume of scientific information. Given the information presented in this report, it can no longer be stated that “This is not known.” However, as alluded to in the paragraph above, additional scientific information that has been added to the report has increased support for a higher retention level. Even before the inclusion of this information (into the revised report), amphibian experts asked why a higher retention level was not being pursued, based on available scientific information.
471	110		There is no literature indicating that this is a limiting factor for frogs and toads. It is assumed by the author, but a treatment effect has not been measured.	See response to comments 151 and 358.
472	110		This is not known and has not been scientifically tested.	See response to comment 470.
473	110		There is no literature supporting the application of retention in this way.	This is incorrect. Support for a 1½ mile buffer is provided in the “Buffer Zones and Levels of Protection” section of the report. Scientific information added to the revised report indicates that many metapopulations have more individuals moving beyond 1/3 mile from breeding sites than was evaluated in the report dated 01/09/2013. The “Height and Structure of Herbaceous Vegetation, Thatch, and Litter” section provides a thorough review of scientific information supporting the statement, and Appendix A of the revised report contains even more scientific information.
474	110		There is no scientific study supporting the assumption that meeting retention levels will result in a "natural	None of the conclusions, objectives, or statements of suitable conditions make this assertion.

			composition of herbaceous vegetation".	
475	110		This has no basis in scientific literature.	A minimum of 70% retention being needed to meet Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and higher-level policy is based on the thorough review and analysis of scientific literature that is presented in the “Height and Structure of Herbaceous Vegetation, Thatch, and Litter” section, and this review was expanded in Appendix A of the revised report. The 80% was incorporated solely in response to making the objective more workable for livestock grazing in recognition that it is near impossible to avoid overuse of some areas. It was removed from this objective.
476	110		This has no basis in scientific literature.	This is based on negative impacts of multiple stressors being compounded in dry years, as discussed in the report. No scientific information was presented that counters this.
477	111		There is no scientific support for the use of retention.	See response to comment 470.
478	111		It depends on the method used to measure utilization.	This is incorrect, but it must be recognized that percent utilization of total herbaceous vegetation is the flip-side of percent retention of total herbaceous vegetation, and that percent utilization of key forage species is the flip-side of percent retention of key forage species.
479	112		It is an acceptable method when sample size and variation are properly accounted for.	Comment noted.
480	112		The landscape appearance method is not intended to accurately estimate utilization levels. It is intended as a broad scale tool for use pattern mapping.	While it is not intended to provide exact estimates of utilization, it does provide estimates of percent utilization in ranges. The Wyoming Rangeland Monitoring Handbook (BLM et al. 2008) does not discuss the use of the landscape appearance method for “use pattern mapping,” but it could conceivably provide information for this.
481	112		What is this number based on?	This is an attempt to identify an ecologically meaningful (to frogs and toads) geographic scale. A danger is that, if too large of an area comprises the “part” discussed in the paragraph, impacts will be diluted by virtue of the sampling method.
482	112		There is no reason to convert back and forth based on assumptions that have not been tested. If retention can be measured directly, it should be.	The Forest Plan call for an adequate amount of suitable forage and cover to be “retained” for wildlife (Objective 4.7(d)) and retention is the most meaningful for wildlife. Regarding the second sentence, this would be the most straightforward for spotted frogs, boreal toads, and other wildlife. Percent herbaceous retention data is needed on too many sites (with high variability among sites) to accurately convert from percent use of key forage species to percent retention of total herbaceous vegetation.
483	113		This may or may not be true. The merits of managing for retention levels has not been evaluated.	No concerns were identified regarding the first sentence. Regarding the second sentence, the merits were thoroughly examined in the report and the review and analysis of scientific data was expanded in the revised report.
484	113		Not in the bibliography. This should be cited alone.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
485	114		What are these numbers based on?	70% retention equates to an estimated 30-50% utilization of key forage species, depending on (1) the composition of key forage species, and (2) percent use of non-key forage

				species. A conservative maximum, therefore, would be 30-35% use of key forage species as pointed out in the highlighted statement. Appendix B in the 01/09/2013 report provides one crosswalk. This was expanded in the revised to include crosswalks going both ways.
486	114		This is extremely site specific, and a general height-weight curve is not intended to provide this level of precision.	Yes, it is an example. There are many sedge communities that have heights of 15-20 inches.
487	114		What is the scientific basis of this value?	This is the flip-side of the 80% in the objectives. See response to 475.
488	114		If this has any basis in literature it should be listed here.	Additional information was added to explain the basis.
489	114		These papers cite other authors (who should be listed here) that studied associated topics.	The highlighted authors cited literature in support of their assessments.
490	114		The references included here do not test of quantify this effect.	The author made an assessment based on his research.
491	114		Citations needed.	A citation was added.
492	116		"Proportional" implies that a specific relationship is known, when this is not the case.	See response to comments 166 and 289.
493	116		This relationship has not been quantified or described in the literature.	Pertinent scientific information is found in the “Soil Looseness and Porosity” section.
494	116		Reduction of what metric?	The metric is streambank stability, as specified in the highlighted sentence.
495	117		This is not true. Wet soils are more easily compacted by livestock.	Yes; the sentence was corrected. The intent was that moist soils contribute to a looser structure, but not when being walked on by livestock.
496	117		This is surely possible but has not been tested.	Comment noted.
497	117		The relationship between these variables and retention is unknown and has not been tested.	See response to comment 445. The general relationship is known (increasing potential for soil compaction with increasing grazing use intensity), and grazing use intensity is inversely related to retention.
498	118		This varies greatly by site.	Yes, percent canopy cover of willows varies by site. No scientific information was cited in support of this comment.
499	119		Climate change may play a large role in willow/aspen decline as well.	Additional information has been added to the revised report.
500	119		If this is specified in scientific literature those references should be cited here. I am not aware of research that verifies this statement.	This sentence has been deleted.
501	122		This may be true, but it has not been recorded, quantified, or tested in any scientific research.	This is comment is incorrect. Additional effort was put into identifying applicable research, and the “Survival as Affected by Trampling” section in the revised report (now in Appendix A) was expanded to incorporate scientific research specific to this topic. Additional Unfortunately time needs to be put into examining scientific information and putting numbers to things that are common sense. We know that cows and sheep step on frogs, toads, and other small wildlife. Logic tells us that, the more times a hoof hits the ground in a given area, the greater the chance of frog

				and toads in the area being stepped upon.
502	123		One document, Ross et al. (1999).	Several additional citations were added to the discussion.
503	125		The effect of retention levels on limiting mortality due to crushing has not been addressed scientifically.	Limiting livestock grazing use (which inversely related to retention) has been identified by several amphibian experts as a way to limit mortality due to crushing of frogs and toads, including spotted frogs and boreal toads (this includes Keinath and McGee 2005). See response to comment 501.
504	125		What constitutes "suspected" breeding sites?	Breeding sites having capable habitat and where juveniles have been observed, or where other signs indicate breeding nearby.
505	125		Culverts have negative impacts on stream channel conditions.	Comment noted. No scientific support was provided. This was identified as a potential conservation action. Additional stipulations were added.
506	126		5-10% is a value that is provided, but the author states that no number is provided.	This is correct. No numbers are provided in the objective, but the range is provided to illustrate the intent.
507	128		There is no indication in the literature that this will have a meaningful effect on frog/toad success.	This is incorrect. Given the elevated probability of crushing of metamorphs associated with higher concentrations of livestock at breeding wetlands when metamorphs are emerging, absence of livestock at breeding wetlands (due to deferred rotation system) would reduce the chances of crushing. Several amphibian experts have expressed concern about livestock being present at amphibian breeding sites when metamorphs are emerging. This discussion was expanded in the revised report.
508	130		This is not known.	This is incorrect. Information is presented in the report showing this is the case.
509	133		They should be cited here.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
510	134		It should be cited here.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
511	134		They should be listed here.	The references can be found in Dawe and Goosen (2008).
512	134		It should be noted that this was a laboratory study.	A note was added to this effect.
513	134		Not in bibliography.	This reference was added.
514	134		This information is from unpublished reports by Bondello and Brattstrom (1979).	The text was modified accordingly.
515	134		They should be included here.	Citations/references to the study can be found in Dawe and Goosen (2008).
516	138		This should be cited alone. It is not in the bibliography.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
517	138		WY G&F may have a lot to say about this objective and its extent.	Comment noted.
518	138		The primary literature cited in these documents should be used here.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
519	138		WY G&F and the fishing public would be interested in the consequences of this action.	Comment noted.
519	140		Not in bibliography.	These reference were added.
520	140		If they are referenced, they must be cited.	Comment noted.
521	140		If they are referenced, they must be	This is a standard way of citing primary literature sources

			cited.	when the primary literature source was not obtained.
522	141		There is reason to believe that disease is the greatest factor causing decline in frog/toad populations. It is not addressed in any of these monitoring objectives.	A monitoring objective was added.
523	142		A strong effort may be useful but doesn't make trend and abundance data issues go away.	
524	142		Not in bibliography.	This is cited in Patla et al. 2008).
525	142		Not in bibliography.	This is cited in Patla et al. 2008).
526	142		Not in bibliography.	This is cited in Patla et al. 2008).
527	143		Not in bibliography.	This is cited in Patla et al. 2008).
528	143		Not in bibliography.	This is cited in Patla et al. 2008).
529	143		Random stratification doesn't require much, if any, more field time. With a small amount of effort up front, the strength of the monitoring data is increased greatly.	The monitoring section has been revised. A stratified random sampling technique has since been used by WNDD to identify monitoring catchments on the BTNF.
530	143		This is not known.	See response to comment 529.
531	143		Is this possible based on time and resources? It seems that other species of interest would suffer.	This is a good point and should be considered further.
532	143		Define a wetland complex for the purpose of this assessment.	The description of wetland complexes was modified.
533	144		These were distinguished from one another on the previous page.	No, they were identified as generally being synonymous.
534	144		The average was approximately 500 acres, which has no bearing on what designates a catchment.	Comment noted.
535	144		Not in the bibliography.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
536	144		Not in the bibliography.	This is a standard way of citing primary literature sources when the primary literature source was not obtained.
537	144		This doesn't work if site selection is not random.	The highlighted sentence pertains to within-catchment analyses, and randomization applies to catchments across the BTNF (or some large geographic scale).
538	145		These should be defined by the author.	They are self explanatory.
539	145		These should be defined by the author.	They are self explanatory.

ECOSYSTEM RESEARCH GROUP

The Sublette County Commissioners, with support from Sublette County Conservation District and Wyoming Game and Fish Department, contracted this review. It was undertaken primarily in response to concerns about the effects that a minimum herbaceous retention level of 70% could have on livestock grazing operations.

I. Overview Comments and Responses

ERG assessed there to be no obvious indication that toads and frogs are at risk on the BTNF and they asserted that management recommendations in the report — in particular the 70% herbaceous-retention threshold — are not biologically defensible, mainly because of what they saw as a lack of local data being analyzed, results of their GIS analysis not revealing any risks to frogs and toads on the BTNF, and scientific studies cited in the report not having application to the BTNF. ERG's conclusion that there are no obvious indications that toads and frogs are at risk on the BTNF is in error because their GIS analysis (upon which their assessment was based) was very cursory and did not address most risk factors, including no assessment of fish introductions which they stressed can have catastrophic consequences to frog and toad populations; a large volume of scientific information summarized in the report demonstrates that many activities on the BTNF pose risks to spotted frogs and boreal toads; and there are no assessments demonstrating that management controls on the BTNF are sufficient to avoid or sufficiently mitigate impacts to spotted frogs and boreal toads.

ERG's assertion that management recommendations in the report — in particular the 70% herbaceous-retention threshold — are not biologically defensible is erroneous for a wide variety of reasons, including the following. 70-100% retention is not a management recommendation; it is a component of suitable conditions for spotted frogs and boreal toads in livestock allotments. The approach used in the report to define suitable conditions — including suitable retention levels — is consistent with the approach outlined in the 2012 Planning Rule (USFS 2012) and scientific publications (see report). ERG claimed that numerous scientific studies cited in the report do not pertain to the BTNF, but they misinterpreted the way in which the studies were applied and they only identified two examples of what they felt were misapplication of scientific studies and a reassessment of these studies revealed they were appropriately applied. Most of ERG's comments focused on a lack of local data on existing conditions, but existing conditions are not used in defining suitable conditions (e.g., for objectives) and conservation assessments many times do not provide detailed analyses of existing conditions, and while it is helpful to have local data for identifying risk factors (which in turn are used to identify potential conservation actions), this is not a necessity. This gets at a major underlying short-coming with ERG's comments: they misinterpreted the purpose of the report, which resulted in most of their comments lacking merit. ERG reviewed the report as if it was a conservation strategy, but the report was built around the specific purpose of outlining "…the basis of the objectives developed for Columbia spotted frogs and boreal toads on the BTNF" (pg. 1 of the report). Nonetheless, however, additional effort was put into characterizing existing conditions of each major habitat and survival element and each of their comments was reviewed to determine whether any adjustments or redirection was needed based on this input.

Responses to Overview Comments are provided below.

A. ERG Assessed that Recommendations are not Biologically Defensible, are Biased, and are Inconsistent with Multiple Economic and Resource Objectives

<u>Summary of Comments and/or Explanation</u>

ERG assessed that the management recommendations in the report are highly questionable and are neither biologically defensible nor consistent with other multiple economic and resource objectives, and they strongly inferred the report is biased against activities like timber harvest and livestock grazing.

Most of the comments in ERG's Review Document focus on what they saw as a lack of an analysis of existing conditions and secondarily on what they saw as a misinterpretation of scientific studies (addressed in detail in responses to Overview Comments B.2, C.1, C.4, and F, below), and the aim of both of these was to show that recommendations in the report are biased and not biologically defensible.

Specific Comments

Lack of Biological Defensibility

- "That lack of local data makes the justification for the management recommendations in the Paper highly questionable" (pg. 3).
- "…recommendations in the DeLong Paper… are [not] biologically defensible…" (pg. 30).

Bias

- "…the DeLong Paper should have taken an unbiased look at all potential limiting factors. For example, research conducted in cool climates suggests that toads seek out openings during cool weather." (pg. 8, comment 44).
- "Nonetheless, any species conservation strategy needs to address all the potential risks in an unbiased manner, regardless of the controversy that might be associated with those risks" (pg. 9, comment 46).
- "The DeLong Paper seems to intentionally handpick some of the research findings. For instance, it focuses on papers (Semlitsch et al. 2009) and (Rittenhouse et al. 2008) that support adverse effects of timber harvest on toads, but ignores a paper (Wind and Dupuis 2002) that concludes timber harvest can be beneficial to toads – within British Columbia, which is arguably more similar to the BTNF in terms of climate and disturbance regimes. Another paper found no relationship between grazing and toad density in the Sierra Nevada range, where elevations, if not latitude, are somewhat more comparable to the BTNF than other papers cited (Allen-Diaz et al. 2010)" (pg. 9; comment 47a).
- "Objectivity is key to disseminating information that is substantively accurate, reliable, unbiased and presented in an accurate, clear, complete, and unbiased manner. Utility is assessed as to the usefulness of information to its intended users, including the public (USDA and Office of the Chief Information Officer 2014)" (pg. 32, comment 134).

Consistency with Multiple Economic and Resource Objectives

- "…recommendations in the DeLong Paper… are neither biologically defensible nor consistent with meeting other multiple economic and resource objectives" (pg. 30).

Response

First, a point of clarification is that the only parts of the report that can be construed as management recommendations are the lists of potential conservation actions. Statements about suitable conditions (e.g., 70-100% retention of herbaceous vegetation) are not recommendations, nor are risk factors recommendations. Nonetheless, for the purposes of addressing the comments quoted above, objectives and suitable condition statements are treated generally in the scope of "recommendations" because it appears ERG was using the term fairly loosely.

A.1. BIOLOGICAL DEFENSIBILITY

Of the two competing approaches to conservation planning addressed in the report and ERG's Review Document (see Overview Comment E.1 for descriptions), the approach used in the report (i.e., start the definition of suitable conditions with estimated natural conditions and expand the scope of suitable conditions as scientific information demonstrates this to be biologically defensible) is substantively more biologically defensible than the approach advocated by ERG (i.e., start with existing conditions and allow these to continue until it is proven that activities have impacted spotted frog or boreal toad populations). ERGs claims — e.g., that management recommendations in the report are not biologically defensible and highly questionable — are erroneous and unsupported for a variety of reasons, especially when considering ERG’s approach:

a. If 70% retention of herbaceous vegetation is not biologically defensible as a low-end threshold for spotted frogs and boreal toads, this means that it is not possible for retention levels below 70% to be biologically defensible. If 70% retention is not biologically defensible as a low-end threshold, then incrementally higher retention levels need to be assessed until a biologically defensible retention level is found (see response to Overview Comments C.3 and E.2 for additional discussion).

b. The main parts of suitable condition statements and objectives that are most susceptible to being biologically indefensibility are the parts that deviate from estimated natural conditions to accommodate commercial and recreational activities and developments. This is because (i) most suitable condition statements, risk factors, and conservation actions are primarily aimed at restoring and maintaining the ecosystem health and natural conditions, which is consistent with the 2012 Planning Rule, Noss and Cooperider 1994, Hunter 1996, Applet and Keeton 1999, Haufler 1999a, Haufler 1999b, etc.; and (ii) about the only exceptions are where suitable condition statements were adjusted to accommodate commercial or recreational activities and developments (e.g., livestock grazing, timber harvest, roads, motorized use).

   Regarding ERG’s assertion that the 70% herbaceous retention threshold is not biologically defensible, the report recognized that the threshold is not fully biologically defensible, BUT it is only partially biologically indefensible as a consequence of the low-end threshold being adjusted downward to accommodate livestock grazing use. A moderate amount of scientific information shows that shifting the low-end herbaceous retention level from pre-activity (e.g., near-100% herbaceous retention) conditions to 70% retention would, as a whole, sufficiently provide for the 11 habitat and survival elements examined in the report (as opposed to a relatively large amount of scientific information supporting 80% retention as a low-end threshold). ERG did not contribute any additional scientific or other information that would bolster the confidence in 70% retention as a low-end threshold. Little scientific information shows that a low-end threshold of 60% retention would provide for these 11 habitat and survival elements, and no scientific information supports a low-end threshold of 50% retention of herbaceous vegetation.

   This is addressed in more detail in responses to Overview Comments C.1, C.3, C.4, C.5, D.2, and E.

c. Under ERG’s approach, if local data does not demonstrate that existing conditions (e.g., as influenced by one or more commercial or recreational activities) are negatively impacting spotted frogs or boreal toads, existing conditions are deemed suitable, even if scientific information identifies a moderate or high potential for the commercial and recreational activities to impact frogs and toads. Instead of starting with the assumption that natural conditions are suitable, ERG’s approach starts with the assumption that existing conditions (regardless of how far they have deviated from natural conditions) are suitable for amphibians. It may be possible for ERG’s approach to be biologically defensible if a monitoring program was designed and implemented to be able to detect population changes and cause-and-effect relationships, but (1) the likelihood is low for implementing such a monitoring program given all of the other wildlife species, other priorities on the BTNF, and current and projected budgets; (2) sufficient local data is not currently available; and (3) suitable conditions still need to be defined in order to determine the extent to which existing conditions meet suitable conditions. Because sufficient local data is currently not available and in all likelihood will not be available in the foreseeable future, taking ERG’s approach errs on the side of existing conditions (as affected by commercial, recreational, and other) activities and, therefore, is not biologically defensible. ERG’s approach favors “economic objectives” at the possible expense of spotted frogs and boreal toads.

As observed by Karl Sagan (Astronomer), “Absence of evidence is not evidence of absence.” Applied to the situation at hand, the absence of evidence of amphibians being impacted by one or more activities does not provide evidence that amphibians are not being impacted by these activities, especially given that local data to address relevant issues is currently very limited.

This is addressed in more detail in responses to Overview Comments C.3 and E.

d. Most of ERG’s comments focused on a lack of local data on existing conditions, but (i) existing conditions are not used in defining suitable conditions, and (ii) suitable conditions is the main focus of the report. While it is helpful to have local data for identifying risk factors, this is not a necessity. Also, while local data on existing conditions is not analyzed in the report, summaries of existing conditions was provided in the 01-09-2013 version of the report for several key habitat elements, with citations to reports and papers, and additional information on existing conditions was added to the revised report.

This is addressed further in responses to Overview Comments C.1, C.3, C.4, C.5, and C.6.

e. Three factors provide strong indication that that activities and developments on the BTNF (e.g., roads and motorized use, livestock grazing, fish stocking, reservoirs and other water developments, and camping) have negatively impacted spotted frogs and boreal toads on the BTNF: (i) a large volume of scientific information from a wide range of disciplines was examined in the report, and this information showed that these activities negatively impact spotted frogs and boreal toads if the activities are not adequately controlled or mitigated; (ii) no management controls are in place on the BTNF that were designed to protect spotted frogs and boreal toads from the identified activities and developments; and (iii) many of the identified activities and developments occur or exist in spotted frog and boreal toad habitat, and some are prevalent in occupied habitat and other capable habitat (possibly including previously occupied habitat).

This — along with limited or no local data on frog and toad population trends, survival rates, and effects of individual activities and developments on population dynamics — means that it is not biologically defensible to assume that existing conditions are suitable for spotted frogs and boreal toads on the BTNF unless local data demonstrates otherwise. To be biologically defensible where local data is limited and given i – iii, above, any deviations from estimated natural conditions need to be shown — with scientific information — to be suitable. And this is what was done in the report.

This is addressed in more detail in responses to Overview Comments C.3 and E.

f. ERG recognized historic (i.e., natural or pre-activity) conditions as desired or suitable conditions.

g. Despite efforts that ERG put forth in the report to show there to be a lack of risks to spotted frogs and boreal toads, they provided no evidence (or, at most, very weak evidence) of a lack of risks to spotted frogs and boreal toads. This is based on their analysis being very cursory, ERG admitting to shortcomings in their analysis, ERG addressing only a small subset of risk factors and not addressing several major risk factors, their reliance on a GIS analysis that was very limited in scope and that made erroneous assumptions, ERG ignoring a large volume of scientific information, and ERG not addressing the absence of management controls on the BTNF to prevent negative impacts to spotted frogs and boreal toads. ERG spent considerable effort attempting to show why much of the scientific information in the report should not be considered, even though they only specifically addressed a small fraction of the science that was cited in the report.

See responses to Overview Comments B.1 and B.2 for additional discussion of each of these.

h. While ERG claimed that many of the scientific studies cited in the report are not useable because the studies were conducted elsewhere (e.g., differences in climate and disturbance regimes), they did not appear to recognize that (i) results of most studies were only applied toward basic principles or building blocks of frog and toad habitat and survival elements, and (ii) specific measurements from other locations were not directly applied to suitable condition statements or statements of risk for the BTNF.

See response to Overview Comment F.1 for details.

In particular, ERG appears to argue that setting the low-end herbaceous retention level at 70% is highly questionable and biologically indefensible. If 70% retention of herbaceous vegetation is not biologically defensible or scientifically supportable as a low-end threshold for spotted frogs and boreal toads, this means that all retention levels below 70% are also not biologically defensible or scientifically supportable. If 70% retention is biologically indefensible as a low-end threshold, then incrementally higher retention levels need to be assessed until a biologically defensible retention level is found (see response to Overview Comment E.2).

It is recognized that 70% retention is not fully biologically defensible, but this is only because it errs to some degree on accommodating continued livestock grazing use. On balance, however, there is moderate support showing that ≥70% retention of herbaceous vegetation in plant communities with suitable plant species composition provides, on average, suitable (1) cover for retaining humidity and moderating temperature near the ground surface; (2) shading and protection from the sun; (3) hiding and escape cover; (4) forage for tadpoles; (5) forage, cover, and structure for diverse invertebrate communities; (6) shallow waters exposed to the sun and open patches for basking; (7) water quality, as related to urination, defecation, and trampling by large ungulates; (8) water retention in small breeding pools; (9) survival rates as affected by trampling; (10) soil looseness and porosity; and (11) integrity of near-surface burrows used by frogs and toads.

ERG did not contribute any additional scientific or other information that would bolster the confidence in 70% retention as a low-end threshold, much less did they provide any scientific or other information showing that 60% or 50% retention would be sufficient as a low-end threshold.

ERG's assertion that the 70% herbaceous-retention threshold is not biologically defensible begs the question of the biological defensibility of lower thresholds, like 50% retention of key forage species. There is no evidence demonstrating that a minimum 50% retention of key forage species is a sufficient to provide suitable conditions for spotted frogs, boreal toads, or other wildlife dependent on mountain meadow and wetland habitats. And there is scientific information demonstrating adverse impacts at the associated total-herbaceous retention level (e.g., 50-70% retention, depending on composition of key forage species and percent use of non-key forage species). The Forage Utilization Standard of the Forest Plan requires that site-specific utilization limits be prescribed to meet Forest Plan objectives, and Forest Plan Objective 4.7(d) calls for the retention of an adequate amount of suitable forage and cover for wildlife. Identifying a minimum 70% retention of herbaceous vegetation for spotted frogs and boreal toads is among the first attempts on the BTNF to meet this requirement.

A.2. BIAS

ERG did not adequately support their claims that the report is biased:

a. ERG provided the following as an example of the report being biased: "…research conducted in cool climates suggests that toads seek out openings during cool weather." (pg. 8, comment 44). This comment is not only unsupportable, it is countered by information provided in the version of the report reviewed by ERG. The report acknowledged the importance of basking sites for boreal toads (pgs. 11, 12, 19, 20, 57, 86, 95, 96, 104, and 110 of the report) and cited five papers that identified the importance of open patches and the potential use of livestock grazing to create them (Maxell 2000, Watson et al. 2003, Bull 2005, Keinath and McGee 2005, and Shovlain 2006). Furthermore, the section on "Openings Providing Sun Exposure" had been greatly expanded in the 09-26-2014 version of the report. In this expanded section, a substantial amount of additional scientific information was pulled into the discussion. While it is recognized that open patches are important for boreal toads, ERG did not cite any scientific studies showing "that toads seek out openings during cool weather;" they should have cited supporting scientific information in making the claim that the 01-09-2013 version of the report was biased by not citing any scientific information.

Also, ERG placed considerable weight on Wind and Dupuis (2002), which they argued addressed conditions more similar to the BTNF than other cited references since the assessment by Wind and Dupuis (2002) was for Canada (comments 4 and 47a). However, even Wind and Dupuis (2002) recognized the importance of moist microsites to western toads, the need to ensure sufficient microsites are provided (Wind and Dupuis 2002:12, 18, 19), and they characterized climatic conditions in clearcuts as being "extreme" for metamorph toads, and that metamorphs may be "seriously disadvantaged" by these extreme climatic conditions (Wind and Dupuis 2002:16).

b. Regarding ERG's comment that "…any species conservation strategy needs to address all the potential risks in an unbiased manner, regardless of the controversy that might be associated with those risks" (pg. 9, comment 46): (i) ERG provided no examples of risk factors being presented in an unbiased manner; and (ii) the only controversy on this subject thus far has been generated by livestock-grazing interests expressing concern about a 70% herbaceous-retention threshold and concerns about implications to logging, and ERG was contracted to review the report due to these concerns.

c. ERG erred in their claim that studies cited in the report were "intentionally handpicked" to show commercial activities like timber harvest adversely affect boreal toads, including errors in the examples of studies they cited:

   i. The report shows the net effects of logging to be beneficial on the BTNF so long as sufficient mitigation measures are implemented (see additional discussion in response to Overview Comment A.3, *Timber Harvest*).

   ii. ERG partially mis-cited Semlitsch et al. (2009) as "supporting adverse effects" when the report identified Semlitsch et al. (2009) as showing benefits and negative impacts of timber harvest (see additional discussion in response to Overview Comment A.3, *Timber Harvest*).

   iii. Wind and Dupuis (2002) was not ignored with respect to potential benefits of logging on boreal toads, as it was cited 3 times in statements about the benefits of logging and about mature, high-canopy-cover forestlands having *too* much shade for boreal toads. It is also important to point out that Wind and Dupuis (2002) did not state that clearcuts were beneficial to western toads without identifying any negative impacts. They recognized that toads need moist microsites in terrestrial habitats (see pgs. 77-78 and 101 of the 01-09-2013 version of the report) and they identified negative impacts of clearcuts: e.g., increased predation in clearcuts based on two studies, and "…toadlets that emerge from breeding sites within clearcuts may be seriously disadvantaged by extreme climatic conditions and increased predation" (Wind and Dupuis 2002:16). These types of considerations are important for conducting timber harvesting in ways that minimizes or avoids negative impacts.

The report shows there to be net benefits of logging to boreal toads and spotted frogs on the BTNF so long as measures are implemented to minimize the negative aspects of logging (e.g., roads, potential of crushing toads with skidders).

d. ERG implied that the report was not objective and that it was not "substantively accurate, reliable, unbiased and presented in an accurate, clear, complete, and unbiased manner" (pg. 32, comment 134) but they did not provide any substantive examples or proof of this. Efforts were made to compile information for the report and to write the report to provide substantively accurate information that is reliable, unbiased, and presented in an accurate, clear, complete, and unbiased manner. Adjustments were made and additional information added, based on ERG's comments (and other comments received on the 01-09-2013 version of the report) to better meet the identified criteria where they may not have fully been met.

It is interesting to note that a recent conservation assessment for Yosemite toads, prepared by 5 technical coordinators as part of a 36-member working group, identified livestock grazing as one of two high priority risk factors (Brown et al. 2015:75) even after the completion of a series of studies on the effects of livestock grazing on Yosemite toads that are viewed by some as demonstration that livestock grazing is compatible Yosemite toads (however, see the "Information on Key Amphibian-Livestock Grazing Studies Cited in this Report" subsection in Appendix A).

A.3. CONSISTENCY WITH MULTIPLE ECONOMIC AND RESOURCE OBJECTIVES

The main purpose of the report is to identify suitable conditions for spotted frogs and boreal toads (in the form of objectives in the 01-09-2013 version of the report and suitable condition statements thereafter) and to outline the basis for these definitions of suitable conditions. Characterizing suitable conditions for given wildlife species is inherently a wildlife biologist function because suitable condition statements define the biological needs of wildlife species, and there are no requirements for statements of suitable conditions to be consistent with other resource objectives or economic objectives. Introducing non-biological considerations into the development of suitable condition statements by definition introduces biases. Inconsistencies between suitable conditions for a given wildlife species and economic objectives are not addressed at the objective level, but rather are addressed by applying direction in Forest Plan DFCs, as outlined in the Forest Plan:

- "…some objectives will not be met on all areas of the Bridger-Teton National Forest… The conflicts are resolved by application of the different Desired Future Conditions to different areas of the National Forest" (USFS 1990b:93).
- "That the DFCs exist at all is in recognition that not all the Goals and Objectives can be achieved at the same time from the same land areas. Therefore, 17 DFCs… have been developed to accomplish multiple, compatible Goals and Objectives" (USFS 1990b:145).

Defining suitable conditions for a given wildlife species (e.g., defining what is meant by "suitable conditions" in Forest Plan Objectives 3.3(a) and 4.7(d)) is different than defining desired conditions. Defining desired conditions can be done as part of an interdisciplinary team process (e.g., section 92.11 of WO Amendment 2209.13-2005-10). While economic considerations can be built into the process of defining desired conditions, depending on objectives of an area relative to DFCs, there is no place for compromising the biological needs of wildlife to accommodate economic interests in defining suitable conditions for wildlife (which addresses the biological needs of wildlife). Any compromising that is done must be done after suitable conditions are defined for the purposes of Objectives 3.3(a) and 4.7(d) and should be done during the process of defining desired conditions typically on a project-by-project basis following Forest Plan direction (e.g., as outlined in the two bullets above) and Forest Plan policy and guidance (e.g., section 92.11 of WO Amendment 2209.13-2005-10).

That said, effort in the report was put into determining how far conditions can deviate from coarse-filter conditions (e.g., due to roads, livestock grazing use) and still (a) satisfactorily provide for the needs of spotted frogs and boreal toads and (2) satisfactorily protect these species from activities. This is the subject of each subsection titled, "Deviations from Estimated Natural Conditions to Accommodate other Uses," in each habitat/survival element in the 09-26-2014 version of the report and revised report. While the purpose of this step was to determine if the low-end threshold of suitable conditions can be lowered somewhat to accommodate other uses, the low-end threshold still needed to be shown to meet the needs of the species and attempts were made to avoid compromising this. With respect to livestock grazing, Figure A.2 was added to Appendix A to illustrate that 70% retention of herbaceous vegetation fits within contemporary range management.

On the subject of “other resource” objectives, when the process of defining suitable conditions begins with coarse-filter conditions, this builds-in the needs of a wide range of wildlife species thereby reducing the potential for conflict. This also is consistent with Forest Plan direction for restoring and maintaining healthy riparian areas, rangelands, and forests.

Timber Harvest

ERG claimed that studies cited in the report were handpicked to show that commercial activities like timber harvest adversely affect boreal toads (see comments 47a; quoted in the “Specific Comments” subsection, above). This claim is erroneous for two main reasons:

a. The version of the report reviewed by ERG (01-09-2013 version) and all revised versions show net benefits of logging to boreal toads and spotted frogs on the BTNF so long as measures are implemented to minimize the negative aspects of logging (e.g., by mitigating roads, potential of crushing toads with skidders, and retaining large woody material). The following bulleted excerpts from pages 57-59 of the 01-09-2013 version of the report show ERG’s claim with respect to the characterization of logging in the report to be false:

   - “Shading and Cooler Temperatures in Closed-Canopy Conifer Forests – Despite the high amount of large woody material in mature and old forests and their preference for large woody material, there is no indication that boreal toads preferentially select forestland over other habitats, and they appear to select against closed-canopy forests (Bartelt et al. 2004, PARC 2008). Although closed-canopy forests are moist, they appear to have too much shading and too little solar radiation for toads to achieve a preferred body temperature. Rafael (1988) and Wind and Dupuis (2002) noted that the extensive shading and cool temperatures in mature forestland — with few openings that permit sunlight hitting the ground — appeared to be a limitation to occupancy by western/boreal toads, and that openings created by timber harvest and fire may be beneficial.”
   - “Reduced Tree Canopy and Other Altered Structural Conditions at Breeding Pools – Effects of fire and logging on breeding ponds and reproductive success is mixed. Some experts viewed effects of reduced tree canopy cover and altered forest structure next to ponds as detrimental… However, no studies in which specific measures of reproductive success were cited to support their assessments with respect to spotted frogs and boreal toads, or close relatives…. Two studies and one set of observations suggest that fires and logging in the vicinity of breeding pools are beneficial to boreal toads breeding and may be neutral beneficial for spotted frogs breeding…,” followed by substantial discussion of one of the studies.
   - “Semlitsch et al. (2009) found that clearcutting in three study areas in the eastern United States resulted in increases in all measures of reproductive success in leopard frogs (e.g., tadpole survival, mass at metamorphosis) and gray tree frogs (e.g., calling by males, oviposition by females, growth rate of tadpoles).” Semlitsch et al. (2009) was identified by ERG as one of two examples of handpicked research findings showing adverse effects of timber harvest. On the other hand, the report also stated that “…Semlitsch et al. (2009) found the net effect of clearcutting to be negative on adults and juveniles of the seven amphibian species studied. Negative effects were somewhat less in partial cut units.”
   - “Increased Amount and Distribution of Openings – The periodic creation of early-seral plant communities in forests is a natural part of forest ecology in this area (Knight 1994, Patla 2001:10, Keinath and McGee 2005:38, LANDFIRE 2006), and clearcuts appear to be within the range of suitable habitat conditions for boreal toads so long as sufficient large woody debris are retained (Raphael 1988, deMaynadier and Hunter 1995, Wind and Dupuis 2002, Bartelt et al. 2004).”

- "…in studies in which toads were part of the amphibian community, anurans as a group were more abundant — in three of four studies cited in Table 1 of deMaynadier and Hunter (1995) — in young clearcuts greater than 6-months than in uncut control plots."
- "Wind and Dupuis (2002) cited five studies indicating that western toads are often found in clearcuts and possibly favoring clearcuts to closed-canopy forests."
- "In a study by Raphael (1988) in Douglas-fir forestland in northwestern California, western toads were substantially more abundant in young clearcuts than in 4 of the 5 other age classes; abundance was similar in 50-150 year-old stands."
- "While Bartelt et al. (2004) found that boreal toads in avoided young clearcuts in their eastern Idaho study site, they found that male toads showed greatest selection for meadow, shrub, and 10-year clearcut patch types (i.e., over open-canopy and closed-canopy forests)."
- Another benefit of reducing the amount of early-seral forestland outlined in the report (pg. 57) include reduced evapotranspiration and potential increases in spring flows.

It should also be noted that, even though Wind and Dupuis (2002) identified net benefits of clearcuts to western toads, they also identified negative impacts of clearcuts, and all of them could be mitigated.

b. Incorporation of material from the report into planning and analyzing the Hams Fork and LaBarge timber sales serves to illustrate that logging on the BTNF can mostly be beneficial or generally neutral to boreal toads and spotted frogs. It is not clear whether ERG highlighted the incorporation of material from the DeLong (2013) into the Hams Fork Vegetation Project EA (see comment 54) as a way to show what they saw as detrimental effects of the potential conservation actions on harvesting timber on the BTNF.

Three design features in the EA were based on conservation actions identified in the report, but the design features did not result in any reductions in acres or volume of timber to be harvested.

Similarly, several design features in the LaBarge Vegetation Project EA were based on conservation actions identified in the report, but — as with the Hams Fork EA — the design features resulted in only minor reductions in the volume of timber to be harvested, and design features also placed restrictions on the timing of timber harvest where harvest units occurred near breeding sites (but only in years when breeding sites were determined to be used). While it is recognized the design features added extra burdens to the process of harvesting timber, this is part and parcel with harvesting timber on lands managed for multiple uses.

These types of adjustments to timber sales are common practice in the Forest Service and are based on the doctrine of "multiple-use." Using restrictions on timber harvest as a way to show that a report is biased against timber harvest is disingenuous, especially since one of the ERG authors is well versed in identifying restrictions to place on logging to ensure that wildlife are not unduly impacted.

As an example, Hillis et al. (19991) identified restrictions on logging to balance the harvesting of timber with the needs of elk. The lead author (Mike Hillis) is one of the lead authors of ERG's Review Document.

Livestock Grazing

Moving the low-end herbaceous retention threshold down to 70% was done solely to accommodate livestock grazing use. Restated, the range of suitable conditions for herbaceous retention was expanded beyond what was identified as suitable for frogs and toads in order to accommodate livestock grazing use, but only to the point that the expanded retention levels could be demonstrated to be suitable. There was moderate scientific support at the 70% retention level, little scientific support at the 60% retention level, and no support at the 50% retention level; and conversely, there was a moderate amount of scientific information showing negative effects at the 70% retention level, substantial scientific information showing negative impacts at the 60% retention level, and even more showing negative impacts at the 50% level).

As such, the range of suitable herbaceous-retention levels was consciously widened to provide opportunities to contribute to Objective 1.1(h) of the Forest Plan (i.e., to provide forage for about 260,000 AUMs of livestock grazing annually), recognizing that there are many factors affecting the degree to which this objective is met, including requirements to restore and maintaining riparian areas and watersheds in healthy, functioning condition; providing suitable conditions for sensitive species; and, depending on DFC area, retaining an adequate amount of suitable forage and cover for wildlife.

An alternative to this approach would have been to identify suitable herbaceous retention levels without considering livestock grazing use (i.e., a low-end threshold greater than 70%) and then to "negotiate" a utilization level that takes into account Objective 1.1(h) along with Objectives 3.3(a) and 4.7(d) relative to management direction for the particular DFC. While this is a different approach, scientific information would only support shifting the maximum herbaceous utilization level to as high as 30% to accommodate Objective 1.1(h).

A maximum utilization level of 30% for total herbaceous vegetation is consistent with at least two range management textbooks (Holechek et al. 2011, Valentine 1990), noting that recommendations by Holechek et al. (2011) for a maximum 30% and 40% utilization of key forage species (during the growing season and after the growing season, respectively) equates to a maximum of an estimated 15-30% and 25-40% utilization, respectively, of total herbaceous vegetation (see Appendix B of the revised report). This means that a minimum of 70% retention of total herbaceous vegetation would actually provide for greater livestock use during the growing season than recommended by Holechek et al. (2011).

Potential benefits of livestock grazing to spotted frogs and boreal toads was considered in the above assessment, but (a) the only potential benefit is the creation and maintenance of open water in dense emergent marsh for tadpole development and openings in dense herbaceous vegetation for basking by frogs and toads; (b) substantially higher than 30% use would be needed for the former and 30% use would be more than enough for the latter; (c) utilization levels to create and maintain openings in dense emergent marsh through the tadpole development phase would have high potential to impact tadpoles due to high utilization levels and trampling during tadpole development, as well as a wide range of other wildlife and other resources due to high utilization levels and trampling in wetlands and elsewhere; (d) there likely are few places on the BTNF where dense emergent vegetation and other dense herbaceous vegetation probably have detrimental impacts on spotted frogs and boreal toads; and (e) other, likely more effective and efficient, methods exist to create and maintain openings in otherwise dense emergent vegetation (e.g., use of mowers, gas-powered lawn trimmers and weed-eaters by hand crews). This is discussed in more detail in the "Openings Providing Sun Exposure" in Appendix A of the 09-26-2014 version and revised report.

B. ERG Provided Virtually No Evidence of a Lack of Risks on the BTNF

B.1. ERG FOCUSED ON A SMALL FRACTION OF THE FACTORS POTENTIALLY AFFECTING FROG AND TOAD POPULATIONS

Summary of Comments and/or Explanation

ERG asserted that the "entire" report focused on the availability of shade in grass/sedge communities, and that the report overemphasized the risk that toads face from desiccation due to a lack of shade and the effects livestock grazing on shade. This summary of ERG's comments on the subject is based on Comments 13, 44, and 119; ERG's 20 references to shade directly in the context of livestock grazing; and another 12 references to shade indirectly related to livestock grazing. Comments on shading in forest and willow communities were apparently made in building their argument that shade for frogs and toads is plentiful on the BTNF and, therefore, of little concern to livestock grazing management. They also brought up the need for basking sites as a counter need to shading and as an apparent justification for livestock grazing.

Although only two of ERG's comments addressed basking sites and their creation with livestock grazing use, this issue is addressed because (a) the creation of basking sites by livestock appears to have been brought up as an answer to too much shading in herbaceous communities, to the extent this occurs; and (b) it was the only potential benefit of livestock grazing use that was identified.

Specific Comments

Each of the quoted comments below are addressed in "III. Responses to Individual Comments in the Review Document."

Shade as Affected by Livestock Grazing Use

- "Maxell suggests that grazing may be harmful to toads if it results in stream down-cutting, loss of hardwoods, trampling of metamorphs (toadlets), or loss of **shade** where shade is limiting" (pg. 1; comment 4).
- "DeLong relies heavily on [a report and article] to make his assertions concerning herbaceous vegetation retention, humidity retention, temperature moderation, and suitable **shading** and sun protection attributes" (pg. 2, comment 11). This was the first and last time humidity retention and temperature moderation were discussed in their comments (except when the same comment was repeated on page 13).
- "Lack of sufficient **shade** for amphibians is repeatedly addressed as a problem needing resolution by restrictions on grazing, yet no data is provided at any scale to disclose the ratio or distribution of **shade** to basking (open) areas. No data on average summer weather conditions is provided to show whether toads and frogs might require a higher percentage of **shade** versus basking areas" (pg. 3, comment 13).
- "…Loren Racich, Sublette County Conservation District, asked how **shade** could be limiting to toads since any toad in the sedge community would literally be no more than two hops away from dense willows" (pg. 3, comment 15).
- "While those relationships could provide useful information if it was determined that a lack of **shade** was a limiting factor to toad and frog populations on the BTNF, no vegetation analysis was provided at any scale that concludes that **shade** is indeed limiting" (pg. 8, comment 43).
- "Although DeLong mentions multiple factors that might limit toad and frog populations, the discussion is heavily focused on grazing with the assumption that **shade** is limiting, again made without supporting data" (pg. 8; comment 44).
- "DeLong Paper, however, devotes one-half of a page to this topic, whereas it devotes 31 pages to comparing the effects of different grazing utilization intensities on ground level wind speed and humidity, as they might lead to toad dessication, a concern that may not even be valid given the BTNF's elevation and predominate mix of **shade**-bearing cover types" (pg. 9, comment 46).
- "DeLong relies heavily on [a report and article] to make his assertions concerning herbaceous vegetation retention, humidity retention, temperature moderation, and suitable **shading** and sun protection attributes" (pg. 13, comment 64).
- "The DeLong Paper emphasizes the risk that toads face from dessication due to a lack of **shade** during hot weather. Zack Walker, non-game biologist for the Wyoming Game and Fish Department, suggested during the September 5, 2014, field trip that toads seek **shade** as temperatures near 80 degrees" (pg. 25, comment 111).

- “In terms of boreal toad habitat, including standing water, **shade**, and adjacent moist microsites, it is hard to visualize how toads could suffer high temperature-related stress even if the wet, sedge-dominated meadows were heavily grazed” (pg. 28; comment 115).
- “…**shade** availability within grass/sedge communities… [is] the focus of his entire Paper” (pg. 28; comment 119).
- “The Cooperators do not discount the value of **shade** within riparian grass/sedge meadows to toads or frogs. In terms of foraging habitat, escape habitat, or thermoregulation, the availability of other **shade** dominant cover types (riparian shrubs, etc.) must be considered when determining whether or not a given level of grazing utilization is detrimental or even pertinent to amphibians” (pg. 30, comment 128).
- “Since adult toads are relatively mobile (Maxell 2000), it is logical to assume that they can and will move to **shaded** cover types to thermoregulate on hot days as the need arises” (pg. 30, comment 129).
- “Thus, utilization that may reduce **shade** within those meadows is likely a one in three or four-year occurrence” (pg. 30, comment 131).
- “The BTNF should further explore this relationship before any decisions are made regarding measures to increase **shade** and burrow habitat for toads” (pg. 31, comment 132).

Basking Sites as Affected by Livestock Grazing Use

- “Maxell also suggests that grazing could be beneficial by creating basking areas where openings are limited, or by adding nutrients where streams are nutrient-poor (Maxell 2000)” (pg. 2, comment 4).
- “Lack of sufficient shade for amphibians is repeatedly addressed as a problem needing resolution by restrictions on grazing, yet no data is provided at any scale to disclose the ratio or distribution of shade to basking (open) areas. No data on average summer weather conditions is provided to show whether toads and frogs might require a higher percentage of shade versus basking areas” (pg. 3, comment 13).

Shade in Forest and Willow Types

- “GIS coarse filter vegetation data which suggest that within stream buffers, **shaded** cover types occur at a higher percentage than open cover types” (pg. 4, comment 19).
- “4) Map of **shade**-producing and non-**shade** cover types” (pg. 5, comment 27).
- “The untested assumption that **shade** is limiting strongly affects recommendations for retaining coarse, woody debris” (pg. 8, comment 45).
- “Of the aforementioned cover types, what is the distribution of **shade**-producing versus open cover types?” (pg. 19, comment 94).
- “Table 1 summarizes the distribution of cover types that provide **shade** (conifers, aspen, dry shrubs, and riparian shrubs) and open grassland/sedges that do not provide **shade** if heavily grazed. Note that 60.3% of the area is **shaded** by conifers, aspen, or shrubs. Only 39.7% of the area is within grasslands or sedge communities where sunlight would reach the ground. These findings provide insight into whether available **shade** (for thermoregulation on hot days) or sunlight (for absorbing heat on cool days) might be most limiting to adult boreal toads or migrating spotted frogs” (pg. 20, comment 101).
- “**Shade**-dominant cover types within riparian buffers appear to be substantial” (pg. 29, comment 125).
- “Doing so would also allow the BTNF to qualify how important **shade** is relative to other risks such as increased conifer size class that reduce surface water availability…” (pg. 129, comment 27).
- “Conversely, when such meadows are interspersed by **shade**-dominant cover types such as the one observed during the previously mentioned September 5th field trip, it has to be assumed that the risk to

> toads of dessication are minimal in riparian systems that contain a diverse mosaic of riparian shrubs and open water" (pg. 30, comment 129).

Response

Shade as Affected by Livestock Grazing Use

The report was in no way entirely focused on shade and it did not even emphasize shade or the effects of livestock grazing on shade:

a. Shade was discussed on less than 3 pages (<10%) of over 27 pages of discussion and diagrams covering all 11 habitat and survival elements affected by livestock grazing use. Also, several of the habitat and survival elements were only minimally discussed since they were discussed in detail in other parts of the report, meaning that discussions of shade constituted substantially less than 10% of the discussion of these habitat and survival elements. With changes in the 09-26-2014 version of the report, this percentage shrunk even further. The other subsections were:
    - Humidity retention and temperature moderation
    - Hiding and escape cover
    - Forage for tadpoles
    - Litter and mulch
    - Invertebrate prey habitat
    - Water quality
    - Surface water duration in small pools
    - Direct mortality (due to trampling by livestock)
    - Soil compaction
    - Integrity of near-surface burrows and streambanks
    - (Shallow waters exposed to the sun and open patches for basking was added to the 09-26-2014 version of the report)

b. All of the above discussions fell under the "Height and Structure of Live Herbaceous Vegetation, Thatch, and Litter" section, which is just one of 15 sections of the report in which risk factors were outlined (i.e., risk factors affecting each of 15 major habitat and survival elements). Shade was addressed on as many as another 2 pages in the "Mix of Succession Stages in Forests" section, beyond the less-than-3-pages identified above.

    Table 2 of the 01-09-2013 version of the report — in the introduction of the part of the report in which livestock grazing and shading were discussed (pgs. 24-25) — identifies 13 broad categories of risk factors. (ERG's analysis only included three of these and only gave cursory attention to these.)

c. Therefore, shade was addressed on ≤3% of the pages in the report.

    There is nothing in the report indicating that the provision of shade is the most important habitat or survival element, and the report shows that other habitat and survival elements are more important than shade.

More than two months prior to ERG submitting their comments, attempts were made to clarify this with Mike Hillis at the September 5, 2014 tour sponsored by Sublette County Conservation District. Mike Hillis and others at the tour repeatedly referenced the report stressing the importance of herbaceous cover for hiding cover and shading. The following was included in the notes, showing an attempt to clarify the issue with ERG:

> "Don pointed out that there has been a lot of discussion about 70% retention in the context of providing cover for boreal toads, but defining a minimum of 70% as a threshold involved much more than hiding cover. Defining a minimum of 70% retention of herbaceous vegetation involved looking at

> a large number of habitat and survival elements, including humidity retention and temperature moderation, hiding cover, insect habitat, and tadpole forage, as well as factors related to the intensity of livestock use, including water quality, mortality caused by trampling, and accelerated drying of breeding wetlands. All of these entered into the equation and some, like trampling by livestock are troublesome because even at low grazing intensities, large impacts can occur."

ERG's comments did not appear to take this into consideration. It is not clear how ERG got the idea that shade is viewed in the report as such an all-important issue.

The 01-09-2013 version of the report stressed, in several places, the importance of multiple stressors and cumulative impacts, and the great importance of considering multiple stressors was discussed in greater detail in the 09-26-2014 version of the report. Additional information was added to the 09-26-2014 version and revised report showing that multiple stressors (e.g., chitrid fungus, roads and motorized use, livestock grazing use, reservoirs, introduced fish, climate change, increases in UV radiation, increased atmospheric nitrogen) are likely negatively affecting spotted frog and boreal toad populations on the BTNF.

Basking Sites as Affected by Livestock Grazing Use

It is unclear why basking sites was identified by ERG as an issue since "A retention level of 70% in a dense emergent marsh would provide numerous small openings or a smaller number of larger openings" (pg. 95 of the report reviewed by ERG). A utilization level of 30% would reduce the canopy of intact and relatively-intact herbaceous vegetation by an estimated 50-65% (see report for details), meaning that openings in herbaceous vegetation would be substantially larger than required for basking sites, and this assumes starting canopy cover of near 100% or 100%. If pre-grazed canopy cover is substantially less than 100%, well over 50% of a given site would be open to the sun at 30% use, and this is well beyond the concept of providing basking sites. The 09-26-2014 version of the report corrected the characterization by showing that 30% use of herbaceous vegetation would "overshoot" the amount of openings needed for basking (rather than stating that it would "provide numerous small openings or smaller number of larger openings"). As such, concerns about 30% utilization / 70% retention not providing sufficient basking sites is unfounded and without merit.

ERG accurately reflected that Maxell "suggests" grazing could be beneficial by creating basking areas (pg. 2; Comment 4) since there are no scientific studies demonstrating the need for basking sites. ERG did not provide any scientific support for the assessment that basking sites are needed by spotted frogs or boreal toads (e.g., prior to suggesting the Forest Service measure ratios of shaded to basking sites), or that livestock grazing can contribute to basking sites.

The extent to which basking sites was addressed in the report, including implications of livestock grazing to creating basking sites, had been greatly expanded in Appendix A of the 09-26-2014 version of the report; open-water areas in otherwise dense emergent marsh was added as a topic to the appendix; and a new section ("Openings Providing Sun Exposure") was added to the appendix that incorporated these two topics. Although no scientific studies have examined whether basking sites are needed to meet biological needs of spotted frogs or boreal toads, the new section in Appendix A ("Openings Providing Sun Exposure") provides scientific information that supports the need for basking sites and shallow, open-water areas for tadpole development, and it provides an assessment of the potential to use livestock grazing to create and maintain them.

ERG called for ratios of shade and basking sites to be determined and then presumably attained through management (e.g., livestock grazing management). Following their line of reasoning (i.e., identifying existing ratios of shade and basking sites, defining suitable ratios, and then producing suitable ratios through management), taking action to create basking sites would entail identifying a suitable ratio of shade/cover and open basking sites and then measuring ratios at each breeding wetland and other habitat area each year. Then, where amphibians occur in allotments, livestock would need to be (1) kept away from the numerous areas where the ratio is suitable or skewed too much toward open basking sites, and (2) carefully managed at each of the other areas to allow openings to be created but then to make sure they do not expand too much. If ratios are defined in objectives, alternative management actions — e.g., use of mowers, gas-powered lawn trimmers and weed-eaters — would need to be considered under NEPA. Again, it is unclear why ERG brought up basking sites as an issue because further assessment, including determining existing ratios, would likely reveal that limits on livestock grazing use would need to be lower than 30% in many areas.

Finally, while ERG call for ratios of shade and basking sites to be determined and then attained through management, they made a big point of saying that "Sensitive species conservation strategies designed to protect a single species should consider other conservation strategies and Forest Plan objectives where habitats overlap" (pg. 7). Altering the ratio would have the potential to negatively impact some wildlife species, while also benefiting other species. This would require assessing the habitat needs of a large number of species. See response to Overview Comment D.3.

Shade in Forest and Willow Types

ERG's assessment that "shaded cover types" occur at a higher percentage across the BTNF than "open cover types" (Comment 94) provides very little meaningful information, including little information that can be used in assessing whether additional basking sites are currently needed in herbaceous communities. This is discussed in detail in the response to Overview Comment B.2, section d.iii, below.

B.2. VIRTUALLY NO EVIDENCE OF A LACK OF RISKS

Summary of Comments and/or Explanation

ERG concluded, based on their analysis, that there is no obvious indication that toads and frogs are at risk on the BTNF.

Specific Comments

ERG's conclusions about the lack of risks to spotted frogs and boreal toads include the following:

- "As is demonstrated later in this document, when the following considerations are made, there are no obvious indications of severe risks to toads at the scales analyzed, including:
    - GIS coarse filter vegetation data which suggest that within stream buffers, shaded cover types occur at a higher percentage than open cover types;
    - Maps of stream condition class overlapping capable (i.e., low gradient streams and open water) habitat and which suggest that most stream habitat is in good condition; and
    - Maps of capable habitat with toad and frog populations that have a high level of overlap suggesting that the aforementioned data layers are correctly identifying toad habitat." (pg. 4)
- "Based on ERG's GIS analysis, there is no obvious indication that toads and frogs are at risk on the BTNF. This in no way indicates that amphibians are not at risk, but further fine scale data is needed to determine under what circumstances and to what degree they might be at risk. Further fine scale data is also required before a conservation strategy can be considered adequate." (pg. 4)
- "Please note that the ERG designation of capable habitat (low gradient streams and lakes) overlaid with inventoried populations (WYNDD data) suggests that a substantial amount of capable habitat is occupied (Figure 2). Of course that does not indicate anything about population density, recruitment rates, or trend, but neither does it suggest that populations are at risk." (pg. 29)
- "The coarse filter analysis completed by ERG does not identify any obvious immediate threats to toads or frogs. Shade-dominant cover types within riparian buffers appear to be substantial. The higher-than

historically normal conifer size class suggests that surface water availability is becoming increasingly compromised from transpiration by excessive large conifers. That size class distribution, presumably due to long-term fire suppression, also likely contributes to a downward trend in aspen vigor and coverage. The current conifer size class distribution predisposes the BTNF to higher-than-normal severity wildfires, all of which create long-term risks to amphibian habitat." (pg. 29)

Response

Despite efforts that ERG put forth in their Review Document to show there to be a lack of risks to spotted frogs and boreal toads, their comments as a whole provided no evidence of a lack of risks to spotted frogs and boreal toads, while the amphibian report (DeLong 2013a) provides substantive evidence of risks on the BTNF:

a. The review of information completed by ERG was very cursory. Of the 13 major groupings of risk factors identified in the report (Table 2, page 25 of the 01-09-2013 version of the report), their analysis only addressed 3 or 4 of them, and they only addressed a small number and narrow range of the many elements within each of these. They relied on an analysis of a small number of coarse-scale habitat variables, which they recognized was insufficient (see 'b,' below), yet they made conclusions about the lack of evidence showing any risk.

b. In their own words:

    i. "Many of the threats identified by DeLong are not detectable by coarse filter data…" (pg. 28), yet they used an analysis of coarse-scale information to build their case that there are not threats to sensitive amphibians on the BTNF.

    ii. ERG's GIS analysis "…in no way indicates that amphibians are not at risk…" (pg. 4).

    iii. "The Cooperators cannot argue, based on the data presented, or lack thereof, that there are not livestock-amphibian related problems on the BTNF" (pg. 17).

    iv. "None of ERG's coarse filter data conclude that there are not grazing related effects on toads or frogs at the fine scale. To make that determination, substantial fine-scale, on-the-ground data is needed" (pg. 29).

c. ERG did not address, in their GIS analysis, many risk factors having high potential for negatively affecting spotted frogs and boreal toads on the BTNF even though they brought attention to one that could have been modeled (introduced fish), and no recognition was given to the compounding effects of multiple stressors including chitrid fungus and climate change. A sampling of factors not addressed by ERG in their assessment:

    i. Proximity of roads and motorized use to frog and toad breeding sites. This major risk factor is readily analyzed with GIS and was done in the analysis for the LaBarge Vegetation Treatment Project (DeLong 2014b). ERG instead analyzed road density at a large geographic scale, which provided little meaningful information to their assessment.

    ii. Introduced fish. This was not included in their assessment despite ERG exclaiming that "... Pilliod, et al. concludes that introduced fish in north central Idaho 'may eventually result in the ***extirpation*** of amphibian populations from entire landscapes…' (emphasis added) (Pilliod and Peterson 2001)" (pg. 9 of the Review Document); and ERG pointing out that "Game fish preying on eggs and tadpoles represent a significant threat to amphibians" (pg. 33). Comparing existing and pre-stocking distributions of fish on the BTNF and overlaying this over the existing known occupancy of spotted frogs and boreal toads can be readily done with GIS, and this may reveal a contribution of fish stocking to limited amphibian breeding in the Wind River Range. This shows substantive risk on the BTNF and nullifies their assessment of no obvious indication of risk.

    iii. Livestock grazing use, including effects on humidity retention, temperature moderation, shade, hiding and escape cover, tadpole forage, invertebrate habitat, basking sites, water quality, surface-water retention, survival (as affected by trampling), soil compaction, and integrity of near-surface burrows. ERG focused their attention almost exclusively on shade and did not address a wide range of effects with high potential to negatively impact frogs and toads.

    iv. Reduced distribution and abundance of beaver pond complexes.

    v. Overrepresentation of late-seral forestland, and implications to things like the recovery of the distribution of beavers, flow volume and timing, open habitat, and sun exposure of breeding ponds. ERG stated that characterizations in the report of overrepresentation of late-seral forestlands are consistent with their findings, but they appeared to ignore this when they concluded there are no obvious indications that toads and frogs are at risk on the BTNF.

    vi. Reservoirs. Reservoirs can eliminate amphibian habitat and can fragment habitat and impede movements. Effects of reservoirs can be analyzed to some degree with GIS.

    vii. Water developments. Water developments can reduce habitat quality and can, depending on the degree of de-watering, eliminate habitat.

    viii. Campgrounds. Campgrounds can eliminate habitat, reduce habitat quality, and increase mortality.

d. In making conclusions, ERG relied heavily on their GIS analysis, which was misguided at best:

    i. *Capable Habitat* (Comments 20, 21, 24, 71, and 93) — No scientific or other information was cited to support their definition of capable habitat ("streams and water bodies <2% gradient," or <2% gradient in other parts of the Review Document). This definition is substantially different than what is supportable based on available scientific information and existing conservation assessments and plans (see report for citations), especially given the emphasis in the scientific literature on the importance of terrestrial habitat (see "2. Metapopulations" in the "C. Multiple Stressors and Viability" section of the 09-26-2014 version of the report).

    ERG refers to capable habitat as both (1) <2% gradient streams and (2) <2% gradient streams and open water, so it is unclear what was actually modeled.

    ii. *Cover Types and Size Classes within 1.5 miles of "Capable Habitat"* (Comments 25, 26, 71, 93, 102-104) — The report (DeLong 2014a) did not recommend a maximum buffer width of 1.5 miles around capable habitat. The 1.5-mile buffer identified in the report was centered on breeding habitat, and scientific information supported this. The report did not center the 1.5-mile buffer on "capable habitat" (i.e., <2% gradient streams and open water as defined in the Review Document). Reviewers did not provide any scientific support for their use of a 1.5-mile buffer around their modeled capable habitat.

    Similarly, no support was provided in limiting vegetation types to those listed.

    iii. *Shade Producing Cover Types Occur at Higher Percentages than Open Cover Types* (Comments 19, 27, 94, 101) — ERG's assessment that "shaded cover types" occur at a higher percentage across the BTNF than "open cover types" (Comment 94) provides very little meaningful information. Specifically in regard to Comment 101, having about 60% of the area shaded by conifers, aspen, or shrubs provides little if any meaningful information that can be used in efforts to meet Forest Plan direction for spotted frogs and boreal toads for several reasons. ("Area" presumably refers to the area within 1.5 miles of "capable habitat" across the entirety of the BTNF.) First, only a small portion of what was modeled as "capable habitat" is actually used by spotted frogs and boreal toads for breeding (as reflected in ERG's Figure 2) and a substantially lower proportion of the area within 1.5 miles of capable habitat is used by these species. Second, shade needs to exist in close proximity to other habitat elements in order for satisfactorily provide for the habitat needs of boreal toads and spotted frogs. As examples, Bartelt et al. (2004) found daily distances moved by radio-tagged boreal toads in eastern Idaho to be about 42.8

± 8.5 yards (males) and 42.4 ± 5.8 yards, and Schmetterling and Young (2008) found that radio-tagged boreal toads moved an average of about 105 yards during a period of 1-10 days. This means that a sufficient number and quality of shade sites, basking sites, foraging areas, and roosting sites need to be located within about 50 yards of where they exist at any given time. Third, it is entirely possible for portions — possibly large portions — of home ranges to not have any "shaded cover types" (as defined by ERG) or to have them concentrated in particular areas with an absence in large areas (i.e., not accessible within 50 – 100 yards). Fourth, a large proportion of conifer and aspen-conifer mix forestland likely is *too* shaded to provide suitable habitat for boreal toads and spotted frogs, except possibly during migration (see report for citations) and this may also be true of dense stands of tall willows. Fifth, many herbaceous meadow communities provide an abundance of suitable shade so long as they are in healthy condition and grazing has not overly eliminated shade. Sixth, shade provided in many shrubland vegetation types likely is of low quality because the potential for near-ground humidity or moisture is low due to sparse herbaceous understories (i.e., while shade is provided, humidity/moisture is too low).

Again, shading is a fine-scale element but ERG modeled it at a landscape scale, which makes their results virtually meaningless.

Neither of the cover types were defined, and it is not clear what vegetation types were included in each category. Some parts, and possibly large parts, of herbaceous vegetation types (likely classified as "open cover types") provide shade to the extent that grazing does not remove vegetation. Also, some forestlands (likely classified as "shade-producing" cover types) provide poor shading unless a relatively high density of large woody material is present.

"Shading" is discussed further in the response to Overview Comment B.1, above.

iv. *Overlap between Known Amphibian Populations and Capable Habitat Shows Strong Correlation Between Capable Habitat and Known Amphibian Occurrences* (Comments 21, 72, 95, 107) — ERG concluded there to be a "strong correlation between" capable habitat and known occurrences of boreal toads and spotted frogs (Comment 107), which "suggests that the GIS query for identifying vegetation within the 1.5 mile zone adequately represents actual amphibian habitat" (Comment 107) and indicates that "…the aforementioned data layers are correctly identifying toad habitat."

From the standpoint of modeled capable habitat predicting the occurrence of boreal toad breeding sites, reviewers are incorrect in concluding there to be a "strong correlation between low gradient streams and known boreal toad populations." While their Figure 2 shows that frog and toad occurrences could very well strongly indicate the presence of mapped <2% gradient streams or open water, the presence of <2% gradient streams and open water, alone, does a relatively poor job of indicating existing toad occurrences. Application of statistics to this data set would likely show a low correlation.

There are two possible reasons for this. First, it is possible that additional model parameters are needed to increase the predictive capability of the model. Second, it is possible that the model accurately predicts capable breeding habitat but a range of factors have reduced the actual occurrence (distribution) of breeding sites. Reality is probably somewhere between these two, since boreal toads likely select breeding site locations more than on the basis of <2% gradient streams and open water, and available information shows a high likelihood that boreal toad occurrences have declined on the BTNF.

It is not clear how occurrences of amphibians in and immediately adjacent to aquatic habitat indicates amphibian habitat throughout a 3-mile corridor centered on these streams. ERG provided no scientific support for their assessment.

v. *Inventoried Stream Class Condition within 1.5 Miles of Capable Habitat Shows Capable Habitat to be in Good Condition* (Comments 20, 73, 96, 112-113) — ERG concluded that "Maps of stream condition class overlapping capable (i.e., low gradient streams and open water) habitat and which suggest that most stream habitat is in good condition" (Comment 20, and consistent with Comment 112).

However, ERG incorrectly characterized it as "stream condition" throughout the Review Document (except in their Figure 3) because it is actually "watershed condition," and there are more variables that went into watershed assessments than the integrity of stream channels. There can be substantial difference between the condition of streams and the condition of watersheds. They did not provide any scientific or other support for the assumption that good watershed condition equates to good boreal toad habitat in the watersheds. ERG themselves stated that "…stream condition class ratings of 'good' may not necessarily equate with good toad or frog habitat" (Comment 112).

Figure 3 shows condition classes for entire HUCs, but does not show condition classes in relation to "capable habitat." It is not clear if they overlaid their modeled capable habitat over the watershed condition class layer or if they did a visual (side-by-side comparison).

vi. *Road Density within 1.5 Miles of Capable Habitat* (Comments 30, 74, 97, 109-110) — Road density, as measured using GIS, is not an issue with amphibians as it is with species like elk. The issue, as outlined in the report, involves the presence of roads in relatively small crucial habitats, the extent to which roads are close to breeding sites, the extent to which they cross riparian travel corridors, and other situations in which frogs and toads need to cross roads during migrations, emigrations, and other movements.

Road density within 1.5 miles of "capable habitat" is a poor indicator for several reasons:

(1) There is no known scientific basis for assessing road density within 1.5 miles of all streams and water bodies having <2% gradient on the BTNF; ERG did not provide any scientific support and it conflicts with available scientific information cited in the report. The 1.5-mile buffer identified in the report centers on breeding sites (citations in the report).

(2) Road densities shown in ERG's Table 3 dilute the effects of roads on frogs and toads because it analyzed the density of roads within 1.5 miles of all low-gradient streams on the BTNF and:

  (a) Density of roads within riparian areas and immediately adjacent to riparian areas is substantively higher than road density further from riparian areas.

  (b) A majority of use by frogs and toads occurs within and adjacent to riparian zones, and the potential for use by frogs and toads declines with increasing distance from riparian zones.

  (c) A large majority of capable habitat modeled by ERG does not appear to be occupied by frogs or toads.

  (d) Road density in ERG's analysis was driven primarily by areas with low potential for use by frogs and toads. Areas 1/3 to 1.5 miles from breeding sites have lower use than areas within 1/3 mile of breeding sites, and areas 1/3 to 1.5 miles from low-gradient streams has lower potential for use by frogs and toads.

(3) Reviewers assessed that "…short segments of roads may indeed impact toads on the BTNF…" Scientific information shows that short segments of roads (e.g., near breeding sites, bisecting movement corridors) can disproportionately impact amphibians, much more so than road density within 1.5 miles of what ERG modeled as capable habitat.

The assessment that "Only 26% of the forest has road densities exceeding 1.5 miles per square mile" (Comment 110) has little apparent meaning because (1) no scientific literature was cited by ERG supporting a threshold of 1.5 miles per square mile, (2) there does not appear to be any biologically-based rationale for this threshold, and (3) road density within 1.5 miles of their modeled capable habitat does not appear to have any merit.

Data does not need to be collected on the BTNF to determine, prior to implementing protective measures, if roads in critical locations impacts frogs and toads. A large volume of scientific information shows high potential for impacts to occur where roads are located near breeding sites, in and adjacent to riparian zones, and in other amphibian travel corridors (see report for citations). Local data demonstrating that frogs and toads would not cross a proposed road under a wide range of pertinent situations would be needed prior to foregoing the implementation of protective measures.

Whether mitigation measures are needed will be considered on a site-by-site basis. As an example, restrictions on roads and use of roads by motorized vehicles were incorporated into the LaBarge Vegetation Project to allow Forest Plan Objective 3.3(a) and applicable standards to be met with respect to boreal toads and spotted frogs, and this was followed by an analysis to determine if restrictions were sufficient to provide suitable conditions for boreal toads and meet this Forest Plan direction, which the analysis demonstrated (DeLong 2014b, USFS 2015).

vii. *Most Elevations on the BTNF are High Enough that Effects of >80ºF Temperatures are Immaterial* (Comments 98, 111) — Elevation was analyzed by ERG in the context of whether the distribution of frogs and toads on the BTNF was high enough for the effects of >80 ºF temperatures and <65% humidity on spotted frogs to be immaterial; ERG reasoned that, because most of the BTNF is above 8,000 feet in elevation (ERG's Table 4), spotted frogs and boreal toads would mostly not be subject to temperatures above 80 ºF (pg. 3, 8, 9, and 25).

Most of the acres on the BTNF being above 8,000 feet in elevation has little meaning for two main reasons. First, only a small proportion of the acres on the BTNF are occupied by spotted frogs and boreal toads, and ERG's Table 4 included all 3.3 million acres of the BTNF. Second, about 65% of spotted frog breeding sites and about 44% of boreal toad breeding sites are at or below about 8,000 feet in elevation.

The majority (about 72%) of spotted frog breeding sites on the BTNF are between about 7,900 and 9,000 feet in elevation, about 26% are between 6,000 and 7,800 feet in elevation, and less than 2% of sites are above 9,000 feet (but only to 9,200 feet). A majority (72%) of boreal toad breeding sites are between about 7,900 and 8,300 feet in elevation, with half of these sites occurring at 7,900-8,000 feet; about 5% of breeding sites are between 6,700 and 7,800 feet, and about 23% of sites are between about 8,400 and 9,800 feet.

e. A large volume of scientific information demonstrates a high potential for spotted frogs and boreal toads to be impacted by activities and developments that occur on the BTNF (see "3. Status with Respect to Risk Factors on the BTNF" in section D of Part I of the report for a summary, and the "Risk Factors and Restoration Factors" subsection in each habitat/survival element in Part II), and ERG did not provide scientific or other information to refute any of this scientific information and they did not demonstrate that any of the scientific information cited in the report does not apply to the BTNF. ERG only identified a small number of examples of studies cited in the report that they felt did not apply to the BTNF, and they were not able to show that the studies do not pertain (see response to Overview Comment F for the assessment of this).

f. Information does not exist demonstrating that existing management controls on the BTNF (e.g., standards, prescriptions) are sufficient to adequately protect spotted frogs and boreal toads from being negatively impacted by activities and developments. As two brief examples, (1) roads exist in proximity to breeding sites and they bisect travel corridors throughout the BTNF and (2) livestock grazing use occurs in and near breeding habitat and other habitats with no restrictions or adjustments to utilization limits to protect frogs and toads. ERG did not consider the large volume of scientific information demonstrating threats posed by these two risk factors, as only two examples.

g. See also discussion in responses to Overview Comments C.4 and C.5.

C. *Reviewers Envisioned a Different Planning Approach and Different Purpose of the Report*

C.1. PURPOSE OF THE REPORT

Summary of Comments and/or Explanation

All indications are that ERG interpreted the purpose of the report as providing a conservation strategy for spotted frogs and boreal toads on the BTNF.

Specific Comments

- *"Sensitive Species Objectives and Recommended Conservation Actions, and their Basis* (the "DeLong Paper") identifies risks to the sustainability of boreal toads (*Bufo boreas boreas*) ("toads") and Columbia spotted frogs (*Rana luteiventris*) ("frogs") based on numerous documents. The DeLong Paper identifies solutions for avoiding or minimizing those risks, based on the numerous documents, by recommending prescriptive measures that restrict logging, road use and road building, fuels management activities, and livestock grazing" (pg. 1, comment 1).
- 19 references in ERG's Review Document to "conservation strategy."

Response

ERG misinterpreted the purpose of the report since they reviewed the report as if it was a conservation strategy and, because ERG envisioned the report to be a conservation strategy, this undoubtedly established certain expectations in their minds as they reviewed the report. Therefore, because the genesis of many of their comments appears to be rooted in an understanding that the report was a conservation strategy, many of their comments lack merit. Nonetheless, however, each of their comments was reviewed to determine whether any adjustments or redirection was needed based on this input.

The report was built around a specific purpose — which was stated on page 1 of the report (01-09-2013 version) — and when the report is reviewed assuming a different purpose, it understandable how reviewers could have identified what they saw to be missing elements or elements developed erroneously.

The purpose of the report was stated on page 1, first sentence of the second paragraph of the report reviewed by ERG: "The main purpose of this report is to outline the basis of the objectives developed for Columbia spotted frogs and boreal toads on the BTNF." This followed the first paragraph of the report: "The Sensitive Species Management Standard of the Bridger-Teton National Forest (BTNF) Land and Resource Management Plan (Forest Plan) requires that quantifiable objectives for sensitive species be developed. Objectives for spotted frogs and boreal toads were developed to meet Objective 3.3(a) of the Forest plan with respect to these species, and the higher-level direction upon which this Forest Plan objective was based." Objectives in the report focused on the provision of suitable conditions, including protection from activities having potential to negatively impact them.

Objectives in the report focus on defining, for spotted frogs and boreal toads, the suitable conditions required by Forest Plan Objectives 3.3(a) and 4.7(d), Sensitive Species Management Standard, and Forage Utilization Standard; these objectives call for suitable conditions to be provided. The purpose of the report, therefore, was to outline the information used in stepping Objectives 3.3(a) and Objective 4.7(d) down to objectives for spotted frogs and boreal toads. Note: objectives in the 01-09-2013 version of the report were converted to "suitable condition statements" in the 09-26-2014 version of the report.

The report also identified risk factors and potential conservation actions.

The purpose of the report contrasts with the apparent interpretation of the purpose of the report by ERG. In their opening paragraph ERG stated that the report (1) identifies risks and (2) identifies solutions for avoiding or minimizing those risks. This fell under the heading entitled “Purpose” in the Review Document. While the report identified risks and conservation actions, this was not the main focus of the report. Furthermore, throughout the Review Document, reviewers refer to the report as a conservation strategy, which the report is not. ERG did not appear to provide any input on objectives or suitable conditions or the development of objectives or suitable conditions.

This apparent misinterpretation occurred despite ERG capturing the essence of the purpose of the report in the title of their Review Document: “Critical Review of ‘Sensitive Species Objectives and Recommended Conservation Actions, and their Basis,’” emphasis added, and this title is identified at the top of every page of their Review Document.

See responses to Overview Comments C.3, C.4, C.5, and C.6 for further details on the difference between the report and a conservation strategy.

C.2. STEPS OF WILDLIFE PLANNING PROCESS COVERED IN THE REPORT

Summary of Comments and/or Explanation

Of the steps in the planning process, the Review Document focused on the identification of existing conditions as being missing from the report and the development of strategies as being deficient or erroneous mainly due to a lack of local data supporting characterizations of existing conditions.

Specific Comments

- About 75 references in ERG’s Review Document to “data” with respect to existing conditions.
- About 20 references to conservation strategy or conservation strategies.
- Only 1 reference to “objective” in context of objectives in the report: “While habitat objectives were seemingly conceptualized based on recommendations within documents cited in the DeLong Paper, without any discussion as to whether or not those documents are pertinent to the BTNF based on local climate and disturbance regimes, there is no basis that shows how current conditions compare to those objectives” (pg. 3).

Response

Both the identification of existing conditions and development of strategies come after the definition of desired or suitable conditions (see Table A, below). The Review Document repeatedly referred to the report as a conservation strategy, but the report is not a conservation strategy as explained in the response to Overview Comment C.1, above. A strategy is a combination of actions deliberately arranged or ordered in particular way to accomplish identified objectives and ultimately goals, while a conservation action is a specific, independent management activity. The report only provides lists of individual conservation actions to consider when planning future projects, with no attempt made to formulate the actions into a strategy for conserving spotted frogs and boreal toads on the BTNF. As more clearly stated in the revised report, information in the report (a technical report) was integrated into a “conservation assessment” for spotted frogs and boreal toads on the BTNF, and even this assessment falls short of outlining a strategy for conserving spotted frogs and boreal toads on the BTNF.

The following table outlines the basic steps in the planning process, and responses to Overview Comments C.3 – C.6, below, respond to ERG’s comments pertaining to the respective steps.

If a conservation strategy were to be developed, the formulation of strategies would take place at the “Develop Proposed Action” stage in the process (see Table A).

Table A. Comparison of planning steps.

Wildlife Planning Steps	**Forest Service Planning**[A]	**Allotment Mgt. Planning**[B]
Conservation Assessment	*Plan-to-Project Analysis*	*Plan-to-Project Analysis*
Definition of Suitable Conditions[C] (stepped down from Forest Plan Obj's)	Determine Desired Conditions based on mgt. direction (e.g., Forest Plan)	Identification of Desired Conditions
Identification of Existing Conditions[D]	Determine Existing Conditions[D]	Identification of Existing Conditions[D]
Identification of Risk Factors and/or Limiting Factors	Identify Need for Changing the Existing Condition	Identification of Resource Mgt. Needs
Identification of Conservation Actions to Consider	Identify Possible Activities to Meet the Need	Identification of Possible Practices
Identification of Information Needs		Identification of Information Needs
Development of Strategy	*Development of Proposal*	*Development of Proposal*
		Decision Framework
Identify Purpose and Need for Strategy	Identify Purpose and Need	Identify Purpose and Need
Formulate Strategy for Achieving and Sustaining Suitable Conditions[D] (Purpose) by Addressing Limiting Factors (Need)	Develop Proposed Action	Develop Proposed Action

[A] As taught in the 1900-1 training course.

[B] WO Amendment 2209.13-2005-10.

[C] Suitable conditions can take the form of goals and objectives.

[D] Based on inventory, monitoring, local studies, GIS coverages, scientific information, and other available information.

It is noteworthy that ERG's approach is conflicting. They assumed historic (i.e., natural or pre-activity) conditions to be desired conditions, but yet they also assumed a management approach of only changing current management when local data demonstrates there to be problems, which errs on the side of existing conditions. This is important because there will continue to be limited data for a majority of sensitive species, including sensitive amphibians; if changes are only made to management when problems can be proven, the default of existing conditions will be continued despite probable impacts; e.g., based on a large volume of scientific information combined with no more than limited management controls to mitigate impacts on sensitive amphibians and no data showing frog and toad populations are at satisfactory levels. Similarly, existing conditions that would exist under a proposed action would assumed to provide conditions within the range of suitability unless local data shows otherwise.

C.3. DEFINITION OF SUITABLE CONDITIONS

Summary of Comments and/or Explanation

Note: ERG provided few comments on objectives or suitable conditions. An exception was their many comments pertaining to the minimum 70% retention threshold.

ERG argued that a minimum 70% retention of total herbaceous vegetation is highly questionable and not biologically defensible, and they characterized it as a management recommendation not as an objective or suitable condition.

See also "Summary of Comments and/or Explanation" subsection of Overview Comment D.2, below).

Specific Comments

- "DeLong relies heavily on the report to the Forest Service (Allen-Diaz et al. 2010) and the Rangeland Ecology and Management journal article (Roche 2012) to make his assertions concerning herbaceous vegetation retention, humidity retention, temperature moderation, and suitable shading and sun protection attributes. A simple search of the texts shows that the word “retention” does not appear in either of these studies. The studies were therefore not relevant to his conclusions (Owings 2014)” (pg. 2, comment 11).

- “While BTNF biologists were explaining how the recommended 70% retention standard would be applied, Loren Racich, Sublette County Conservation District, asked how shade could be limiting to toads since any toad in the sedge community would literally be no more than two hops away from dense willows. BTNF biologists were unable to answer the question. It was evident that the 70% retention standard would have no logical benefit for avoiding temperature stress on toads in that particular situation, yet there was no acknowledgement of that by BTNF staff” (pg. 3, comment 15).
- “…BTNF biologists were asked to explain the limiting factor to toads at that site. The BTNF biologists were unable to answer the question, but did state that the literature (mostly from a California study which actually found no correlation between toads and grazing) recommended the retention of 70% of nongrazed grasses and sedges to avoid dessication of adult toads during hot weather. This is an example of the attempts made in the DeLong Paper to justify far-reaching management decisions” (pg. 4, comment 18).
- “Another paper found no relationship between grazing and toad density in the Sierra Nevada range, where elevations, if not latitude, are somewhat more comparable to the BTNF than other papers cited (Allen-Diaz et al. 2010). It could be expected that some discussion would appear on what the local conditions were that might have explained Allen-Diaz’s findings, and whether any useful information had been found that might be applicable to the BTNF” (pg. 9, comment 47b).

Response

Despite the report focusing on identifying objectives and suitable conditions and the basis for them, ERG did not comment on objectives or desired conditions (except for the 70% retention objectives). Nearly all of their comments addressed what they saw as an absence of analyses of local data on existing conditions. Therefore, nearly all of ERG’s comments could not have pertained to objectives and suitable conditions in the report because determining suitable conditions for wildlife is done prior to and independent of the characterization of existing conditions (Table A, under C.2 above). The definition of suitable conditions is based on Forest Plan and other higher-level management direction for wildlife as informed by scientific information. (While desired conditions are typically defined by interdisciplinary teams, determining suitable conditions for wildlife is the function of wildlife biologists.) It would not have been possible for ERG to use data on existing conditions to determine suitable or desired conditions because they compared existing conditions against historic conditions (suitable or desired conditions) to determine limiting factors. This is important to point out because the bulk of their comments argued that the report was greatly inadequate because it did not sufficiently analyze existing conditions, but the main purpose of the report was to define suitable conditions and to outline the basis for them.

One of ERG’s authors well recognizes that local data is not needed to define suitable conditions for wildlife. Mike Hillis was the lead author on a paper that defined suitable conditions for elk security cover (Hillis et al. 1991). He and the other authors of the paper defined suitable elk security cover as follows: “To provide a reasonable level of bull survival, each security area must be a nonlinear block of hiding cover > 250 acres in size and > one-half mile from any open road. Collectively, these blocks must equal at least 30% of the analysis.”

They followed this by stating that “We developed guidelines for retaining elk security areas west of the Continental Divide in Montana. We suggest that the concepts presented here could assist managers in providing security areas elsewhere…” (Hillis et al. 1991:38). The Review Document, on page 36, characterized the “Hillis paradigm” as being widely used. In suggesting the application of their numeric criteria to other areas, Hillis et al. (19991) did not specify that local data should be used to redefine or refine their definition of suitable security cover, or to determine whether to apply the criteria in the first place. Other papers that followed (e.g., Christensen et al. 1993) did not include analysis of local data as a prerequisite for applying criteria in Hillis et al. (1991) to other areas.

Suitable conditions for spotted frogs and boreal toads were defined in the 01-09-2013 version of the report, and the reason for doing this was to incorporate the information into objectives for spotted frogs and boreal toads. Objectives identify suitable conditions. In the revised report (9-26-2014), the focus of the report was adjusted somewhat by changing the focus from “objectives” to “suitable condition statements.” However, because the 01-09-2013 version of the report incorporated suitable conditions into objectives and because the suitable condition statements in the revised report will be incorporated into objectives in some form or another, the changes have no effect on resource management.

It has been my experience as a Wildlife Biologist, Resource Planner, and Program Manager for Range that, while biologists and range management specialists are comfortable with characterizing existing conditions, most have a difficult time grasping the process of defining suitable conditions and developing objectives. This can be seen in ERG’s Review Document. Despite the main purpose of the report and despite them recognizing the main purpose of the report, ERG placed a great amount of emphasis on defining existing conditions. I have extensive experience developing objectives and leading teams to develop objectives (including at the Regional Office level), was co-author of a goals and objectives development guide (a Washington Office team), published another related paper, and reviewed goals and objectives drafted by more than 20_ national wildlife refuges in California and Nevada. (See the “II. Credentials of the Author of the Report”) section.

A flow chart was added to the 9-26-2014 version of the report (Figure 1) and hopefully will help readers better understand the process of defining suitable conditions and developing objectives. The figure is consistent with the Forest Service planning model and WO Amendment 2209.13-2005-10 (Table 1), the latter of which is especially relevant since emphasis of reviewers’ comments is on herbaceous retention, which is a livestock grazing issue.

Minimum 70% Retention of Total Herbaceous Vegetation — If 70% retention of herbaceous vegetation is not biologically defensible or scientifically supportable as a low-end threshold for spotted frogs and boreal toads, this means that all retention levels below 70% are even less biologically defensible and scientifically supportable. If 70% retention is biologically indefensible as a low-end threshold, then incrementally higher retention levels would need to be assessed until a biologically defensible retention level is found (see response to Overview Comment E.2).

It is recognized that 70% retention is not fully biologically defensible, but this is because it errs to some degree on accommodating continued livestock grazing. On balance, however, there is moderate support showing that ≥70% retention of herbaceous vegetation in plant communities with suitable plant species composition provides, on average, suitable (1) cover for retaining humidity and moderating temperature near the ground surface; (2) shading and protection from the sun; (3) hiding and escape cover; (4) forage for tadpoles; (5) forage, cover, and structure for diverse invertebrate communities; (6) shallow waters exposed to the sun and open patches for basking; (7) water quality, as related to urination, defecation, and trampling by large ungulates; (8) water retention in small breeding pools; (9) survival rates as affected by trampling; (10) soil looseness and porosity; and (11) integrity of near-surface burrows used by frogs and toads.

ERG did not contribute any additional scientific or other information that would bolster the confidence in 70% retention as a low-end threshold, much less did they provide any scientific or other information showing that 60% or 50% retention would be sufficient as a low-end threshold.

See responses to individual comments (“III. Responses to Individual Comments in the Review Document”) for responses to the comments quoted in the “Specific Comments” subsection, above.

C.4. EXISTING CONDITIONS ON THE BTNF AND ANALYSIS OF LOCAL DATA

Summary of Comments and/or Explanation

The Review Document made many references to the lack of data in the report on existing conditions, and made many references about how this renders management recommendations and the conservation strategy questionable or baseless.

Specific Comments

- About 75 references in ERG's Review Document to "data" with respect to existing conditions.

As examples, reviewers stated or asked the following:

- "The DeLong Paper also provides no data on BTNF vegetation conditions, including the distribution of vegetation cover types, size class distribution, grazing utilization, and relative distribution of grazing utilization within allotments" (pg.3).
- "That lack of local data makes the justification for the management recommendations in the Paper highly questionable" (pg. 3).
- "The DeLong Paper recognizes the need for coarse filter data, but no data is provided that addresses disturbance regimes, current vegetation or comparison to historic conditions. Inferences are made to changes in vegetation due to fire exclusion (e.g., aspen) but no data is provided to support those conclusions" (pg. 8, comment 42).
- "Despite the discussion on how coarse filter analyses work, the Paper provides no coarse filter analysis data for the BTNF. The list of mappable data is extensive:…," followed by a list of six "mappable data" (pg. 15).
- "What is the condition of that habitat in terms of stream width, Rosgen channel profile, sinuosity, shrub density, and mix of palatable and non-palatable grasses, sedges, and rushes?" (pg. 16, comment 80).
- "What is the current level of utilization and/or stubble height by allotment within and adjacent to those riparian areas?" (pg. 16, comment 81).
- "What is the status of toads within that capable habitat in terms of percent occupancy, population density, and larvae survival?" (pg. 17).
- "DeLong makes numerous speculations regarding habitat conditions that have changed over time, but does not use any data to support these conclusions," followed be six specific examples (pg. 18).

Response

The 01-09-2013 version of the report did not include a detailed analysis or presentation of data on the existing conditions of habitat and survival elements important to spotted frogs and boreal toads on the BTNF, but the report provided synopses of available for some habitat and survival elements, this analysis of data is not needed given the purposes of the report, and obtaining this information for all important habitat and survival elements is not possible. For the following reasons, ERG's critique that existing conditions were inadequately characterized is baseless given the purposes of the report and given additional information that has been added to more recent versions of the report:

a. Assessments of existing conditions were not absent by any means in the 01-09-2013 version of the report. Existing conditions of many habitat and survival elements (e.g., extent and distribution of willow and other riparian vegetation, stream channel integrity, mix of succession stages, distribution and condition of aspen stands, distribution and abundance of beaver pond complexes, herbaceous species composition, and prevalence of tall, dense herbaceous vegetation) were generally characterized (sometimes by comparing existing to estimated natural conditions; and including some numbers) in the 01-09-2013 version of the report based on BTNF-wide reports, landscape scale assessments, and other pertinent documents. As an example, aspen reductions in the distribution and conditions of aspen stands on the BTNF were discussed in the report and Gruell (1980a), Gruell (1980b), and Loosen et al. (2009), which analyzed local data, were cited in the report. LANDFIRE (2007), which provides a somewhat larger perspective, was also cited.

Also, general characterizations of existing conditions of additional habitat and survival elements were completed for the 09-26-2014 version of the report. Characterization of existing conditions will be done on a project-by-project basis.

b. Characterizations of existing conditions of habitat and survival elements are not needed for and would not contribute to defining suitable conditions, and defining suitable conditions is the focus of the report (see "C.3. Defining Suitable Conditions," above). As an example, data on existing and recent past herbaceous retention levels on the BTNF are not needed for defining suitable herbaceous retention levels for spotted frogs, boreal toads, and other wildlife.

c. Risk factors and potential conservation actions are identified for the ultimate purpose of providing suitable conditions for spotted frogs and boreal toads and protecting them from activities that have the potential to cause long-term or further decline in populations or habitats or trends toward federal listing (FSM 2670.23, Forest Plan Objective 3.3(a), Sensitive Species Management Standard).

Therefore, even though funding for sensitive species conservation does not allow existing conditions of habitat and survival elements to be examined in detail and mapped (which would otherwise allow gaps between suitable and existing conditions to be detailed), risk factors and potential conservation strategies can readily be identified using available information.

See "C.5. Identification of Risk Factors" and "C.6. Identification of Conservation Actions to Consider," above, for more detailed discussion.

d. The level of detail that ERG expected to be analyzed in the report was unrealistic and unneeded since the report covered the entirety of the BTNF and covered a large number and variety of habitat and survival elements. ERG expected that habitat condition in terms of stream width, Rosgen channel profile, sinuosity, shrub density, mix of palatable and non-palatable herbaceous vegetation, current utilization levels, current green-line stubble heights should have been analyzed and presented in the report (from comments 80 and 81).

This level of detail typically is analyzed at the project level on a project-by-project basis. See response to Overview Comments C.4 and C.5. Risks to stream and riparian conditions on the BTNF were generally described in the 01-09-2013 version of the report (see the "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section, pgs. 26-27, and the "Wetland, Stream, and Riparian Habitat Retention" section, pgs. 32-34).

e. Given the reality that sufficient data will not be collected to numerically describe existing conditions of all the important habitat and survival elements across the BTNF for spotted frogs and boreal toads (especially in the context of this same issue for all sensitive wildlife species and wildlife MIS on the BTNF), combined with the understanding that risk factors are just that, risk factors (and not limiting factors) and affirmative requirements to protect sensitive species and provide suitable conditions for them, risk factors and potential conservation actions need to be identified using available information.

f. Many conservation actions are tied directly to suitable conditions and should be or need to be applied regardless of existing conditions. As examples, management actions to retain a minimum of 10-15 tons/acre of large woody material need to be implemented in timber harvest units regardless of existing conditions; management actions to retain ≥70% of total herbaceous vegetation across ≥80% of spotted frog or boreal toad habitat within 1/3 mile of breeding sites are needed to provide suitable conditions; and roads within 200 yards of breeding sites should be re-routed and no new roads should be located within this distance, regardless of the extent to which roads currently exist within 200 yards of breeding sites.

g. Characterizing existing conditions of habitat and survival elements can be important in developing a conservation strategy, but the identification of conservation-actions-to-consider necessitates a less thorough and less rigorous assessment of existing conditions. The report is not a conservation strategy.

h. There is no support in law, regulation, or policy for holding the meeting-of-sensitive-species-requirements hostage to the shortage of data on existing conditions, especially given the large volume of scientific information demonstrating negative impacts of the activities addressed in the report and the deficiency of management controls in place to minimize impacts.

i. The following statement was made in the draft report in the "Mapped Habitat and Adjoining Uplands" section: "A map showing… capable wetland habitat for spotted frogs and boreal toads will be created incorporated into the final report."

j. In September 2013, the Forest Supervisor committed the BTNF as follows: "By December 30, 2015, complete initial modeling and mapping of capable/suitable habitat for each Sensitive Species at the Forest Plan level; initiate habitat modeling validation at the project/zone level and modify modeling parameters/habitat maps as appropriate and necessary."

   This effort, which is now underway, will provide information for refining risk statements and conservation actions to consider, and could be used if a conservation strategy were to be developed for the BTNF.

k. It is not realistic to think that a sufficient amount of data will be collected in the foreseeable future to determine spotted frog and boreal toad population status and trends, habitat conditions, and effects of activities and developments on the BTNF as a whole or for specific meta-populations (see comment 82). Determining their population status and examining the comparative effects of limiting factors on their populations (which would involve examining a broad range of other environmental factors) would cost many 100s of thousands of dollars if not millions of dollars. And spotted frog and boreal toads are only two of 27 sensitive species and MIS.

l. The 2012 Planning Rule emphasizes taking a coarse-filter approach to management to the extent possible, and making fine-filter adjustments as needed where this approach is not adequate for meeting the needs of species of conservation concern. An important reason for taking this approach is that it is unreasonable to expect the Forest Service to be able to obtain enough information on each and every species of conservation concern to effectively manage them individually.

m. ERG argued against taking a single species approach to management, but the compilation and analysis of information on spotted frogs and boreal toads asserted by ERG would set the stage for single species management.

n. Also, even though data was not presented, the author has worked in this part of Wyoming for nearly 15 years and is familiar with habitats used by spotted frogs and boreal toads and the elevation ranges of these species on the BTNF, climatic conditions at these elevations, vegetation patterns across the landscape, riparian conditions, etc. Where this local knowledge was used in developing parts of the report, ERG is correct that actual data or reports analyzing or summarizing this data should be documented or cited in the report, and this has been done to a greater degree.

o. Conservation assessments typically do not provide a substantial amount of analysis of data (e.g., Hogrefe et al. 2005, Keinath and McGee 2005, Patla and Keinath 2005, Brown et al. 2015).

ERG repeatedly stated that no changes to management are warranted unless it can be demonstrated with local data that current management is negatively impacting sensitive amphibian species. This is incorrect as explained in the subsection entitled “D. Point from which Burden of Proof is Examined.”

Regarding comments that local data on existing habitat and disturbance regimes needs to be analyzed in order to have a defensible conservation strategy, (1) the report is not a conservation strategy; (2) several papers, reports, and assessments cited in the report (e.g., Gruell 1980a, Gruell 1980b, LANDFIRE 2008, Loosen et al. 2009) analyzed local data or other local information, and a reanalysis of this information is not necessary; and (3) see other pertinent points above.

C.5. IDENTIFICATION OF RISK FACTORS

Summary of Comments and/or Explanation

ERG did not comment on the merits of risk factors as risk factors (as risk factors were defined in the report). Instead, ERG treated risk factors as if they were factors that have been shown, with local data, to limit spotted frog and boreal toad populations on the BTNF.

ERG’s Review Document made many references to the risk factors in the report not having relevancy to spotted frogs and boreal toads on the BTNF since the report did not include an in-depth analysis of locally-collected data. Comment 84 (pg. 18 of the Review Document) summarized their assessment of the report with respect to risk factors as follows: “DeLong makes numerous speculations regarding habitat conditions that have changed over time, but does not use any data to support these conclusions,” which was followed by six examples of what they thought were speculations lacking supportive data (comments 85-90).

Specific Comments

This is exemplified by the following examples of comments from ERG:

- “It is evident that no limiting factors to toads and frogs specific to the BTNF have been identified, and any measures meant to resolve those presumed factors are fixes to problems that have not been demonstrated to exist” (pg. 4).
- “The Paper also stresses the importance of minimizing compaction near streams, yet no data is provided on the BTNF’s soil sensitivity to compaction or documented cases of compaction from cattle” (pg. 3).
- “And while the Paper also stresses the risks associated with roads near streams, no data is provided on road density within or adjacent to suitable toad and frog habitat” (pg. 3).
- “The need to preface management actions with a strong, biologically-based understanding of limiting factors has long been the basis of sound wildlife management (Leopold 1933)” (pg. 5, comment 32).
- “Many of the threats identified by DeLong are not detectable by coarse filter data…” (pg. 28).
- “The Methods section (4.1) within this review describes the importance of comparing current to historic conditions and describes data typically used to make those comparisons. DeLong makes numerous speculations regarding habitat conditions that have changed over time, but does not use any data to support these conclusions. The following are some examples of his deductions:” (pg. 18, comment 84).

  This was followed by six paragraphs for each of the following issues: heavy grazing on streambanks (comment 85), depleted ground cover in uplands (comment 86), road effects on water tables (comment 87), reduced stream flow rates (comment 88), reduced occurrence and extent of beaver pond complexes (comment 89), and grazing-induced headcuts and down-cut trails in meadows (comment 90).

Response

The way in which ERG viewed “risk factors” heavily influenced their comments, and their misinterpretation makes many of their comments on this subject irrelevant. They viewed risk factors as factors that have been shown with local data to limit a given wildlife population, for which local data would be needed. However, the 01-09-2013 version of the report characterized risk factors as having the *potential* to impact spotted frogs and boreal toads: “Factors that have been identified that have the potential to be affecting amphibian habitat and populations on the BTNF include…” (DeLong 2013a:24). Then, the opening sentence of each “Risk Factors and Restoration Factors” subsection in the report characterized risk factors as factors that have the potential to cause [impacts to a given habitat or survival element] or factors that have altered or have the potential to alter [the given habitat or survival element]. Examples of introductory language these sections include the following:

- “The following risk factors have altered and/or have the potential to alter the extent of riparian vegetation in valley bottoms and seasonal water-level fluctuations in riparian wetlands” (DeLong 2013a:).
- “The following activities and conditions (risk factors) have the potential to cause the loss of wetland habitat, including the accelerated loss of wetlands due to elevated sedimentation rates” (DeLong 2013a:32).
- “The following activities and conditions (risk factors) have the potential to accelerate the decline in water levels in wetlands” (DeLong 2013a:38).
- “The following activities and conditions reduced beaver populations historically and/or have the potential to limit the recovery of a natural distribution and abundance of beavers and, therefore, have the potential to limit the achievement of Forest Plan Objective 3.3(a) and Sensitive Species Management Standard with respect to spotted frogs and boreal toads” (DeLong 2013a:51).

The role of risk factors in the report was to identify risk factors so that a list of conservation-actions-to-consider could be formulated, in contrast to determining limiting factors in order to develop a conservation strategy for the BTNF.

All of the risk factors identified in the report specifically pertain to the BTNF. No risk factors were identified that are not supported by information showing potential for spotted frogs or boreal toad populations to be negatively affected on the BTNF. Discussions in the 09-26-2014 version of the report had been expanded to address this to a greater degree and the revised report expands on the discussions even further. Potential for risk on the BTNF is influenced and/or shown by the level of risk state-wide, information demonstrating a lower (or higher) risk level on the BTNF, local data on a given component habitat or survival element where this is available, scientific information demonstrating impacts from a given activity or form of development, and management controls on the BTNF that prevent or sufficiently mitigate impacts. Scientific literature demonstrates impacts of activities and developments as outlined in the report and, if sufficient management controls are in place to specifically avoid or mitigate impacts of activities and developments with potential to impact frogs and toads and if there is no data demonstrating that negative impacts are being sufficiently mitigated, there is a reasonable chance of negative impacts occurring. This is a particularly important point given the sensitive species status of both species, the conservation status of both species in the State of Wyoming, and consideration being given to protection of the boreal toad under the Endangered Species Act.

Only risk factors relevant to the BTNF are addressed in the report, but no attempt was made to provide a detailed examination of existing conditions of any of the risk factors on the BTNF. The following two examples generally show the approach used in the report:

	Example 1 — Crushing by Motorized Vehicles	**Example 2 — Effects of Livestock Grazing Use**
1.	Are there places on the BTNF where motorized routes exist, especially within riparian zones, within 200 yards, 1/3 mile, or 1½ mile of breeding sites metamorph, juvenile, or adult spotted frogs or toads cross roads and motorized trails and does motorized use of these routes occur between June and September? ***If ‘yes,’ proceed to no. 2.*** (Note: In the LaBarge watershed, numerous examples exist of this (DeLong 2014), and other examples exist across the BTNF.)	Is there overlap in the distribution of livestock grazing use and habitat used by spotted frogs and boreal toads, particularly breeding habitat, migration habitat, and summer habitat, during the associated season? ***If ‘yes,’ proceed to no. 2.*** (Note: There is a large overlap in the areas grazed by cattle and the habitats used by spotted frogs and boreal toads, including breeding habitat, migration habitat, and summer habitat).
2.	Does scientific information demonstrate there is risk of spotted frogs and boreal toads being crushed by motorized vehicles under the circumstances outlined above, including studies on Forest Service roads? ***If ‘yes,’ proceed to no. 3.***	Does scientific information demonstrate there is risk of tadpole, metamorph, juvenile, or adult spotted frogs or boreal toads being negatively impacted by livestock grazing use through reductions in hiding cover, humidity retention, tadpole forage, insect habitat, or water quality; or accelerated declines in water levels; or trampling effects (crushing)? ***If ‘yes,’ proceed to no. 3.***
3.	Are there management controls currently in place to avoid or greatly reduce the potential for crushing by motorized vehicles wherever there is a potential for crushing to occur, and can this be demonstrated? ***If ‘no,’ proceed to no. 4.***	Are there management controls currently in place to avoid or greatly reduce the potential for livestock grazing use to impact spotted frogs and boreal toads wherever livestock distribution overlaps with frogs and toads, and can this be demonstrated? ***If ‘no,’ proceed to no. 4.***
4.	Is there BTNF-specific information or published scientific information demonstrating that crushing of spotted frogs and boreal toads does not materially contribute to negative population-level effects? ***If ‘no,’ proceed to no. 5.***	Is there BTNF-specific information or published scientific information demonstrating that livestock grazing use at existing levels does not materially contribute to negative population-level effects at the metapopulation level and BTNF scale? ***If ‘no,’ proceed to no. 5.***
5.	There is a risk of impacts occurring, and potential conservation actions to mitigate impacts need to be listed.	There is a risk of impacts occurring, and potential conservation actions to mitigate impacts need to be listed.

Given the status of both species, the opportunity for activities and developments to impact both species, and the preponderance of scientific information demonstrating the potential for impacts, combined with no more than limited pertinent BTNF-specific information, the burden of proof is on demonstrating activities and developments are not materially contributing to negative effects on metapopulations and BTNF-wide populations.

To obtain an accurate and detailed read on the factors currently limiting spotted frog and boreal toad populations on the BTNF, existing conditions of habitat and survival elements and population status and trend would need to be known. However, (1) as discussed previously, information on existing conditions of many habitat and survival elements does not exist, will not exist in the foreseeable future[1], and existing population status and population trends will not be known for spotted frogs and boreal toads on the BTNF in the foreseeable future[2]; and (2) the presentation of risk factors in the report is not done in a way that definitively identifies factors that currently limit populations on the BTNF, although the text makes a strong case that they likely affect populations to the degree identified in the report.

The 01-09-2013 version of the report discussed risk factors prior to defining suitable conditions and this has been corrected in the revised report.

See also responses to individual comments (e.g., comments 84-90).

C.6. IDENTIFICATION OF CONSERVATION ACTIONS TO CONSIDER

Summary of Comments and/or Explanation

ERG did not comment on the merits of potential conservation actions as conservation *actions* (a word search revealed no references to "conservation actions"). Instead, ERG treated the report as if it was a conservation strategy and the conservation actions as if they were part of such a strategy. All critiques in ERG's Review Document related to conservation actions (in the form of comments on conservation strategy and management recommendations) either involved ERG's assessment that they are questionable due to a lack of local data or use of scientific studies that are not pertinent to the BTNF.

Specific Comments

- 19 references in ERG's Review Document to "conservation strategy."
- 4 references in ERG's Review Document to "management recommendations" and "recommendations" (it is assumed that "management recommendations" refers to conservation actions listed in the report):

> "That lack of local data makes the justification for the management recommendations in the Paper highly questionable" (pg. 3, comment 15).
>
> "In July of 2014, Sublette County Commissioners, with the support of the Sublette County Conservation District ("Cooperators") and the Wyoming Game & Fish Department, asked Ecosystem Research Group ("ERG") to critically review and prepare appropriate responses to the recommendations within the DeLong Paper" (pg. 7, comment 36).
>
> "While all-purpose management recommendations such as are currently recommended in the DeLong Paper may be easier to administer for the BTNF, they are neither biologically defensible nor consistent with meeting other multiple economic and resource objectives" (pg. 30, comment 129).
>
> "When, however, conservation strategies are used for National Environmental Policy Act (NEPA) decisions, for example, the Hams Fork Vegetation Project EA and the upcoming Green River AMP, any conclusion based on recommendations made in a conservation strategy must meet the same rigor for using the best science and analyzing the biological variables as is mandated by NEPA" (pg. 33, comment 140).

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[1] While the study planned for the Upper Green project area will improve our understanding of existing conditions, it will only address a small number of variables for a short period and in a small geographic area.

[2] Monitoring data from the BTNF amphibian monitoring protocol now in place will not be able to be used for assessing population status or for ascertaining trends in population numbers.

- One reference each to “conservation action” and “management action”:

  > “Approximately 50 publications, referenced in over 250 individual citations, have been identified for their questionable relevance to the topic of sensitive species objectives and the bases for recommended conservation actions, as the draft DeLong Paper purports to address” (pg. 10, comment 52).
  >
  > “The need to preface management actions with a strong, biologically-based understanding of limiting factors has long been the basis of sound wildlife management (Leopold 1933)” (pg. 5, comment 32).

Response

ERG only commented on the report as if it were a conservation strategy (see response to Overview Comment C.1) and assumed that conservation actions listed in the report were part of such a conservation strategy. As pointed out in response to Overview Comment C.1, the report is not a conservation strategy. Therefore, their misinterpretation makes many of their comments on this subject irrelevant. Conservation actions were listed in the report to make them readily available when site-specific projects are being designed. Hams Fork Vegetation Treatment Project (brought up in the Review Document) and LaBarge Vegetation Treatment projects provide two recent examples of assessing risks at the project level using information contained in the report and site-specific information, and then considering the report’s conservation actions based on examinations of existing habitat conditions related to the risk factors.

The original (01-09-2013) version of the report should have been more clear on whether conservation actions are required or if they are listed as considerations. The title of the report characterized them as “…Recommended Conservation Actions…,” and the body of the report characterized the list of conservation actions as “…potential conservation actions to implement” (DeLong 2013a:2), but the latter was not in a prominent place in the report. Potential conservation actions were listed under subheadings titled “Conservation Actions.” This was clarified in the 09-26-2014 version of the report by using the heading “Conservation Actions to Consider” rather than “Conservation Actions.”

While identification of limiting factors on the BTNF using local data would be helpful in identifying conservation actions to consider, it is not necessary, particularly a general understanding of activities and developments that occur on the BTNF, a large volume of scientific information on the effects of these activities and developments on frogs and toads, and an understanding of management controls currently in place. Examination of local data occurs on a project-by-project basis, and this is where potential conservation actions listed in the report would be considered. It is recognized that it would be more important — but not absolutely necessary — for a conservation strategy to be developed in part with locally collected data. The report is not a conservation strategy. See response to Overview Comments C.1 and C.2 for additional discussion.

D. Reviewers Envisioned a Different Application of the Coarse-Filter/Fine-Filter Approach

D.1. MISINTERPRETATION OF THE COARSE-FILTER / FINE-FILTER APPROACH

Summary of Comments and/or Explanation

ERG criticized the way in which the coarse-filter/fine-filter approach was applied in the report, mainly that the report lacked an analysis of broad-scale and fine-scale data.

Specific Comments

The following quotes from the Review Document show that reviewers limited their view of “coarse filter” to assessments of coarse-scale habitat attributes:

- "The DeLong Paper recognizes the need for coarse filter data, but no data is provided that addresses disturbance regimes, current vegetation or comparison to historic conditions" (pg. 8).
- "Despite the discussion on how coarse filter analyses work, the Paper provides no coarse filter analysis [sic] data for the BTNF. The list of mappable data is extensive," and this was followed by a list of six examples (pg. 15).
- "The Cooperators asked ERG to conduct the following GIS analysis to identify broad-scale habitats that may have changed dramatically since historic periods as a means of identifying coarse-filter risks to amphibians. ERG designed the coarse filter analysis to specifically address the risks identified in the DeLong Paper.…" (pg 15).
- "The Cooperators understand that coarse filter data (i.e., distribution of forest cover types at a landscape scale and/or comparison to historic conditions) does not address all the habitat variables that affect toads and frogs that depend on microsites in or near streams. It is therefore understood that there is a need to collect and evaluate data on a finer scale" (pg. 16).
- "The Cooperators understand that coarse filter data (i.e., distribution of forest cover types at a landscape scale and/or comparison to historic conditions)…" (pg. 16).

The following quotes from the Review Document show that reviewers limited their view of "fine filter" to assessments of fine-scale habitat attributes:

- "The Paper also recognizes the need for fine filter data, but that fine filter data is limited to a very extensive review of the literature that addresses factors such as the relationships of grazing utilization levels on ground-level humidity and ground-level wind speeds" (pg. 8).
- "The Cooperators understand that coarse filter data (i.e., distribution of forest cover types at a landscape scale and/or comparison to historic conditions) does not address all the habitat variables that affect toads and frogs that depend on microsites in or near streams. It is therefore understood that there is a need to collect and evaluate data on a finer scale" (pg. 16).

Response

ERG's critique that the report lacked an analysis of broad-scale and fine-scale data is addressed in in part in I.A(4), above. ERG did not recognize in their comments that (1) the report outlined coarse-filter conditions to some degree, including the characterization of a natural extent and distribution of riparian vegetation, natural stream channel integrity, natural mix of succession stages, natural distribution and abundance of beaver pond complexes, and natural herbaceous species composition; and (2) these reported conditions were supported by scientific information that included, in many cases, local data (e.g. Gruell 1980a, Gruell 1980b, Youngblood et al. 1985, O'Brien et al. 2003, Loosen et al. 2009) and analyses that included the BTNF (LANDFIRE 2007). While it is recognized that broad-scale and fine-scale data can be used in the coarse-filter/fine-filter approach to conserving wildlife, discussions of coarse-filter and fine-filter in the report focused on the overall approach to conserving wildlife.

ERG's critique stemmed from having a different perception of the coarse-filter/fine-filter approach than what was used and cited in the report. ERG's use of "coarse-filter" and "fine-filter" is not consistent with the use of these terms in the 2012 Planning Rule (USFS 2012) and in Applet and Keeton (1999), Haufler (1999a), and Haufler (1999b), and ERG did not cite any supportive literature for the way they applied the terms. The coarse-filter/fine-filter approach was specifically applied to the development and definition of suitable conditions for use in objectives, which does not involve analysis of existing conditions (see "C.2. Steps of Wildlife Planning Process Covered in the Report," above).

Analysis of coarse-scale data is different than taking a coarse-filter approach to wildlife conservation (Applet and Keeton 1999, Haufler 1999a, and Haufler 1999b, USFS 2012). Regarding the third quote above, any assessment of "coarse-filter risks" would be done for native wildlife-communities as a whole, based on the concept of the coarse-filter approach. Identification of risks for individual species — assuming a coarse-filter analysis has already been completed — by definition moves into a fine-filter.

Analysis of fine-scale data is different than adjusting the coarse-filter approach in order to take into account the needs of individual wildlife species of conservation concern (same citations as above). The last quote, above, indicates the confusion between fine-filter adjusting to a coarse-filter approach and analysis of fine-scale data.

Additional explanation had been added to the coarse-filter / fine-filter approach in the 09-26-2014 version of the report.

The following provides additional information on the approach, including quoted material in the Review Document. The following quote from ERG explains the coarse-filter / fine-filter approach in simple terms:

> "The Cooperators understand and support the concept of using a coarse-filter approach to both simplify analysis and avoid problems associated with seemingly endless single species analyses. DeLong quotes the 2010 Proposed Planning Rule[10], and states:
>
> > 'The coarse-filter should provide ecological conditions for the long-term persistence of the vast majority of species within the plan area. The fine-filter would identify specific habitat needs of species with known conservation concerns or whose long-term persistence in the plan area is at risk, and for which the coarse-filter protection is insufficient.'" (pg. 15, Review Document)

A fundamental premise of the coarse-filter/fine-filter approach is that the needs of most native species, including sensitive species, would be adequately met where environmental conditions approximate the conditions under which native wildlife-communities formed (i.e., natural conditions), as explained in the *Federal Register* notice of the final 2012 Planning Rule:

> "The 'if then' statement in paragraph (b)(1) [of section 219.9] conveys the Department's expectation that for most native species, including threatened, endangered, proposed, candidate, and species of conservation concern, the ecosystem integrity and ecosystem diversity requirements (coarse-filter) would be expected to provide most or all of the ecological conditions necessary for those species' persistence within the plan area. However, for threatened, endangered, proposed, candidate, and species of conservation concern, the responsible official must review the coarse-filter plan components, and if necessary, include additional, species-specific (fine-filter) plan components to provide the ecological conditions to contribute to recovery of threatened and endangered species, to conserve proposed and candidate species, and to maintain viable populations of species of conservation concern in the plan area…" (USDA 2012:21214)

The central focus of the coarse-filter approach is on restoring and maintaining overall ecosystem integrity and ecosystem diversity, as described in the *Federal Register* notice of the 2012 Planning Rule:

> "Based upon the current science of conservation biology, by working toward the goals of ecosystem integrity and ecosystem diversity with connected habitats that can absorb disturbance, the Department expects that over time, management would maintain and restore ecological conditions which provide for diversity of plant and animal communities and support the abundance, distribution, and long-term persistence of native species. These ecological conditions should be sufficient to sustain viable populations of native plant and animal species considered to be common or secure within the plan area. These coarse-filter requirements are also expected to support the persistence of many species currently considered imperiled or vulnerable across their ranges or within the plan area.
>
> For example, by maintaining or restoring the composition, structure, processes, and ecological connectivity of longleaf pine forests, national forests in the Southeast provide ecological conditions that

> contribute to the recovery of the red-cockaded woodpecker (an endangered species) and conservation of the gopher tortoise (a threatened species), in addition to supporting common species that depend on the longleaf pine ecosystem." (USDA 2012:21212)

Specific to spotted frogs and boreal toads, restoring and maintaining ecosystem integrity, ecosystem diversity, and habitat connectivity (coarse-filter conditions) in wetland systems, riparian areas, rangelands, and forestlands would (1) provide the foundation upon which specific habitat elements are produced and maintained; (2) allow the effects of major disturbances to be absorbed, with impacts to spotted frogs and boreal toads being mitigated to some degree; and (3) otherwise provide ecological conditions that would prevent further declines in spotted frog and boreal toad populations on the BTNF, facilitate improved status, and prevent federal listing. Providing first for ecosystem functioning and ecological integrity is a fundamental principle of wildlife conservation (Dasmann 1981, Robinson and Bolen 1989, Noss and Cooperrider 1994, Hunter 1996, Everett and Lehmkuhl 1999).

Estimations of relatively natural conditions at a broad scale, especially at landscape scales and other broad scales, provided a set of coarse-filter conditions that were used as a starting point for defining suitable conditions, and these conditions were subsequently adjusted (1) as needed to meet the needs of spotted frogs and boreal toads where coarse-filter conditions would not adequately meet their needs or where a narrower set of conditions within coarse-filter conditions would be needed to meet their needs (fine-filter adjustments) and (2) where the restoration or provision of coarse-filter conditions would substantially hinder the provision of opportunities for recreational or commercial activities, so long as the lower threshold of conditions in these cases would still provide suitable conditions for spotted frogs and boreal toads (i.e., so long as the specified lower-than-natural conditions would still meet the needs of these species). Regarding the first item, few adjustments needed to be made to estimated natural conditions to better meet the needs of these species.

D.2. PRE-ACTIVITY CONDITIONS AS STARTING POINT FOR ANALYSIS

Summary of Comments and/or Explanation

ERG treated historic conditions and historic range of variability as suitable or desired conditions. This observation is based on ERG comparing historic conditions against existing conditions to determine limiting factors and by ERG using limiting actors to drive the development of conservation strategies. Since conservation strategies are designed to resolve limiting factors in order to achieve desired or suitable conditions, this means historic conditions are desired or suitable conditions. ERG referred to "historic" and "historic range of variability" (HRV) a total of 18 times in their comments.

Specific Comments

This assessment is based on the following quotes from the Review Document:

- "…no data is provided that addresses… comparison to **historic** conditions…" (pg. 8, comment 42).
- "Conifer size class data strongly suggests that presumably due to long-term fire suppression, coarse, woody debris occurs at substantially higher than **historic** levels" (pg. 8, comment 45).
- "The list of mappable data is extensive: …Information on **Historic** Range of Variability (HRV)… Discussion of departure from HRV…" (pg. 15, comment 69).
- "The Cooperators asked ERG to conduct the following GIS analysis to identify broad-scale habitats that may have changed dramatically since **historic** periods as a means of identifying coarse-filter risks to amphibians" (pg. 15, comment 70).
- "5.1 Comparison of **Historic** to Current Vegetation Data" (pg. 18).

- “The Methods section (4.1) within this review describes the importance of comparing current to **historic** conditions and describes data typically used to make those comparisons” (pg. 18, comment 84).
- “The Cooperators asked ERG to conduct the following GIS analysis to identify broad-scale habitats that may have changed dramatically since **historic** periods as a means of identifying coarse filter risks to amphibian” (pg. 19, comment 92).
- “Conifer coverage and size class distribution also allows us to assess the relative abundance of coarse, woody debris (likely at higher than **historic** levels),…” (pg. 21, comment 102).
- “No discussion of **HRV** is provided in the DeLong Paper. Other published findings for interior lodgepole pine-dominated forests suggest that nearly half of lodgepole pine forests would have been in un-stocked or seedling-sapling size classes during **historic** periods (Losensky 1995)” (pg. 21, comment 105).
- “5.3.6 Identification of Habitats with Substantial Departure from **Historic** Conditions” (pg. 28, comment 116).
- “…suggests that coarse, woody debris likely occurs at higher than **historic** levels (see Table 2)” (pg. 28, comment 118).
- “The higher-than **historically** normal conifer size class suggests that surface water availability is becoming increasingly compromised from transpiration by excessive large conifers” (pg. 29, comment 125).
- “The DeLong Paper largely ignores the potential effect of higher-than-**historically** normal elk populations” (due to artificial winter feeding programs)” (pg. 30, comment 130).

Response

Use of historic conditions as desired or suitable conditions **—** as was done in ERG’s Review Document **—** is consistent with the report because historic conditions generally equate to natural or pre-Euro-American conditions, and the historic range of variability equates to natural range of variability (Aplet and Keeton 1999). According to Aplet and Keeton (1999:73), “‘Historic range of variability’ (HRV) describes the bounded behavior of ecosystems prior to the dramatic changes in state factors that accompanied the settlement of North America…” They continued by stating that “Though we prefer the use of ‘historical,’ we intend that HRV be interpreted as a description of ‘natural conditions’” (Aplet and Keeton 1999:74-75).

ERG’s use of historical (natural) conditions as desired or suitable conditions is noteworthy because natural conditions are the foundation upon which desired or suitable conditions are developed under the coarse-filter / fine-filter approach (USFS 2012), and the Review Document does not provide any critique of this nor are there any comments that are inconsistent with this aspect of the coarse-filter / fine-filter approach.

D.3. FROG AND TOAD CONSERVATION IN THE CONTEXT OF WILDLIFE COMMUNITIES & ECOSYSTEMS

Summary of Comments and/or Explanation

ERG indicated disapproval of single-species management and appeared to express support for taking a coarse-filter approach to management, including use of historic conditions as desired ore suitable conditions. ERG inferred that the objective of retaining 70-100% of herbaceous vegetation is part of a single-species approach for conserving spotted frogs and boreal toads.

Specific Comments

Comments Showing Disapproval of Single-Species Management

- "Protecting wetland frog habitat and toad nursery habitat… dovetails with other conservation strategies, including the protection of native fish habitat, neotropical migrants, aspen, moose, and downstream water uses…." (pg. 7, comment 34).
- "Sensitive species conservation strategies designed to protect a single species should consider other conservation strategies and Forest plan objectives where habitats overlap. For instance, a conservation strategy that precludes natural disturbance to protect one species might make restoring disturbance dependent species like aspen or whitebark pine impossible. For non-listed species, restoring or mimicking natural disturbances, patterns, and vegetation composition should generally trump a single species' needs to avoid such traps" (pg. 7).
- "The Cooperators understand and support the concept of using a coarse-filter approach to both simplify analysis and avoid problems associated with seemingly endless single species analyses" (pg. 15).

Comments that Point in Direction of Single-Species Management

- "Lack of sufficient shade for amphibians is repeatedly addressed as a problem needing resolution by restrictions on grazing, yet no data is provided at any scale to disclose the ratio or distribution of shade to basking (open) areas" (pg. 3, comment 13).

Treatment of Historic Conditions as Desired Conditions

- See the 18 references to "historic conditions" and "historic range of variability" in the response to Overview Comment C.3.

Response

ERG's comments that ""Protecting wetland frog habitat and toad nursery habitat… dovetails with other conservation strategies, including the protection of native fish habitat, neotropical migrants, aspen, moose, and downstream water uses…." and "…For non-listed species, restoring or mimicking natural disturbances, patterns, and vegetation composition should generally trump a single species' needs to avoid [traps caused by single-species management]" are not only in line with the approach taken in the report, concerted effort was made to have this type of approach form the foundation of spotted frog and boreal toad conservation on the BTNF. A new section was added to Appendix A of the 09-26-2014 version of the report to address this issue; it is titled "Managing Sensitive Amphibian Species as Part of the Native Wildlife-Community."

In only a few cases do the suitable condition statements for spotted frogs and boreal toads veer outside estimated natural conditions, and in virtually all cases this was done to accommodate commercial and recreational activities (e.g., livestock grazing, roads, motorized use) not to ensure that the needs of frogs and toads would be adequately met.

Suitable condition statements and conservation-actions-to-consider were developed in the context of restoring and conserving habitat conditions under which native wildlife-communities formed, and then adjustments were made if any of these conditions were deemed unsatisfactory for spotted frogs or boreal toads; this was explained in the "Approach for Developing Objectives and Suitable Condition Statements" section of the 01-09-2013 version of the report. This is a cornerstone of the approach for conserving wildlife outlined in the 2012 Planning Rule and is supported by a large volume of scientific information (USFS 2012; see also Noss and Cooperider 1994, Hunter 1996, Aplet and Keeton 1999, and Haufler 1999a). Using the coarse-filter approach as the start for formulating suitable and desired conditions looks out for the long-term persistence of the vast majority of wildlife species in the area.

Only a few minor possible fine-filter adjustments were identified for spotted frogs and boreal toads in the report, meaning that estimated natural conditions, including a natural range of variability — for the most part — provides the best target for meeting Forest Plan direction for these species. Therefore, amphibian conservation is in line with, and does not conflict with, conserving all or nearly all other native wildlife species. In particular, the report shows that estimated natural conditions of the following elements provide suitable conditions for spotted frogs and boreal toads:

- Stream channel integrity
- Mix of succession stages in forest types
- Occurrence and extent of beaver pond complexes
- Herbaceous species composition
- Canopy cover and health of willow communities
- Habitat connectivity
- Water quality

Natural processes and simulated natural processes (through management actions) are important in maintaining these conditions.

ERG identified the importance of dovetailing the protection of wetland habitat for frogs and toads with other conservation strategies, "including the protection of native fish habitat, neotropical migrants, aspen, moose, and downstream water uses," inferring that the report took too much of a single-species approach. In particular, ERG inferred that the objective of retaining 70-100% of herbaceous vegetation constitutes single-species management for spotted frogs and boreal toads. This is incorrect for two reasons:

a. Expansion of the range of herbaceous retention levels (in objectives and suitable condition statements) downward to include 70% was in no way done to accommodate spotted frogs and boreal toads. Rather, <u>this was done solely to accommodate livestock grazing use</u>. This is discussed in more detail below (after the "Note").

b. Expansion of the range of herbaceous retention levels downward to include 70% — again to accommodate livestock grazing use — was demonstrated to be suitable for native wildlife-communities on the Greys River Ranger District of the BTNF (DeLong 2009b), recognizing that 70% retention was at the absolute low end of suitability. The assessment included "neotropical migrants," "moose," as well as spotted frogs and boreal toads. The 01-09-2013 version of the report (and subsequent versions) merely validated that 70% retention would sufficiently protect spotted frogs and boreal toads and would retain sufficient amounts of herbaceous vegetation, rather than having the low-end retention being cut-off at 90% or 80%. This is discussed in more detail in the paragraphs that follow (after the "Note").

   <u>Note</u>: It is important to understand that identification of a low-end threshold for suitable herbaceous retention — in support of Objectives 2.1(a), 3.3(a), and 4.7(d) and the Forage Utilization Standard — starts with pre-activity conditions (i.e., pre-grazing conditions in a given season) and consideration is given to incrementally-lower retention levels as scientific information demonstrates that the level provides suitable conditions for dependent wildlife, including protection from trampling. At the point where scientific information does not demonstrate that the given retention level provides suitable conditions, the low-end threshold needs to be set at the next highest retention level (for which scientific information demonstrates suitable conditions). This is outlined in more detail in response to Overview Comment E.2, section c, below.

Regarding 'a,' above, there is a moderate level of support for the assessment that the low-end herbaceous retention level in migratory bird habitat can be shifted downward as low as 70% to accommodate livestock grazing use and still provide suitable habitat for many migratory bird species, including savannah sparrows, western meadowlarks, fox sparrows, white-crowned sparrows, MacGillivray's warblers, and Lincoln sparrows (DeLong 2009b). However, little or no scientific information was found to support the assessment that 70% retention of total herbaceous vegetation is sufficient to maintain suitable habitat for species like nesting mallards, green-winged teal, northern harriers, and short-eared owls, nor for species like microtine voles which are the cornerstone of small-mammal prey for a wide range of predatory birds and mammals associated with mountain meadows. Also, DeLong (2009b) did not sufficiently take into account the detrimental effects of trampling of ground nests during the nesting season. Scientific information added to the 009-26-2014 version of the report shows that a low-end threshold of 70% retention is not be high enough to prevent the potential for substantial nest loss during July through mid to late July.

If 70% retention of herbaceous vegetation is not scientifically supportable or biologically defensible as a low-end threshold for native wildlife-communities, this means that all retention levels below 70% are definitely not scientifically supportable. Little scientific information supports a low-end threshold of 60% retention of total herbaceous vegetation for native wildlife-communities in mountain meadows and riparian habitat. This is because few of the meadow-habitat attributes remain when only an estimated 35-50% of the canopy cover of intact and relatively-intact vegetation remains, only an estimated 0-53% of the biomass above 2 inches remains, and only 10-40% of hiding-cover qualities remain (as measured by a Robel pole) (01-09-2013 version of the report). This is compounded by tall, dense herbaceous vegetation being underrepresented on the BTNF and surrounding lands due to a variety of reason identified in the report. The overabundance of short and/or sparse herbaceous vegetation compared to pre-Euro-American conditions likely more than adequately provides for the needs of wildlife species that requires these conditions. Also, no documentation exists to demonstrate that a maximum utilization rate of 50% of key forage species is sufficient to retain suitable conditions for dependent wildlife on the BTNF and the preponderance of scientific information shows that it is not (see DeLong 2009b).

Beyond scientific information, advocating a retention level that maintains no more than a minor proportion pre-activity meadow habitat characteristics goes against common sense. How can one argue, for example, that 60% retention of herbaceous vegetation would maintain suitable habitat conditions when the habitat characteristics that "make" the community are mostly to nearly totally removed by grazing?

It is also noteworthy that ERG does not support actions to support single-species management, except apparently in the case of identifying the ratio of shade to basking (open) areas for frogs and toads, and then presumably determining a suitable ratio and producing this ratio through management, e.g., livestock grazing use (see the bottom of page 1 and top of page 3). Despite their emphasis on assessing local climate and disturbance processes, they infer the Forest Service should veer from this to provide for a higher-than-natural amount of "openings" in herbaceous communities.

Controversy over the report, including concerns over potential implications to livestock grazing management that led to ERG's review of the report, stems in part from wildlife needs not having received more than cursory consideration in the development of forage utilization limits on the BTNF until recently. The report represents one of the first efforts to seriously examine the needs of wildlife prior to or during the development of utilization limits on the BTNF. Relationships between sage grouse and livestock grazing are also being examine, at a larger scale than just the BTNF, and this is being met with opposition as well.

E. Point from which Burden of Proof is Examined

<u>Summary of Comments and/or Explanation</u>

The approach taken by ERG — based on comments throughout the Review Document (see examples quoted below) — is to start with (1) current management where this involves ongoing activities (e.g., livestock grazing) and (2) proposed management for activities not yet occurring on a given site (e.g., future logging), and then requiring the Forest Service to prove with local data that sensitive species' populations have been impacted by current management (e.g., ongoing livestock grazing) or would be impacted by proposed management (e.g., logging) before changes are made to current management or proposed management, respectively, to protect sensitive species.

Specific Comments

Examples of statements in the Review Document include:

- "That lack of local data makes the justification for the management recommendations in the Paper highly questionable" (pg. 3).
- "Given that careful logging could rectify the age class disparity, DeLong's concerns over logging-related effects in his Paper have no basis in the coarse filter findings. DeLong is fixing a problem that has not been demonstrated to exist" (pg. 21).
- "He concludes that habitats may be at risk from wildfires, logging, and offroad vehicles, but again bases his hypotheses on research from other environments" (pg. 28).
- "Prescribed burning, wildland fires for beneficial use, and logging, however, are tools to resolve those problems. Therefore, the long list of prescriptive measures DeLong recommends, which limit timber harvest and fuels management practices, are again fixes to problems that have not been demonstrated to exist. For example, DeLong concludes on page 60 that "[p]ossibly the largest impact to boreal toads and possibly spotted frogs resulting from changed habitat conditions after timber harvest is the reduction in large woody material." This assertion is again based on research recommendations from other locales" (pg. 28).

Response

E.1. TWO APPROACHES

There are two competing views on the starting point from which the burden of proof should be examined:

1. *Starting Point = Current Management; and then Only Make Changes to Current Management where Impacts to Sensitive Species are Demonstrated*

   This is the approach advocated by ERG, as shown by many comments throughout their Review Document. To the extent information is limited or non-existent on spotted frog and boreal toad populations and habitat and information on effects of activities on these species, this approach errs on the side of continuing current management without any changes.

   The Review Document makes clear ERG's view that the only basis for making changes to ongoing activities (e.g., with respect to livestock grazing) is definitive local information demonstrating the activity has impacted spotted frog or boreal toad populations. Similarly, they make it clear that the only basis for making changes to a proposed action (e.g., logging) is definitive local information demonstrating the activity would, without mitigation measures, impact spotted frog or boreal toad populations.

2. *Starting Point = Pre-Altered Conditions; and then Demonstrate that Suitable Conditions would be Maintained before Allowing a Use or Development at Prescribe Levels*

   This approach is routinely taken on national forests, including the BTNF, prior to decisions on proposed timber sales, recreation activities, etc., and this approach is easily applied to ongoing activities like livestock grazing. It is supported by the 2012 Planning Rule (USFS 2012) and a wide range of scientific papers and texts (e.g., Noss and Cooperider 1994, Hunter 1996, Aplet and Keeton 1999, and Haufler 1999a). This is discussed further in Overview Comments C.1 and C.3.

No documentation exists showing that livestock grazing under current management on the BTNF meets Forest Plan and other direction for spotted frogs and boreal toads, but this is currently being addressed through allotment management planning and associated NEPA analysis on an allotment-by-allotment basis. Before current management can be continued without any adjustments — after completion of planning — it must be demonstrated that current livestock grazing management meets requirements for sensitive species with respect to spotted frogs and boreal toads. If this cannot be demonstrated, livestock grazing management needs to be adjusted until this can be demonstrated.

E.2. REASONS THE 2ND APPROACH IS MOST SUPPORTABLE AND THE 1ST APPROACH IS LEAST SUPPORTABLE

The following outlines reasons the second approach is most supportable for sensitive species on the BTNF and first approach is least supportable:

a. Spotted frogs and boreal toads are USFS Region 4 sensitive species, the U.S. Fish and Wildlife Service is assessing whether to list the eastern clade of boreal toads as threatened (or endangered), both species are listed as Species of Greatest Conservation Concern by the State of Wyoming, and WNDD ranked them as vulnerable and critically imperiled, respectively. Even if the U.S. Fish and Wildlife Service does not list the portion of the boreal toad population that exists in the BTNF, the fact they are reviewing the species for listing demonstrates the concern about past and future reductions in distribution and abundance of this species.

   The status of spotted frogs and boreal toads are recognized by the second approach but is immaterial to the first approach.

b. Forest Plan and higher-level direction on sensitive species is not set up for the agency to have to prove there are problems with sensitive species populations before current management is changed or before any action is taken to protect them from activities and development. The Forest Plan provides proactive direction.

   Requirements to provide an adequate amount of suitable habitat for sensitive species and to protect sensitive species, including retention of an adequate amount of suitable forage and cover, are affirmative requirements of Forest Plan Objective 3.3(a) and Objective 4.7(d) (as the latter applies to sensitive species) and the Sensitive Species Management Standard, depending on direction for individual DFC areas. These affirmative requirements must be met regardless of whether local data is available and regardless of results of monitoring. The affirmative nature of the requirement with respect to Forest Plan Objectives stems from the following:

   i. "…the first and most important part of the [Forest] Plan is…. Goals and Objectives" (USFS 1990a:6-7). The Sensitive Species Management Standard is important, but the role of standards is to support Forest Plan goals and objectives (USFS 1990a), and the Sensitive Species Management Standard requires that crucial habitats will be protected and maintained.

   ii. FSM 2670.22.3 (WO Amendment 2600-2005-1) states: "Develop <u>and implement</u> management objectives for populations and/or habitat of sensitive species" (emphasis added).

   iii. Direction on objectives with respect to DFC areas further highlights the affirmative requirement to achieve Forest Plan objectives. The Forest Plan requires that, when there is a conflict between objectives in a particular DFC area on the BTNF, the Forest Service defer to resource objective emphasized in that particular DFC area:

      - "…some objectives will not be met on all areas of the Bridger-Teton National Forest… The conflicts are resolved by application of the different Desired Future Conditions to different areas of the National Forest" (USFS 1990b:93).

- “That the DFCs exist at all is in recognition that not all the Goals and Objectives can be achieved at the same time from the same land areas. Therefore, 17 DFCs… have been developed to accomplish multiple, compatible Goals and Objectives” (USFS 1990b:145).

Before an action is implemented on the BTNF, biologists must be able to demonstrate that suitable conditions (including sufficient protection) for sensitive species will continue to be provided (or restored if currently below suitable conditions) by (1) designing actions specifically to restore and/or maintain these conditions, and (2) modifying the design of projects (e.g., through the use of mitigation) to ensure an adequate amount of suitable conditions will continue to be maintained or will be restored (i.e., so the project does not move conditions further from suitable conditions). Conversely, because the requirement is an affirmative one, the agency is not required to demonstrate (1) that suitable conditions are not being provided before making any adjustments to current management to restore an adequate amount of suitable habitat, or (2) that suitable conditions would not be provided before implementing a project that could potentially hinder the attainment of these conditions.

c. The requirement of Forest Plan Objective 4.7(d) is *to retain* an adequate amount of suitable forage and cover for wildlife, including for frogs and toads, where livestock grazing occurs. Two things are inherently implied in the use of the term “retain” with respect to an activity like livestock grazing: (1) pre-grazed conditions for the season are suitable (otherwise, the activity would not be allowed until conditions return to suitable); and (2) the incremental reduction in the amount of herbaceous vegetation stops before conditions are no longer suitable, thereby retaining or holding on to suitable conditions.

The approach of having to prove current utilization levels are negatively impacting wildlife populations before any changes can be made to utilization levels is not supported by the use of “retain” in Forest Plan Objective 4.7(d).

Achieving Objective 4.7(d) is central to meeting the requirement of the Forest Plan Utilization Standard to prescribe site-specific utilization levels to meet Forest Plan objectives.

d. Because the Forage Utilization Standard of the Forest Plan affirmatively requires site-specific utilization levels to be prescribed during allotment management planning *to meet* Forest Plan objectives, the agency must be able to demonstrate that utilization limits will meet the objectives prior to implementing utilization limits:

i. The Forage Utilization Standard requires site-specific utilization levels to be formulated *to meet Forest Plan objectives* (e.g., Objectives 3.3(a) and 4.7(d)), and it further emphasizes this by requiring site-specific utilization levels to be established on key wildlife ranges; and

ii. Forest Plan Objectives 3.3(a) and 4.7(d) require that activities be managed to protect sensitive species and that an adequate amount of suitable habitat be provided and retained for sensitive species, including spotted frogs and boreal toads; and

iii. The adequate and suitable habitat conditions and protection from activities referenced in Forest Plan Objectives 3.3(a) and 4.7(d) are met, with respect to spotted frogs livestock grazing utilization, by retaining 70-100% of herbaceous vegetation as outlined in suitable condition statements.

iv. Therefore, to meet the Forage Utilization Standard requirement to meet Forest Plan objectives, scientific information cited in the report shows that utilization of total herbaceous vegetation would need to be capped at 30% within 10 feet of breeding sites and at 30% across ≥80% of frog and toad habitat within 1/3 mile of breeding sites, as more specifically outlined in suitable condition statements in the revised report.

This is site-specific and it contributes to meeting the part of the standard requiring the establishment of site-specific utilization levels on key wildlife ranges.

v. Also, because the standard requires site-specific utilization limits to meet Forest Plan objectives to be prescribed "During AMP revision," available information must be used to define utilization limits rather than taking an approach like starting with an existing utilization limit or setting a utilization limit based on criteria other than meeting Forest Plan objectives relative to DFC direction, and then adapting based on planning monitoring.

The Forage Utilization Standard does not require utilization limits to be prescribed in response to declining wildlife populations, low reproduction rates, or other problems. The standard specifically requires utilization limits to be prescribed *to meet* Forest Plan objectives and that utilization limits are to be prescribed *during* allotment management planning.

Note: The report reviewed by ERG demonstrated strong or moderately-strong evidence that ≤10% and ≤20% utilization of total herbaceous vegetation would meet Forest Plan Objectives 3.3(a) and 4.7(d) with respect to spotted frogs and boreal toads, and it demonstrated moderate evidence for ≤30% utilization, and low or no evidence for ≤40% or ≤50% utilization of total herbaceous vegetation. Furthermore, there is considerable information showing that 40% and 50% utilization rates would result in negative impacts to spotted frogs and boreal toads.

Note: There are no requirements for the agency to demonstrate (with or without local data) that wildlife populations are being impacted by livestock grazing prior to establishing utilization limits or changing utilization limits.

e. The proactive nature of Forest Plan direction is also illustrated by wildlife-related standards, prescriptions, and guidelines. The agency is required to meet them regardless of whether local data is collected and regardless of results of monitoring. Examples are listed below. Standards for big game are included to illustrate the point that there is more justification to proactively manage species for which there is conservation concern than to proactively manage species for which there is no conservation concern (e.g., big game) and for which large amounts of local data exists (e.g., big game), yet standards for big game place definitive constraints on activities regardless of the results of monitoring.

   i. Sensitive Species Management Standard — Crucial habitats of sensitive species (and WGFD's priority I, II, and III species) must be protected and maintained, regardless of whether local data is collected on sensitive species and regardless of the results of monitoring.

   ii. Allotment Management Plan Standard — Allotment management plans must address the needs of fisheries; riparian habitats; and threatened, endangered, and sensitive species. Findings from big-game winter range evaluations must be incorporated into allotment management plans as wildlife habitat objectives and management procedures. Plans will identify the amount and kind of streamside vegetation needed to maintain or improve riparian areas. With respect to wildlife, this standard must be met regardless of whether local data is collected on fish and wildlife populations or what this data may show.

   iii. Big Game Winter Range Standard — Human activity must be restricted from November 15 to April 30 on winter range actively used by big game, regardless of what local data shows about population trends. Note that there is an abundance of local data from WGFD.

   iv. Habitat Effectiveness Standard — Vehicle access must be regulated, including with closures, to protect big game primary feeding areas, crucial winter range, calving/fawning/lambing areas, rearing areas, and migration corridors, regardless of what local data shows about population trends. Note that there is an abundance of local data from WGFD.

   v. Elk Calving Area Standard — Human activity must be restricted in elk calving areas from May 15 to June 30, where elk are present, regardless of what local data shows about population trends.

   vi. Peregrine Falcon Disturbance Standard — Land use practices or development that would eliminate peregrine falcon habitat are not allowed within 1.0 miles of occupied or suitable-but-unoccupied cliffs within a recovery area, regardless of whether local data is collected or what this data may show.

   vii. Fish; Wildlife; and Threatened, Endangered, and Sensitive Species Standard (Range) — Range improvements, management activities, and trailing must be coordinated with <u>and designed to</u> help meet fish and wildlife habitat needs, especially on key habitat areas such as crucial winter range, seasonal calving areas, riparian areas, sage grouse leks, and nesting sites (emphasis added), regardless of whether local data is collected on fish and wildlife populations or what this data may show.

   viii. Created Opening Size Standard — The maximum allowed size of an opening created by application of even-aged management will be 40 acres, regardless of whether local data is collected on wildlife populations or what this data may show. This standard was included in the Forest Plan to protect forest wildlife species such as goshawks, great gray owls, and boreal owls.

   ix. Dead and Down Large Woody Material Standard (DFC areas 10 and 12) — Four or more logs (in decomposition class 1 or 2, and measuring ≥12 inches diameter and ≥20 feet in length) must be retained per acre on logged sites, regardless of whether local data is collected on wildlife populations or what this data may show for log-dependent wildlife species.

   x. Streambank Stability Guideline — At least 90% of the natural bank stability should be maintained, regardless of whether local data is collected on fish or wildlife populations or what this data may show.

   <u>Note</u>: Even though suitable conditions statements in the report do not have the stature of Forest Plan objectives or standards, they define the suitable conditions and crucial habitat the Forest Plan requires the agency to provide for sensitive species, in this case, for spotted frogs and boreal toads.

f. Because current management under the first approach is “innocent until proven guilty,” and because there is and will continue to be insufficient monitoring data to prove either direction, this approach errs on the side of continued current management. This conflicts with Forest Plan direction in DFC areas in which wildlife is emphasized (e.g., DFC areas 7A-B, 10 and 12), probably conflicts DFC areas in which wildlife is at least co-equal with activities like livestock grazing (e.g., DFC 2A, 3, 4, 6A-D), and may even conflict in DFC areas in which commercial activities like livestock grazing and timber harvest are emphasized (DFC 1B).

g. There does not appear to be any population information showing that the status of spotted frogs and boreal toads is different on the BTNF than that outlined above or that these species are not at risk. In particular, available population data has not demonstrated that populations:

   i. have not declined since pre-Euro-American settlement times,

   ii. are at robust, sustainable levels well-distributed across the BTNF,

   iii. are currently occupying all or most available capable habitat, or

   iv. are not currently being negatively affected by existing conditions and current management.

h. A large volume of scientific information demonstrates that a wide range of human activities and developments — including motorized routes and motorized use, livestock grazing use, fish stocking, large reservoirs, spring developments, land conversion — have and continue to negatively impact spotted frogs and boreal toads (see report for citations). Where local data is lacking, this scientific information shows there to be a major risk in assuming ‘no impacts unless local data shows otherwise.’

i. Motorized routes and motorized use, livestock grazing use, fish stocking, large reservoirs, spring developments, land conversion, and other activities and developments occur within the existing distribution and in other capable habitat of spotted frogs and boreal toads on the BTNF; and (a) there currently are no management controls specifically aimed at reducing or mitigating potential impacts of these activities and developments on spotted frogs and boreal toads, and (b) there are relatively few general standards and prescriptions that provide sufficient management controls to protect these species. This contributes further to a major risk in assuming ‘no impacts unless local data shows otherwise.’

j. There are gaps in the known, existing distribution of spotted frogs and boreal toads, some of them quite large (e.g., both species are nearly absent in the Wind River Range and west side of the Salt River Range, boreal toads are absent from the Greys River watershed and much of the Gros Ventre and Teton Wilderness Areas, spotted frogs are nearly absent from the southwestern portion of the BTNF and few have recently been found on the east side of the Wyoming Range). There is a reasonable chance that activities and developments contributed to absences and low densities in some watersheds. To the extent this is true, the first option could very well contribute to further declines.

k. There is no available information demonstrating that activities and developments on the BTNF are currently being management carefully enough (e.g., through implementation of management controls like standards, prescriptions, mitigation measures) to avoid negative impacts of these activities and developments, the impacts of which are extensively documented in the scientific literature.

l. The newly established monitoring program for amphibians on the BNTF is not designed to be able to ascertain changes in population levels, reproductive success, survival rates, or movement patterns (see the “B. Population-level Monitoring” section of “Part III — Monitoring” of the report). This, under the first approach, builds in the potential for the distribution and abundance of sensitive species to decline without these declines being “known.” Being able to fix this short-coming by greatly increasing the number of monitoring sites and intensity of data collection is limited by a total of 26 sensitive wildlife species and MIS that need to be monitored on the BTNF, combined with funding levels and other priorities on the BTNF.

m. If the detection of amphibian population changes and habitat changes is subjected to the rigors of statistical analyses, this further reduces the chances of making changes to management under the first approach. This is because statistical analyses, as traditionally performed in wildlife and natural resources research, err on the side of failing to detect treatment effects. Under the traditional approach of statistically analyzing wildlife data, analyses are specifically designed to minimize type I errors, which means that great efforts are made to only conclude there is a treatment effect if there is very high certainty and a very low chance of erroneously making this conclusion. Where this is applied to monitoring programs, negative impacts could very well occur without being “detected” at a given alpha threshold. This is discussed more fully in the report.

Therefore, by only being able to make changes to current management and proposed actions where local data demonstrates that sensitive species’ populations have been impacted by current management or would be impacted by proposed management (first approach), and recognizing the low level or lack of local data (e.g., on population levels/trends, reproductive success rates, survival rates, movement patterns, and on effects of various factors on these parameters on the BTNF), it is very possible that spotted frogs and/or boreal toads would be negatively impacted without these impacts being known or documented.

Reviewers stated that a conservation strategy, in part, must include “…monitoring of habitat and populations [that] is sufficient to demonstrate habitat recovery, or if not, adaptive measures are in place to correct any deficiencies in the overall conservation strategy” (Review Document, pg. 5). This spot on!

F. ERG Claimed that Many Studies Cited in Report are not Pertinent to the BTNF

Summary of Comments and/or Explanation

“Approximately 50 publications, referenced in over 250 individual citations in the report, have been identified for their questionable relevance to the topic of sensitive species objectives and the bases for recommended conservation actions, as the draft DeLong Paper purports to address" (pg. 10, comment 52). ERG expressed, throughout the Review Document, that climate and disturbance regimes in the BTNF area were not addressed sufficiently in the report to be able to apply research results from other areas to the development of objectives and identification of limiting factors on the BTNF.

Their comments on this topic are addressed from two angles (C.1 and C.2, below).

Specific Comments

The following quotes from the Review Document show a range of the comments pertaining to this topic:

- "…For example, where a study conducted by Schmutzer, et al. found logging in Tennessee to be detrimental to amphibians, a study conducted by Wind and Dupuis found logging to be beneficial in western Canada (Schmutzer et al. 2008; Wind and Dupuis 2002). Much of the pertinent, published research that identifies factors that may be detrimental to toads and frogs depends upon local conditions" (pgs. 1-2).
- "Obviously, whether or not grazing is a limiting factor to toads and frogs depends entirely upon local conditions" (pgs. 1-2).
- "While habitat objectives were seemingly conceptualized based on recommendations within documents cited in the DeLong Paper, without any discussion as to whether or not those documents are pertinent to the BTNF based on local climate and disturbance regimes, there is no basis that shows how current conditions compare to those objectives" (pg. 3).
- "DeLong also states: 'Dumas (1964) reported that relative humidity of 65% at about 80°F is lethal to adult spotted frogs in approximately two hours. Therefore, for those that migrate from their breeding site when humidity is low and/or temperatures are high, survival may depend on migration habitat that retains higher moisture/ humidity at ground level and protection from the sun and predators (e.g., herbaceous and shrub cover) or that otherwise provides micro-sites with these qualities.' This is possible but cannot be deduced from Dumas (1964). There is no indication whether the temperature/ humidity/time tests in the study were conducted in the wild or a lab. The purpose was to examine differences in how species respond to their environment (Owings 2014). One must also ask how commonly those conditions would occur at over 8,000' elevation" (Pg. 2).
- "If a conservation strategy has any chance of being upheld during legal challenges, it must be based on best available science. This means: 1) research findings cited have been demonstrated to be pertinent based on local climate, vegetation and disturbance regimes…" (pg. 5).
- "The DeLong Paper recognizes the need for coarse filter data, but no data is provided that addresses disturbance regimes, current vegetation or comparison to historic conditions. Inferences are made to changes in vegetation due to fire exclusion (e.g., aspen) but no data is provided to support those conclusions" (pg. 8).
- "The DeLong Paper seems to intentionally handpick some of the research findings. For instance, it focuses on papers (Semlitsch et al. 2009) and (Rittenhouse et al. 2008) that support adverse effects of timber harvest on toads, but ignores a paper (Wind and Dupuis 2002) that concludes timber harvest can be beneficial to toads – within British Columbia, which is arguably more similar to the BTNF in terms of climate and disturbance regimes (pg. 9).
- "Approximately 50 publications, referenced in over 250 individual citations, have been identified for their questionable relevance to the topic of sensitive species objectives and the bases for recommended conservation actions, as the draft DeLong Paper purports to address. Topics are wide-ranging…" This was followed by a listing of 38 topics and locations (pg. 10, comment 52).

- "Since toads and frogs lack waterproof skin and are cold-blooded, factors limiting toad and frog populations can differ drastically by local climate and disturbance regimes. For instance, Maxell (2000) concludes:

  > 'In order to ensure the presence of habitats critical to the survival of amphibians, management plans need to consider the disturbance regimes that create and maintain them. Disturbance regimes that create and drive the succession of breeding, foraging, and overwintering habitats used by amphibian species include glaciation, flooding, fire, and the dam building, wallowing, and foraging activities of beaver and other large mammals'

  Despite Maxell's emphasis on understanding local conditions, DeLong cites the findings of numerous nationwide papers without making any rigorous attempt to evaluate whether the climatic conditions or disturbance regimes in those areas studied are pertinent to the BTNF" (pg. 12).
- "Interestingly, in one of the very few examples where DeLong actually discussed whether or not a paper was relevant to the BTNF, he concludes from another study in Missouri that '(t)heir study area receives an average of about 17 inches of rain from March through May…This means principles found in their study are generally applicable to the BTNF.' (Rittenhouse et al. 2008) Of course, combinations of summer temperature and humidity in Missouri (lethal to sun-exposed toads) are unlike anything the BTNF will ever experience. We suspect that anyone who had spent time in Missouri's summer temperatures and humidity would beg to differ with DeLong's conclusion" (pg. 12, comment 57).
- "DeLong misinterprets his sources in places, rendering them irrelevant as reliable research cited. The following are a few examples:" (pg. 12, comment 58), followed by 7 examples (pgs. 12-14, comments 59-65).
- "Disturbance regimes must also be analyzed and considered when characterizing limiting factors" (pg. 28).
- "Based on aforementioned deficiencies in the DeLong Paper, NEPA decisions based on that report would not meet the basic NEPA requirements for applying the best science or taking a hard look at the climate, vegetation, and disturbance regimes unique to the BTNF" (pg. 33).

Response

F.1. APPLICATION OF RESEARCH RESULTS TO BASIC PRINCIPLES VERSUS SPECIFIC MEASURES IN SUITABLE CONDITION STATEMENTS AND STATEMENTS OF RISK

Results of studies from other areas were not applied directly to the definition of suitable conditions. For example, water chemistry, water depth patterns, emergent plant species composition, composition of tree size-classes, and density and sizes of large woody material from the Sierra Nevada Range of California, Oregon, Missouri, Tennessee, British Columbia, and Australia were not directly applied to definitions of suitable conditions for these parameters on the BTNF. It is possible that ERG misinterpreted the report and thought that this was done. Obviously, specific measures of natural, pre-activity water chemistry, water depths, emergent plant species composition, tree-size composition, and density of large woody material from other parts of the world cannot be applied directly to definitions of suitable conditions on the BTNF. One exception to this is that maximum concentrations of nitrogen (in various forms) were directly applied to suitable condition statements, recognizing that differences in water temperature, pH, and other variables can affect the degree of negative impacts on tadpoles. Another partial exception is the application of percent utilization and percent-reduction in Robel pole readings. This is treated as a "partial" example because figures used in the report are percentages and percentages from one locale can more readily be applied to another locale than absolute measures (e.g., plant height).

A specific example of ERG misinterpreting the application of research findings in the report (e.g., directly applying research results from other locations to defining existing conditions or effects on the BTNF) is as follows: "…the fine filter analysis provided seems to be based on a perception that if grazing related effects on toads have been documented and published from other locales (Missouri, for example) they must exist at comparable levels on the BTNF" (pg. 17, comment 83). The report did not in any way directly apply research results to characterizing levels of effects on the BTNF or to otherwise define or characterize existing conditions on the BTNF. [None of the livestock-related studies in the report were conducted in Missouri, and ERG's misinterpretation of the fine-filter approach is discussed in the response to Overview Comment D.1.]

Instead, for the vast majority of studies cited in the report, individual aspects of research results were indirectly applied to the definition of suitable conditions and identification of risk factors, primarily in the form of basic ecological principles. Examples include research showing the importance of moist microsites where ambient humidity is too low and daytime air temperatures are too high, in combination, for amphibians to not need these sites (note: ambient humidity is too low everywhere outside of tropical rainforests); research showing that near-ground humidity is higher where herbaceous canopy cover is high versus where herbaceous canopy cover is low, regardless of whether this occur in a soybean field in the mid-west or a tufted hairgrass meadow on the BTNF; research demonstrating mortality caused by motor vehicles or trampling by cattle has applications regardless of where the research was conducted, so long as basic similarities exist (e.g., roads near breeding wetlands and/or bisecting movement corridors, cattle in habitat used by amphibians especially where high densities of amphibians exist); and research on the effects of multiple stressors versus the effect of one stressor.

Another important consideration in applying research from other areas is, the more that similar results are found in different environmental conditions (e.g., different states, countries) and from a range of approaches and by different disciplines (e.g., wildlife, range management, environmental protection, crop sciences, hydrology), the greater the confidence in those results.

While ERG made a big issue of studies from other areas being applied to the BTNF, they only provided two examples: two concurrent studies conducted in Missouri and a study by Dumas (1964). These are addressed below:

a. The report specifically stated that "principles found in [Rittenhouse et al. (2008)] are generally applicable to the BTNF" (pg. 60 of 01-09-2013 version of the report), and there was no application of specific densities of large woody material, size classes of logs, sizes of clearcuts, etc. to defining suitable conditions for these parameters on the BTNF. (Rittenhouse et al. 2008 was brought up in Comments 47a and 57.)

   The basic principle that Rittenhouse et al. (2008) supports, as outlined on page 60 of the 01-09-2013 version, is that "…desiccation risks [were] greatest in areas with low soil moisture conditions, which in their study included clearcuts without large woody material." Not only is this intuitive given the need for moist microsites in otherwise dry environments (clearcuts without large woody material), it is supported by other studies cited in the report, including one conducted adjacent to the BTNF on the Caribou-Targhee National Forest (Bartelt et al. 2004). While temperatures are higher in the Missouri study site, humidity is higher. Regardless of specific differences between the study site and the BTNF, the study contributes to our understanding of the need for moist microsites in clearcuts in areas where ambient humidity is too low and temperatures can be too high for spotted frogs and boreal toads.

b. The discussion of applying results from Missouri studies to the BTNF, as basic principles of amphibian ecology in clearcuts, was continued with discussions of studies by Semlitsch et al. on the bottom of page 60 and top of page 61 of the report. Two example statements are as follows: "They attributed the strong results for clearcut units to alteration of '…the fundamental structure of forests by removing the canopy and exposing the forest floor to more sunlight and wind, leading to warmer, drier surface microclimate…' (Semlitsch et al. 2009:857); and "While there clearly are differences between the ecology of amphibians using forests in Missouri and amphibians using forests in western Wyoming, mechanisms of effects appear to be similar. As pointed out by Semlitsch et al. (2009),

'…because all the basic needs of amphibians (e.g., food, shelter) usually require movement overland, every aspect of their lives in the terrestrial environment is affected by water loss.' This applies in Wyoming just as it does in Missouri."

Again, similar conclusions were reached by Bartelt et al. (2004), which was conducted immediately to the west of the BTNF.

c. Results of Dumas (1964) depict what would appear to be a rather extreme situation: death in 2 hours under a given set of environmental conditions. However, the environmental conditions are by no means extreme: 80°F and relative humidity of 65%. The question of "how commonly those conditions would occur at over 8,000' elevation" is only partially relevant because about 2/3 of spotted frog breeding sites on the BTNF occur at or below about 8,000 feet, with about 10% of breeding sites occurring between 6,000 and 6,900 feet in elevation, and nearly all are below 9,000 feet.

   Maximum daytime late-June through early September temperatures at NRCS weather stations on the BTNF between about 7,000 and 8,500 feet typically range from the low 70s to the mid 80s (NRCS temperature data for Hams Fork, Snider Basin, Base Camp, and Loomis Park SNOTEL sites; expressed in ºF). About 72% of spotted frog breeding sites occur between 7,000 and 8,500 feet in elevation or lower, recognizing that maximum daytime temperatures at sites below 7,000 feet are somewhat higher than those shown. Daytime humidity during late June through early September in open country can range widely, depending on weather conditions, but is substantially less than 50% on most days (humidity as low 20% or lower are not uncommon). Although humidity levels are higher in some forest types when treed canopy cover is high, this is immaterial for the subject at hand because at issue are herbaceous communities and conditions in recently-burned forests and clearcuts.

   An important point is that 80°F and relative humidity of 65% resulted in *death* within 2 hours. Somewhat lower temperatures (e.g., 75°F, 70°F) and/or somewhat higher relative humidity (e.g., 70%, 75%) would appear to have substantive negative impacts, but presumably short of actual mortality within 2 hours. In other words, humidity somewhat above 65% with temperatures somewhat below 80°F still have the potential to adversely affect spotted frogs in 2 hours. Because humidity in lower elevations of the BTNF are commonly well below 65% (e.g., 20% and 30% humidity is common), adverse impacts to spotted frogs could likely occur at temperatures in the low 70s in relatively short periods of time where an inadequate amount of suitable microsites are available.

   Another important consideration is that, while temperatures in the vicinity of 80 ºF at moderately-high humidity levels are detrimental to spotted frogs crossing terrestrial habitats without sufficient humid/moist microsites, these higher temperatures are beneficial (and may be needed) for spotted frog and boreal toad egg and tadpole development and for maintaining sufficiently high body temperatures in metamorph, juvenile, and adult spotted frogs and boreal toads. For example, Carey et al. (2005) argued that upper-elevation limits of boreal toad distributions are probably driven by the period of time during which daytime water temperatures are well above 55 ºF (probably above 70 ºF), which requires daytime high air temperatures to be well above 55 ºF (i.e., approaching 80 ºF or higher is beneficial). This may explain in part why nearly all boreal toad breeding sites are below about 8,500 feet. The higher daytime temperatures that commonly occur at lower elevations of the BTNF where boreal toads occur are, therefore, both detrimental and beneficial, but they are only detrimental where an adequate amount of moist/humid habitat and/or microsites do not exist (but outside of forests and willow stands that are *too* shaded).

   ERG did not provide any scientific information showing that survival would not at least be partially affected by migration habitat that does not retain sufficiently high moisture/humidity at ground level and sufficiently high protection from the sun or that otherwise provides micro-sites with these qualities. Also, the quoted statement from the report qualified with "may."

ERG did not identify any specific instances in which the application of research results from elsewhere erroneously affected the definition of suitable conditions or identification of risk factors or potential conservation actions.

The author of the report (DeLong 2013a) limited the scope of references to amphibian-related documents when directly identifying known aspects of suitable conditions, risk factors, and conservation actions. However, where documents on amphibian literature did not identify specific aspects of amphibian habitat, risk factor, or conservation action that needed to be addressed in the report, the author searched other sources for the information. The following examples should help clarify the use of scientific information from other disciplines and from other locations:

- Spotted frogs and boreal toads require moist or humid conditions (supported by amphibian-related literature cited in the report), but amphibian-related literature does not define the amount of herbaceous canopy cover needed to maintain suitable near-ground humidity under environmental conditions occurring on the BTNF, nor does it address the mechanics of how herbaceous vegetation traps humidity below their canopies and how changes in canopy cover affect humidity retention at ground level. Crop science was the only source of information that was located in searches for information. While specific measures of near-ground humidity and temperatures in soybean and cereal crops would differ from that of meadows in western Wyoming, the principles summarized in the report apply regardless of the type of habitat and regardless of location (e.g., wind speed in herbaceous vegetation is lowest at ground level, humidity at ground is highest where percent canopy cover of herbaceous vegetation is highest and humidity levels decline as percent canopy cover of herbaceous vegetation declines). No attempts were made to define suitable ground-level humidity levels or mid-day temperatures for spotted frogs or boreal toads in meadows based on scientific information obtained in soybean and cereal crops in other states. In fact, no attempt was made to quantify suitable ground-level humidity levels or mid-day temperatures for meadows.
- Studies by Schmutzer et al. (2008) and Burton et al. (2009) were conducted at the Plateau Research and Education Center in Tennessee, and ERG implied that results from these studies are not applicable to the BTNF because they were conducted in Tennessee (comments 4 and 52; and see comments 278 and 283 by Sublette County Conservation District). This comment would be valid if attempts were made in the report to directly apply measures of water quality, egg-mass densities, tadpole abundance, or abundance of adult frogs and toads to suitable condition statements or objectives for the BTNF.

  However, although the studies were conducted in an ecosystem that is different than wetland systems in the intermountain West, many mechanisms by which livestock grazing affects frogs and toads are similar, for example: effects of changes in water quality (e.g., increases in nitrate, ammonium) on tadpoles, effects of reductions in hiding cover, and effects of trampling on the survival of tadpoles, metamorphs, and adults. Given the small number of studies that have examined the effects of livestock grazing on frogs and toads, Schmutzer et al. (2008) and Burton et al. (2009) add substantively to the information available to assessing cause-and-effects relationships between livestock grazing and frog/toad breeding and survival. Additional information was added to the 09-26-2014 version of the report to discuss the application of these studies.

  It is noteworthy that results of Schmutzer et al. (2008) and Burton et al. (2009) for frogs appear to be consistent with findings of Munger et al. (1994), Munger et al. (1996), and possibly Bull and Hayes (2001) which were conducted on spotted frogs in southeastern Idaho and Oregon.

F.2. DISTURBANCE REGIMES PERTINENT TO DEVELOPMENT OF OBJECTIVES AND IDENTIFICATION OF RISK FACTORS

ERG's comments on this topic are primarily addressed above, under F.1, but the following discussion provides additional response to their comments.

A more in-depth discussion on the applicability of cited studies to the BTNF had been added to the 09-26-2014 version of the report and discussions of individual studies and discussions of the application of scientific information were expanded further in the revised version based on comments by ERG.

Reviewers did not appear to see the parts of the 01-09-2014 report that described estimated natural disturbance regimes and associated estimated natural vegetation conditions. Discussions were provided for each of the key habitat elements as pertinent (e.g., for the riparian sections, mix of succession stages, beaver pond complexes, herbaceous species composition, herbaceous retention). Some of these discussions were further expanded in the 09-26-2014 version of the report, and headings were changed to clarify discussions; this included the addition of a heading entitled “Estimated Natural Conditions.” Expansion of discussions included a somewhat more in-depth discussion of herbivory and associated herbaceous vegetation conditions in riparian zones and in and around wetlands prior to the onset of livestock grazing; this is important to the definition of suitable conditions. (See response to Overview Comments C.3, C.4, and C.5.)

Regarding ERG’s contention that an understanding of climate and disturbance regimes, both where studies took place and on the BTNF, is needed to apply results of research is correct to the extent that research results are directly applied to the definition of suitable conditions and/or to the identification of risk factors and possible conservation actions. As already explained, nearly all results of research were not applied in this way. They are less important when applying specific, detailed findings of research to basic principles as discussed in C.1, above.

ERG stated that the report “…ignores a paper (Wind and Dupuis 2002) that concludes timber harvest can be beneficial to toads – within British Columbia, which is arguably more similar to the BTNF in terms of climate and disturbance regimes,” emphasis added, and a similar theme was reiterated several times in their Review Document. They apparently felt that climate and disturbance regimes of interior western Canada are similar enough to the BTNF to use information contained in Wind and Dupuis (2002). However, of the studies cited by Wind and Dupuis (2002) showing benefits of clearcuts to western toads, 4 were conducted in coastal forestlands (e.g., Vancouver, California) and 2 were conducted in interior Canada, and several of these identified negative impacts of logging as well as documenting benefits. ERG was operating on a false assumption that Wind and Dupuis (2002) *was a study* (as characterized in comments 4 and 56) conducted in interior western Canada. One of the studies cited in Wind and Dupuis (2002) was one that ERG criticized for being cited in the 01-09-2013 version of the report since it was conducted in “Douglas-fir forests of northwestern California,” and 3 other cited studies were conducted in coastal forests along the coast of Canada.

ERG’s comments on livestock grazing as it pertains to applying results of studies from other areas is encapsulated by the following statement, “Obviously, whether or not grazing is a limiting factor to toads and frogs depends entirely upon local conditions” (pgs. 1-2), emphasis added, recognizing also that ERG focused their livestock grazing comments on effects on shading. Local habitat conditions is one set of factors affecting the extent to which livestock grazing is a limiting factor, but the quoted sentence overstates the importance of local conditions and completely ignores the possibly more important roles of intensity and timing of livestock grazing use in amphibian habitat. Other factors that affect “whether or not grazing is a limiting factor to toads and frogs” include the differential role that a large number of habitat and survival elements play in population dynamics; effects of livestock trampling on mortality rates, which may be no more than minimally influenced by local climate conditions and disturbance regimes; and synergistic and cumulative effects relative to climate change, UV radiation, diseases like chytrid fungus, and others.

ERG was inconsistent with their comments in some of their citations. Two citations to Maxell (2000) provide an example:

> “Maxell also suggests that grazing could be beneficial by creating basking areas where openings are limited, or by adding nutrients where streams are nutrient-poor (Maxell 2000)” (pg. 2, comment 4).

> "Since toads occur globally from sea level to 12,000 feet, toads on the BTNF occur at the extreme upper edge of occupied habitat (Maxell 2000)" (pg. 3, comment 13).

In neither case did ERG assess whether climate or disturbance patterns were similar enough to apply information from Maxell (2000) to the BTNF. More so, Maxell (2000) did not make any assessments that boreal toads on the BTNF occur at the upper edge of occupied habitat, nor was any information provided to show that conditions outlined by Maxell (2000) are similar to conditions on the BTNF. With only two exceptions, boreal toad breeding sites occur below 9,600 feet in elevation.

F.3. Reviewers Generally Questioned the Relevance of a Large Number of Cited References

In response to ERG's comment about 50 publications having "…questionable relevance to the topic of sensitive species objectives and the bases for recommended conservation actions…," they did not identify any of these publications, except possibly some of the references they cited in other parts of the Review Document (but the connection is not clear).

ERG also provided no explanation as to why they felt the publications were inappropriately used. In other parts of the Review Document where specifics are provided, explanations are given and these are addressed comment by comment in "III. Responses to Individual Comments in the Review Document," below.

The list of "types of information" and "topics" compiled by ERG (comments 48 and 52, respectively) helps demonstrate the length to which author of the report (DeLong 2013a) went to track down scientific information from a wide range of disciplines that addressed specific issues involved in determining individual aspects of suitable conditions, risk factors, and conservation actions (especially suitable conditions). Use of scientific information from a wide range of disciplines, as needed, has been identified as central to wildlife management (Bailey 1984:6-8), biodiversity conservation (Hunter 1996:16-17), and range management (Holechek et al. 2011:6). Bailey (1984:7) explained it as follows:

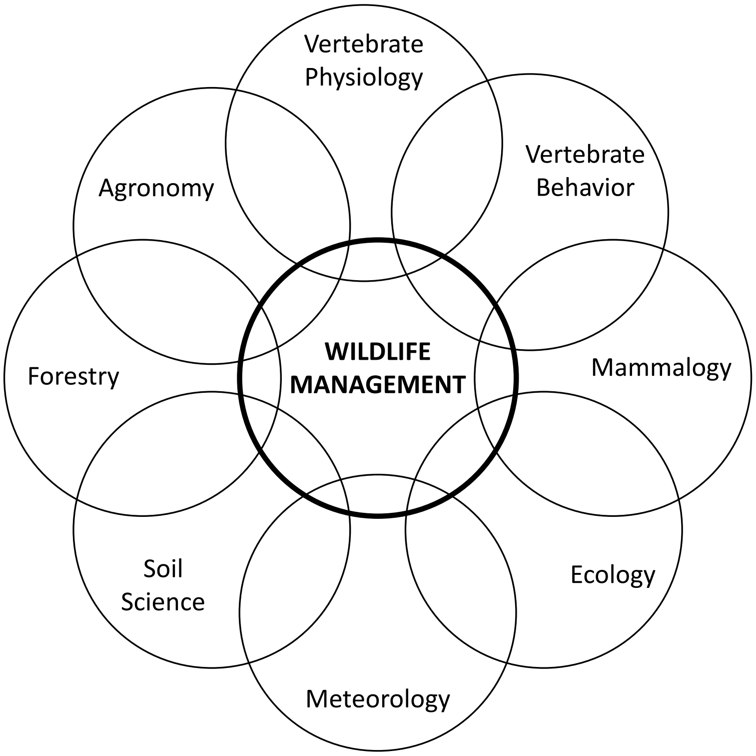

Figure 1.1 (recreated from Figure 1.1 of Bailey 1984:8). "The principles of wildlife management, portrayed by the central circle, include many concepts shared with several sciences and other professions, only a few of which are shown. Wildlife management requires application of an abundance and diversity of information and is one of the most complex occupations" (Bailey 1984:8).

> "Wildlife is a diverse resource. There are many species of vertebrates, even on small areas. Each species population is influenced by its behavior and physiology and by many factors of its environment: foods, weather, soils, predators, and land-use practices, for example. Wildlife management is the application of knowledge about wildlife and about all of these other factors. The principles of wildlife management include some

> that are specific to the profession and many that are shared with other professions and sciences (Fig. 1.1). Therefore, the education of a wildlife manager should include the study not only of wildlife biology and management, but also of basic sciences, such as chemistry and meteorology, and applied sciences related to land use, such as forestry, agriculture, and economics (King 1938a)."

Note the last sentence in Figure 1.1 of Bailey (1984:8): "Wildlife management requires application of an abundance and diversity of information and is one of the most complex occupations."

It is important to note that the author of the report limited the scope of references to amphibian-related documents when directly identifying known aspects of suitable conditions, risk factors, and conservation actions. However, where documents on amphibian literature did not identify specific aspects of amphibian habitat, risk factors, or conservation actions that needed to be addressed in the report, the author searched other sources for the information. In some cases, different aspects of suitable conditions needed to be pulled from different information sources.

An example includes the following. Spotted frogs and boreal toads require moist or humid conditions (supported by amphibian-related literature cited in the report), but amphibian-related literature does not address the mechanics of how herbaceous vegetation traps humidity below their canopies and how changes in canopy cover affect humidity retention at ground level. The only source of information was crop-science (see "Crop density and microclimates of cereal fields" to left). While specific measures in soybean and cereal crops differ from measures in meadows in western Wyoming, the principles summarized in the report apply to both (e.g., wind speed in herbaceous vegetation is lowest at ground level, humidity at ground level declines as herbaceous vegetation is removed).

Regarding the 7 sources that ERG felt were misinterpreted in the report, only 1 was actually misinterpreted, but it was a minor misinterpretation and it was corrected. ERG had commented that "DeLong misinterprets his sources in places, rendering them irrelevant as reliable research cited" (pg. 12, comment 58), which was followed by 7 examples (pgs. 12-14, comments 59-65). Of the 7 examples ERG provided in support of their statement:

- Only 1 was a misinterpretation (Comment 65), but it was only a minor misinterpretation. The report cited Goates et al. (2007) as recommending a greater than 100 ft. buffer zone for boreal toads. While they did not recommend this, they provided substantive information showing that greater than 100-ft. buffer zones are needed. ERG also misinterpreted Goates et al. (2007). See response to 65 for details.
- 1 involved what ERG felt was only part of the information from Keinath and McGee (2005) on egg-laying habitat being included in the report (Comment 62). Additional citations were added that supported the statement, which was also modified somewhat. Furthermore, the entirety of Keinath and McGee's (2005) statement was added to the report. See response to Comment 10 for more explanation.
- 2 did not address research and these sources were not misinterpreted in the report. Comment 59 deals with the Forest Plan, which was not misinterpreted. Comment 63 deals with Forest Service policy and involved a Forest Service objective that was left out of the report for reasons outlined in the response to Comment 63; there was no misinterpretation of the source. See responses to Comments 59 and 63 for more details.
- 3 involved research results (at least indirectly), but did not involve misinterpretations of research results:
  - Comment 60 simply involved the wrong conservation assessment being cited in the report, and this had already been corrected in the 09-26-2014 version of the report.

- ▫ Comment 61 asserted that findings of Dumas (1964) were inappropriately cited in the report because ERG felt temperatures were too cool on the BTNF for his findings to apply, but Dumas (1964) was not inappropriately cited for reasons outlined in the response to Overview Comment F.1.c, above. Additional information was provided in the report in response to ERG's comment .
- ▫ Comment 64 asserted that, because Allen-Diaz et al. (2010) and Roche et al. (2012) did not use the term "retention," none of their results could be used to address herbaceous retention, which is not the case as explained in the response to Comments 11 and 64.

See responses to Comments 59-65 (in "III. Responses to Individual Comments in the Review Document") for responses to the 7 specific examples.

See also the response to Overview Comment F.1 for additional discussion on this subject.

II. Credentials of the Author of the Report

Credentials of ERG were outlined on page 36 of the Review Document. Credentials of Don DeLong are outlined below.

B.S. degree in Wildlife Biology, Colorado State University
M.S. degree in Wildlife Science, Virginia Polytechnic Institute and State University\
Certified Professional Wildlife Biologist, The Wildlife Society

Don DeLong has 23 years of experience in resource management planning, NEPA, field data collection and oversight of data collection, and project management with the U.S. Forest Service and U.S. Fish and Wildlife Service, and another 44 months (3.6 yrs.) of experience collecting field data as a wildlife technician for a range of employers on a wide range of projects. When working for the USFWS, Don led major planning efforts (EISs) on three national wildlife refuges/complexes (250,000, 165,000, and 25,000 acres; plus a 310,000-acre national park), oversaw comprehensive conservation planning (similar to Forest Planning) for refuges in California and Nevada for two years, and has led vegetation treatment planning and allotment management planning (EAs, CEs) on the Greys River Ranger District of the BTNF. In particular, Don has led several efforts to develop resource management goals and objectives (e.g., for wildlife, rangelands, watersheds, wetlands, recreation) for small to large projects on five national wildlife refuges and on the BTNF, he reviewed goals and objectives of more than 20 national wildlife refuges in California and Nevada, and coauthored a guide for developing goals and objectives for the WO of USFWS (Adamcik et al. 2004). A large portion of Don's time during the past 22 years has involved addressing wildlife-livestock issues; he authored and coauthored technical appendices (for EISs) on the effects of livestock grazing use on wildlife; authored/coauthored two peer-reviewed papers on this subject; and he managed the Greys River District's Range Program for 10 years. Don also was the wildlife biologist on three major logging/ vegetation treatment projects on two BTNF districts, and was heavily involved in planning for wetland management on two national wildlife refuges. Don has spent numerous hours in the field on the Greys River and Kemmerer Ranger Districts of the BTNF, including collecting range vegetation data, riparian condition (MIM) data, wildlife-cover data, and assessing habitat conditions for amphibians and other wildlife. Don has also been involved in non-federal organizations, including president of the Star Valley Land Trust / Star Valley Chapter of the Stock Growers Agricultural Land Trust for 6 years, Associate Supervisor of the Star Valley Conservation District for 4 years, and active member of the Nevada Chapter of The Wildlife Society.

III. Responses to Individual Comments in the Review Document

Note that page numbers ("Page No.") refer to ERG's Review Document, not the report.

Cmt. No.	Page No.		Comment (*Headings from the Review Doc. are shown*)	Response
			1. Executive Summary	
1	1		**1.1 Purpose** *Sensitive Species Objectives and Recommended Conservation Actions, and their Basis* (the "DeLong Paper") identifies risks to the sustainability of boreal toads (*Bufo boreas boreas*) ("toads") and Columbia spotted frogs (*Rana luteiventris*) ("frogs") based on numerous documents. The DeLong Paper identifies solutions for avoiding or minimizing those risks, based on the numerous documents, by recommending prescriptive measures that restrict logging, road use and road building, fuels management activities, and livestock grazing.	This is a misinterpretation of the main focus or purpose of the report, which appears to have misdirected a large number of their comments on the report. See response to Overview Comment C.1 for more detail. While the report identifies risks and potential conservation actions, "The main purpose of this report is to outline the basis of the objectives developed for Columbia spotted frogs and boreal toads on the BTNF" (third sentence, page 1 of report). While "prescriptive measures that restrict logging, road use and road building, fuels management activities, and livestock grazing" are listed in the report, major logging and fuels management would continue (see Hams Fork and LaBarge Vegetation projects as examples), roads would continue to be major features on the landscape, and substantive opportunities for livestock grazing would continue under recommended conservation actions, recognizing that conservation actions are only recommended not required. See response to Overview Comment A.3 for additional discussion.
2	1		When Western Watershed Project filed an administrative appeal in accordance with 36 CFR 215 of the District Ranger's September 26, 2013, decision authorizing grazing on the Sherman Allotment located on the Bridger-Teton National Forest ("BTNF"), the DeLong Paper was adopted for its guidance in suggesting mitigations and management decisions2. Given the importance of these decisions and their effects on public land access and usage, a group of cooperating agencies3 ("Cooperators") decided to critically review the Paper for its scientific accuracy and adherence to the quality of information requirements of the U.S. Department of Agriculture ("USDA").	Comment noted.
	1		**1.2 Introduction**	
3	1		The Cooperators recognize and agree with statements in the Paper that globally, amphibians are declining. It is also recognized that a science-based conservation strategy for toads and frogs is needed on the BTNF, not just to sustain toads and frogs, but to ensure	Comment noted.

			that other management actions can proceed without legal challenges.	
4	1-2		Because toads and frogs lack waterproof skin and are cold-blooded, the factors limiting toad and frog populations can vary drastically depending on local climate and vegetation (Maxell 2000). For example, where a study conducted by Schmutzer, et al. found logging in Tennessee to be detrimental to amphibians, a study conducted by Wind and Dupuis found logging to be beneficial in western Canada (Schmutzer et al. 2008; Wind and Dupuis 2002). Much of the pertinent, published research that identifies factors that may be detrimental to toads and frogs depends upon local conditions. Maxell suggests that grazing may be harmful to toads if it results in stream down-cutting, loss of hardwoods, trampling of metamorphs (toadlets), or loss of shade where shade is limiting. Maxell also suggests that grazing could be beneficial by creating basking areas where openings are limited, or by adding nutrients where streams are nutrient-poor (Maxell 2000). Obviously, whether or not grazing is a limiting factor to toads and frogs depends entirely upon local conditions. Thus, detailed local, multi-scale information is essential to creating a scientifically defensible conservation strategy.	At least two of the three citations are incorrect and one is used in a misleading way. Schmutzer et al. (2008) was conducted in Tennessee but involved the effects of livestock grazing not logging. Semlitsch et al. (2009) (in the literature cited of the Review Document) is a literature review on effects of logging. Wind and Dupuis (2002) is not a study, although they cited results of studies on effects of logging on western toads albeit only at a cursory level. While factors limiting toad and frog populations can vary considerably from location to location depending on local climate and vegetation, frogs and toads have some very basic requirements that need to be met. One of these, related to the comment, involves the need for moist or humid habitat or, if this is not available in relatively dry environs, sufficiently distributed moist or humid microsites, *regardless of the particular location in the United States*. See “C. Insufficient Discussion of Climate, Vegetation, and Disturbance Regimes in Applying Research Results,” above, for more detail. ERG focused many of their comments on shading, water balance, and basking, but this only involves two of a large number of diverse factors whereby logging and livestock grazing has potential to affect frog and toad populations (numerous citations are provided in the report in support of this). See response to Overview Comment B.1. for more discussion of this. The information in the comment supported by Maxell (2000) is addressed in detail in the report. It is unclear why basking sites was identified by ERG as an issue. The assessment in version of the report reviewed by ERG (01-09-2013 version) was that “A retention level of 70% in a dense emergent marsh would provide numerous small openings or a smaller number of larger openings” (pg. 95 of the report). This means that concerns about 30% use not providing sufficient basking sites is unfounded. The 09-26-2014 version of the report corrected the characterization by showing that 30% use of herbaceous vegetation would actually “overshoot” the amount of openings needed for basking. This is discussed in more detail in the response to Overview Comment B.1. Regarding the second to the last sentence, while local habitat conditions is one set of factors affecting the extent to which livestock grazing is a limiting factor, it is overly simplistic ignores a large number and diverse factors that affects the degree to which livestock grazing use affects frogs and toads. This is discussed in more detail in the response to Overview Comment F.
5	2		**1.3 DeLong Paper Review**	
6	2		Of the over 200 citations listed in the bibliography, fifteen are never cited in the draft Paper. These include references to information about a variety of topics,	In preparing the literature cited section, the literature cited section of another report was cut-and-paste into the subject report, and sufficient care was not taken to delete all references that were not cited in the subject document. See response to Overview Comment F for further

			including timber harvesting, livestock grazing, defoliation of grasses, entomology, road impacts, heavy metals, fire, introduced aquatic vertebrates in Mexico, absorption by vegetation, wildlife habitats in the Blue Mountains of Oregon and Washington, the 2012 US Fish & Wildlife Service's Threatened and Endangered Species 90-day finding on the eastern and southern Rocky Mountain populations of the boreal toad, leaf photosynthesis, Wyoming bird conservation plan, and a Wyoming State species abstract of the boreal toad. While the relevance of some of the topics is questionable, their presence in the bibliography could suggest that DeLong used their information without citing them in the Paper, that he intended to use their information but inadvertently left it out, or that the extra citations were in the bibliography for an unknown reason.	discussion.
7	2		Nine reports cited in the draft DeLong Paper which appear in 62 individual citations are from unpublished reports and were not provided with the draft Paper, nor can they be located online. Of the nine, five of the unpublished reports were written by DeLong himself, and comprise 23 of the individual citations.	Comment noted. Effort has been made to compile electronic copies of all documents cited in the report.
8	2		Other problems appear within the Paper. For example, in a general discussion of the range and status of Columbia spotted frogs, DeLong quotes Keinath and McGee (2005) as to their status, however, their report is about boreal toads (Owings 2014).	Keinath and McGee (2005) was erroneously cited; Patla and Keinath (2005) is the correct citation. Both are Region 1 conservation assessments. This was corrected earlier based on comments from the Sublette County Conservation District.
9	2		DeLong also states: "Dumas (1964) reported that relative humidity of 65% at about 80°F is lethal to adult spotted frogs in approximately two hours. Therefore, for those that migrate from their breeding site when humidity is low and/or temperatures are high, survival may depend on migration habitat that retains higher moisture/ humidity at ground level and protection from the sun and predators (e.g., herbaceous and shrub cover) or that otherwise provides micro-sites with these qualities." This is possible but cannot be deduced from Dumas (1964). There is no indication whether the temperature/ humidity/time tests in the study were conducted in the wild or a lab. The purpose was to examine differences in how species	Additional information was added to the discussion in the main body of the report, including additional citations and information on BTNF elevations and temperatures. While Table 4 in the review document is interesting, it did not consider habitat of spotted frogs and boreal toads on the BTNF, nor did it consider the elevations used by these species. About 65% of spotted frog breeding sites and about 44% of boreal toad breeding sites are at or below about 8,000 feet in elevation. See responses to Overview Comments B.2 (section d.vii) and F.1 (section c) for further details.

			respond to their environment (Owings 2014). One must also ask how commonly those conditions would occur at over 8,000' elevation.	
10	2		DeLong also states "Sedges and other emergent vegetation appears [sic] to be an important component of breeding habitat, and there appears to be a propensity for toads to lay their eggs in the in [sic] or near the marshy parts of wetlands (Keinath and McGee 2005)." The cited document actually states, "within 6m of shore, in marshy areas with emergent sedges or shrubby willows, or even bare substrate" (Owings 2014).	Additional citations were added in support of the statement. Note that the quoted statement from the report is qualified with "appears to be" and "an important" component (not sole component), and the quoted statement by Keinath and McGee (2005) uses the phrase "or even" bare substrate. "Or even" typically denotes an uncommon occurrence or something that is somewhat surprising. Many accounts identify the importance of sedge and other emergent vegetation. Additional information from Keinath and McGee (2005) was added. This is similar to Comment 44 from the Sublette Conserv. District, and the same as Comment 62, below.
11	2		DeLong relies heavily on the report to the Forest Service (Allen-Diaz et al. 2010) and the Rangeland Ecology and Management journal article (Roche 2012) to make his assertions concerning herbaceous vegetation retention, humidity retention, temperature moderation, and suitable shading and sun protection attributes. A simple search of the texts shows that the word "retention" does not appear in either of these studies. The studies were therefore not relevant to his conclusions (Owings 2014).	While the word "retention" did not appear in the cited report and paper, retention of herbaceous vegetation is the exact opposite of utilization of herbaceous vegetation, and it is retained vegetation that provides habitat. Effects of utilization of herbaceous vegetation was a key variable in their research; it provided a direct measure of the proportion of herbaceous habitat that remained.
12	3		**1.4 DeLong Paper Methodology and Results**	
13	3		The DeLong Paper does not rely on local data. Since toads occur globally from sea level to 12,000 feet, toads on the BTNF occur at the extreme upper edge of occupied habitat (Maxell 2000). No discussion is provided in the Paper, however, that addresses the high elevation and relatively cool climate of the BTNF, or how those climate variables might make some potential limiting factors identified in the literature more of a concern than others. Lack of sufficient shade for amphibians is repeatedly addressed as a problem needing resolution by restrictions on grazing, yet no data is provided at any scale to disclose the ratio or distribution of shade to basking (open) areas. No data on average summer weather conditions is provided to show whether toads and frogs might require a higher percentage of shade versus basking areas.	Additional information was added on elevations, temperatures, and relative humidity for the BTNF (local data outlined in response to Overview Comment F.1, section d.vii) and how this has the potential to affect frog and toad ecology, and additional discussion had been added to the 09-26-2014 version of the report on factors limiting boreal toad above certain elevations (the "Openings Providing Sun Exposure" section of Appendix A). See response to Overview Comment B.2 (section d.vii) and F.1 for additional discussion. Maxell (2000) does not show that "toads on the BTNF occur at the extreme upper edge of occupied habitat" since his report is only for Montana. Based on local data (note the first sentence of the comment), there are no known boreal toad breeding sites above about 9,800 feet, and about 85% of breeding sites are at or below 8,400 feet. There are two "suspected" breeding sites on the BTNF (one at 10,000 feet and the other at 11,600 feet), but there is no evidence that breeding occurred. Even if breeding had been documented at these sites, only 0.3% of breeding sites would occur over 9,800 feet. Local data also does not show that boreal toads exist in an elevation zone that is "relatively cool," and this can be explained in part by their need for relatively warm waters

				during mid summer for tadpole development (see response to Overview Comment F.1, section d.vii for more detail). Lack of sufficient shade for amphibians is not "repeatedly addressed as a problem needing resolution." In fact, of the factors associated with herbaceous vegetation retention, it is discussed relatively little in the report. It is unclear why ERG so strongly emphasized shading in their comments. See response to Overview Comment B.1 for discussion. Basking sites was discussed in response to Comment 4 and to Overview Comment B.1; ratios of shade and basking sites is discussed in the latter.
14	3		The DeLong Paper also provides no data on BTNF vegetation conditions, including the distribution of vegetation cover types, size class distribution, grazing utilization, and relative distribution of grazing utilization within allotments. Inferences are made that some habitats (i.e., aspen) have declined, but no supporting data is provided to explore the reasons for decline or the impacts such decline might have on amphibians.	See discussion in the response to Overview Comment C.4," above, for the response to this comment. Regarding the second half of the paragraph (i.e., on aspen , lack of data on aspen decline, and effects of declining aspen on amphibians), the 01-09-2013 version of the report described the cause of the decline in aspen and implications to amphibians on pages 16, 26, 39, 51-52, 56, 58, 65, and a large amount of data is contained in Loosen et al. (2009), which is cited in the report. This discussion was expanded in the 09-26-2014 version of the report, including implications of the decline in aspen to amphibians.
15	3		That lack of local data makes the justification for the management recommendations in the Paper highly questionable. For instance, during a field trip on September 5, 2014, a group of government officials and biologists visited Beaver Creek on the BTNF, which is dominated by open beaver ponds and dense willows. Narrow stringers (6-10 feet wide) of beaked sedge were represented on 10 to 20% of the area. While BTNF biologists were explaining how the recommended 70% retention standard would be applied, Loren Racich, Sublette County Conservation District, asked how shade could be limiting to toads since any toad in the sedge community would literally be no more than two hops away from dense willows. BTNF biologists were unable to answer the question. It was evident that the 70% retention standard would have no logical benefit for avoiding temperature stress on toads in that particular situation, yet there was no acknowledgement of that by BTNF staff.	There are several reasons why the management recommendations in the Paper are <u>not</u> highly questionable due to lack of local data. These are outlined in "C.4. Existing Conditions on the BTNF and Analysis of Local Data," above. 70% retention of herbaceous vegetation is not a standard or management recommendation; it is a component of suitable conditions (see response to Overview Comment A.1for further discussion). Regarding the question by Loren Racich: (1) a response by D. DeLong was captured in the notes for the meeting (see response to Overview Comment B.1 for quote from meeting notes); and (2) shade is only one of a large number and variety of factors that need to be considered and it is unclear why this one habitat element (shade) has received such high attention from ERG and Sublette County Conservation District (see response to Overview Comment B.1). The 01-09-2014 version of the report and Appendix A of the 09-26-2014 versions of the report address this subject in detail; the 09-26-2014 version of the report was reformatted to provide greater clarity. More detail was added to the revised report on implications of mosaics of herbaceous communities and willow communities. Local data is not needed in defining 70% retention of herbaceous vegetation as part of suitable conditions, as explained further in "C.3. Definition of Suitable Conditions," above.
16	3		Although the DeLong Paper stresses the importance of good stream conditions, no data is provided on the BTNF's stream	Similar to the explanation in the responses to Overview Comments C.3 and C.4, a detailed presentation of data on the BTNF's stream condition is not needed for the report.

			condition classes to include Rosgen stream profile, bank stability, riparian hardwood density and condition, stream sinuosity, or gradient. The Paper also stresses the importance of minimizing compaction near streams, yet no data is provided on the BTNF's soil sensitivity to compaction or documented cases of compaction from cattle. And while the Paper also stresses the risks associated with roads near streams, no data is provided on road density within or adjacent to suitable toad and frog habitat.	The focus of the report is to define suitable conditions (e.g., suitable conditions for streams) and the basis for these conditions. A detailed characterization of existing stream conditions is not needed to define suitable conditions. Where streams are below suitable conditions (e.g., where project level monitoring identifies problems), the report provides a list of conservation actions that could be taken to remedy the situation. Information was added to the revised report to address the comment on the BTNF's soil sensitivity to compaction. However, the discussion was kept short and data was not presented because this goes beyond the scope of the report. Road density is not an issue, as discussed in detail in the response to Overview Comment B.2, section d.vi. There is no need to do an analysis of the existing road situation near breeding sites and riparian areas as part of the process of defining suitable conditions (see response to Overview Comment C.3) or in the process of identifying risks and potential conservation actions (see response to Overview Comments C.5 and C.6). Nonetheless, the existing risks associated with roads will be mapped and assessed, as pertinent and on a project-by-project basis, using GIS, as they were for the LaBarge vegetation treatment project (DeLong 2014b). This will provide biologists with geographic information to be able to identify areas of greatest risk on the BTNF.
17	3		While habitat objectives were seemingly conceptualized based on recommendations within documents cited in the DeLong Paper, without any discussion as to whether or not those documents are pertinent to the BTNF based on local climate and disturbance regimes, there is no basis that shows how current conditions compare to those objectives.	The response to this comment can be found in Overview Comment "C. Insufficient Discussion of Climate, Vegetation, and Disturbance Regimes in Applying Research Results" above.
	4		**1.5 Conclusions**	
18	4		It is evident that no limiting factors to toads and frogs specific to the BTNF have been identified, and any measures meant to resolve those presumed factors are fixes to problems that have not been demonstrated to exist. That point was further exemplified during the September 5th field trip to Beaver Creek when BTNF biologists were asked to explain the limiting factor to toads at that site. The BTNF biologists were unable to answer the question, but did state that the literature (mostly from a California study which actually found no correlation between toads and grazing) recommended the retention of 70% of nongrazed grasses and sedges to avoid dessication of adult toads during hot weather. This is an example of	The first sentence is incorrect, as detailed in the response to Overview Comment B.2. All of the risk factors identified in the report specifically pertain to the BTNF. The revised report provides more explanation of the degree to which each risk factor has the potential to negatively affect each of the habitat and survival elements. There is no recollection of biologists being asked to explain the limiting factor to toads at the Beaver Creek site, and it is not in the notes for the meeting/site-visit. A discussion on limiting factors at the site, following such a question, would/should have included potential effects of chitrid fungus, climate change, UV radiation, increased aerial nitrogen inputs, roads/motorized vehicles (a road parallels the riparian area/breeding area), changes in vegetation disturbances, livestock grazing use, and other potential risk factors. The BTNF biologist did not state that most of the basis for the 70% retention threshold was based on "a California

			the attempts made in the DeLong Paper to justify far-reaching management decisions.	study." There is no reference to such an answer in the notes from the meeting/site-visit, it contradicts the response given by Don DeLong that was captured in the notes (e.g., that it considered ramifications to 11 habitat/survival elements… each of which were supported by a substantial amount of scientific information), and the report cites hundreds of papers, reports, and books for the development of a retention threshold. The suitable condition of 70-100% retention of total herbaceous vegetation is based on a comprehensive and detailed analysis of scientific information (several hundred papers and books) from a wide range of disciplines. A minimum of 70% retention of total herbaceous vegetation is not a recommendation; it was stated as an objective in the 01-09-2013 version of the report and is stated as important component of suitable conditions under Forest Plan Objective 3.3(a) and it defines suitable conditions for Forest Plan Objective 4.7(d) for spotted frogs and boreal toads. The "retention of 70% of nongrazed grasses and sedges" is erroneous; it is the retention of 70% of all (total) herbaceous vegetation. See also the Response to Comment 15 for the part of the comment about the field trip. Regarding the reference to "no correlation between toads and grazing," the Roche et al. (2012b) assessed that Yosemite toads and cattle selected different parts of meadows, not that cattle did not affect toad occupancy: "…there are potentially two co-occurring mechanisms driving the overall lack of direct connection between cattle grazing and toad occupancy in this system: 1) for the majority of the grazing season, the two species mostly occupy differing zones along the moisture gradient, resulting in physical partitioning of the meadow habitat and minimizing any potential direct or indirect negative impacts; 2) when there is habitat use overlap (e.g., during the early part of the grazing season) grazing levels are low to moderate, resulting in no detectable impacts on toad occupancy" (Roche et al. 2012b:9). Early-season grazing was 0-25% use (Roche et al. 2012:6). Another possible reason for no direct connection between cattle and toad occupancy being detected is that toad occupancy was not measured in August and September when grazing use increased substantially. No management decisions were made in the report.
	4		As is demonstrated later in this document, when the following considerations are made, there are no obvious indications of severe risks to toads at the scales analyzed, including:	See Response to Comment 22, below, for summary response to Comments 19-21.
19	4		• GIS coarse filter vegetation data which suggest that within stream buffers, shaded cover types occur at a higher percentage than open cover types;	This is addressed in the response to Overview Comment B.2.
20	4		• Maps of stream condition class overlapping	This is addressed in the response to Overview Comment

			capable (i.e., low gradient streams and open water) habitat and which suggest that most stream habitat is in good condition; and	B.2.
21	4		• Maps of capable habitat with toad and frog populations that have a high level of overlap suggesting that the aforementioned data layers are correctly identifying toad habitat.	This is addressed in the response to Overview Comment B.2.
22	4		Based on ERG's GIS analysis, there is no obvious indication that toads and frogs are at risk on the BTNF. This in no way indicates that amphibians are not at risk, but further fine scale data is needed to determine under what circumstances and to what degree they might be at risk. Further fine scale data is also required before a conservation strategy can be considered adequate.	Regarding the assessment that "…there is no obvious indication that toads and frogs are at risk on the BTNF…," and based on the above responses to the three bulleted comments and discussion under Overview Comments C.4 and C.5, above, ERG provides no viable evidence that spotted frogs and boreal toads are not at risk on the BTNF (See response to Overview Comment B.2). Regarding the last half of the comment, see discussion under Overview Comment C.4 and C.5. In summary, collection of a sufficient amount of "fine scale data" is not reasonable and it is not needed to effectively meet sensitive species requirements for spotted frogs and boreal toads.
	4		**1.6 Recommendations**	
23	4		Toad and frog populations may have declined on the BTNF, if only because other studied populations have declined. However, before the BTNF takes measures that may or may not be warranted based on actual population status, the BTNF should inventory the current population status. Dr. Wendy Estes-Zumpf is currently planning additional occupancy surveys. Given that toad and frog tadpoles are not that difficult to inventory (compared to say, wolverines), any science-based approach to sustaining these species should first confirm that the species are indeed at risk on a local level. It is recommended that the BTNF be closely involved with Dr. Estes-Zumpf's inventory.	The Forest Service must be able to demonstrate that ongoing activities and proposed future activities will not impair the achievement of Forest Plan Objectives 3.3(a) and higher-level sensitive species requirements. The design of the monitoring program designed by Dr. Estes-Zumpf based on USG's ARMI approach (see Patla et al. 2008) will not result in "actual population status" being ascertained. The comment that "any science-based approach to sustaining these species should first confirm that the species are indeed at risk on a local level" conflicts with management requirements for sensitive species. See the response to Overview Comment E for more detail. BTNF biologists are working closely with Dr. Estes-Zumpf on implementing amphibian monitoring.
	4		Based on the findings of Maxell, Keinath and McGee, and Pilliod et al., at a minimum the BTNF should collect and rely on the following crucial data:	See responses to comments 24-30, below.
24	4		1) Maps of toad and frog-capable habitat (standing water or <2% stream gradient) with appropriate buffers;	Capable habitat is more than aquatic habitat (see response to Overview Comment B.2, and see the revised report for numerous citations supporting this). This said, the identified parameters have been incorporated into the capable habitat model for the BTNF.
25	5		2) Maps of the mix of cover types within that habitat;	A map of the mix of vegetation types within designated buffers around known existing breeding sites can be produced by biologists on a case-by-case and project-by-project basis. See also the response to Overview Comment B.2.
26	5		3) Identification of size classes within that habitat;	See above.
27	5		4) Map of shade-producing and non-shade	Reviewers did not define each of these categories, or

			cover types;	support their definition with scientific information. See responses to Overview Comment B.1 and B.2.
28	5		5) Collection of utilization data (livestock and wild ungulates) by cover type within capable habitat;	This was included as a conservation action and is included in the monitoring subsection of the herbaceous retention section in the 01-09-2014 report.
29	5		6) Identification of soil sensitivity to compaction; and	This likely will not be included in the capable habitat model.

30	5		7) Identification of road density within capable habitat and buffers. (Keinath and McGee 2005; Maxell 2000; Pilliod et al. 2002)	See response to Comment 16 and to Overview Comment B.2.d.vi.
31	5		If a conservation strategy has any chance of being upheld during legal challenges, it must be based on best available science. This means: 1) research findings cited have been demonstrated to be pertinent based on local climate, vegetation and disturbance regimes; 2) identified limiting factors are based on extensive local data, not just published data from other locales; 3) measures to resolve those limiting factors consider the effects on other ongoing programs, including measures designed to protect and restore habitat for other sensitive species; and 4) monitoring of habitat and populations is sufficient to demonstrate habitat recovery, or if not, adaptive measures are in place to correct any deficiencies in the overall conservation strategy.	Comment noted. A more accurate version of the second part of the first sentence is that it must be based on legal, regulatory, and policy requirements and informed by the best available science. Items 1, 2, and 4 are addressed in responses to Overview Comments C.4, C.5, E, and F, in addition to the response to Overview Comment C.1, which is pertinent to all four items. Regarding number 3, consideration of the effects on other ongoing programs would need to involve other disciplines, but the report (which is not a conservation strategy) is written by a wildlife biologist. Because the report is technical document supporting a conservation assessment and not a stand-alone conservation strategy, it is most appropriately written by a wildlife biologist. Also, a subsection "Deviations from Estimated Natural Conditions to Accommodate other Uses" had been added to the 09-26-2014 to address a similar issue.
32	5		The need to preface management actions with a strong, biologically-based understanding of limiting factors has long been the basis of sound wildlife management (Leopold 1933). Habitat and population trend monitoring should be an integral part of any conservation strategy. If it is determined that restrictions on grazing, logging, fuels management, or road management are needed, adaptive management measures should be implemented.	The importance of identifying limiting factors in the process of conserving wildlife is evident in Leopold (1933), and this citation had been added to the 09-26-2014 version of the report in support of this. It is agreed that "Habitat and population should be an integral part of any conservation strategy" *to the extent possible*, recognizing that population monitoring likely is not possible for all species of conservation concern, it may not be possible to obtaining numeric population trends for more than a small number of species (which does not include amphibians under the new monitoring program). This is consistent with provisions of the 2012 Planning Rule. Yes, where restrictions on livestock grazing, logging, fuels management, and road management are needed, they would need to be implemented, with consideration given to adaptive management.
			2. Introduction	
33	7		The DeLong Paper is an ambitious attempt to address the vexing problem of the global decline of amphibians on a local scale. Amphibians are considered to be an	Regarding the first sentence, see Overview Comment C.1 for a clarification of the purpose of the report. The remainder of the comments appears to be consistent the ecological literature, recognizing there is more to the

			indicator species for environmental health, as they have delicate skin that readily absorbs toxins from their environment, are easy prey for non-native predators, and rely on both aquatic and terrestrial habitats at various times during their life cycle. The quality of their habitat is obviously key to their existence.	conservation of amphibians than restoring and maintaining quality habitat.
34	7		Protecting wetland frog habitat and toad nursery habitat is critical to the survival of frog and toad habitat, and dovetails with other conservation strategies, including the protection of native fish habitat, neotropical migrants, aspen, moose, and downstream water uses. Upland terrestrial habitats are also critical for toads, and include a matrix of meadow, shrubland, forested lands, and ephemeral streams. Developing a biologically defensible conservation strategy for the sensitive toad and frog populations is essential for avoiding litigation and meeting U.S. Forest Service ("USFS") plan objectives, which include responsible domestic livestock grazing.	To be all inclusive, habitats needing protection include breeding habitat (aquatic); shoreline habitat for metamorphs and adults; summer aquatic habitat for frogs and toads; terrestrial migration habitat for frogs and toads; summer terrestrial habitat for toads; and hibernation habitat for frogs and toads (see report for supporting citations). It is agreed that conservation of these habitats "dovetails with other conservation strategies" such as those listed. Regarding the last sentence, the report is not a conservation strategy (see Overview Comment C.1). While law, regulation, and policy require that conservation strategies meet Forest Plan objectives, there is no management direction calling for conservation strategies to avoid litigation.
35	7		Sensitive species conservation strategies designed to protect a single species should consider other conservation strategies and Forest plan objectives where habitats overlap. For instance, a conservation strategy that precludes natural disturbance to protect one species might make restoring disturbance dependent species like aspen or whitebark pine impossible. For non-listed species, restoring or mimicking natural disturbances, patterns, and vegetation composition should generally trump a single species' needs to avoid such traps. A modest level of "take" is acceptable to meet other objectives as long as the sensitive species population is not placed at risk from a viability standpoint.	This is addressed in the response to Overview Comment D.3. See also response to Comment 31. The remainder of the comment (except the last sentence) generally falls in line with taking a coarse-filter approach and only making fine-filter adjustments as necessary (i.e., the approach taken in the report).
			2.1 Cooperators	
36	7		In July of 2014, Sublette County Commissioners, with the support of the Sublette County Conservation District ("Cooperators") and the Wyoming Game & Fish Department, asked Ecosystem Research Group ("ERG") to critically review and prepare appropriate responses to the recommendations within the DeLong Paper. This review reflects ERG's findings, and was completed with the oversight and assistance	This is not a comment. No response necessary.

			of all the Cooperators.	
			2.2 Science-Based Conservation Strategy	
37	7		The Cooperators support the BTNF's effort to develop a science-based conservation strategy for the boreal toad and Columbia spotted frog that provides reasonable long-term protection for the species. It is understood that the risk of litigation faced by grazing permittees and other Forest users if the BTNF cannot demonstrate that species sustainability is assured under current management practices.	Comment noted.
			2.3 The Global Risk of Amphibians	
38	7		The Cooperators also understand the somewhat perilous worldwide status of amphibians. Suggested causes for amphibian declines worldwide include global warming, ozone depletion, chemical pollution, pesticides, mining residue, disease, increased predation by ravens, and habitat destruction or alteration.	Comment noted.
39	8		*Batrachochytrium dendrobatidis*, "Bd" or chytrid fungus, is the only chytrid that is a parasite of a vertebrate animal, and amphibians specifically; Bd has not been observed to infect other vertebrates such as reptiles, birds or mammals (Briggs et al. 2010).	Comment noted. Chytrid fungus was addressed in some detail in the report.
40	8		A recent study moves focus from the dynamics of the pathogen in its amphibian hosts to investigating the actual free-living fungus and how it occurs and thrives in amphibian habitats (Chestnut et al. 2014). While the DeLong Paper, and subsequently this review, focus on risks to habitat and how they may or may not be present on the BTNF, an entire body of research exists concerning the chytrid fungus and could be the sole topic of another review.	Chytrid fungus was addressed in the 01-09-2013 version of the report, and the discussion on this disease had been expanded substantially in the 09-26-2014 version of the report prior to receiving ERG's comments, including disease in the context of multiple stressors. The citation identified in the comment (Chestnut et al. 2014) and discussion of how the free-living fungus occurs in amphibian habitat was added to the report. Yes, the topic identified in the comment could be the topic of another review.
41	8		Fortunately, the BTNF, due to its isolation and elevation, is more removed from many of those risks than other portions of the country. The Cooperators therefore see a need to focus very carefully and identify with hard data any limiting factors to toads and frogs associated with current authorized uses on the BTNF.	No scientific support was provided for the first sentence, and it does not appear to be consistent with available scientific information. A large majority of spotted frog snd boreal toad breeding sites are at relatively low elevations. Boreal toads at higher elevations in Colorado have declined markedly, and the Greater Yellowstone ecosystem is not "isolated" from agents that can be transported by vehicles, people, and the air (e.g., elevated nitrogen inputs into water bodies), nor is it isolated from the effects of climate change and UV radiation (see the 09-26-2014 version of the report for supporting literature). Additionally, roads, motorized vehicles, livestock grazing, reservoirs, and other activities

				and developments pose additional risks, as discussed in the report.
			2.4 DeLong Paper Findings	
42	8		The DeLong Paper recognizes the need for coarse filter data, but no data is provided that addresses disturbance regimes, current vegetation or comparison to historic conditions. Inferences are made to changes in vegetation due to fire exclusion (e.g., aspen) but no data is provided to support those conclusions.	Note the distinction between “coarse-filter data” and “coarse-filter approach;” see discussion in Overview Comment D. The comment made in the second sentence was addressed under Overview Comments C.4 and C.5. Different types of vegetation disturbances, disturbance regimes, and current vegetation conditions were discussed in the report, and discussions were expanded in the 09-26-2014 version of the report. Given the availability of papers, reports, and assessments that included analysis of data and other information, there is no need to do this in the report. See also discussion in Overview Comment C.4 and C.5.
43	8		The Paper also recognizes the need for fine filter data, but that fine filter data is limited to a very extensive review of the literature that addresses factors such as the relationships of grazing utilization levels on ground-level humidity and ground-level wind speeds. While those relationships could provide useful information if it was determined that a lack of shade was a limiting factor to toad and frog populations on the BTNF, no vegetation analysis was provided at any scale that concludes that shade is indeed limiting.	Fine-filter is used in a different context in the Review Document than it was in the report (see discussion underOverview Comment D). The examination of “fine filter data” (as used in the comment) was in no way limited to ground-level humidity and ground-level wind speeds. Wind speeds is a component of humidity at ground level, and this is one of 11 habitat/ survival elements assessed with respect to herbaceous retention on livestock allotments, and this is one of a wide range of habitat elements examined in the main body of the report. Regarding the comment that “…those relationships could provide useful information if it was determined that a lack of shade was a limiting factor…,” see Overview Comments C.3, C.4, and C.5 (information on near-ground humidity and shading, in the context of the comment, were used in the process of defining suitable conditions). It is unlikely that sufficient information would be collected on the BTNF to determine if shade is limiting, and this information is not needed to define suitable conditions.
44	8		Although DeLong mentions multiple factors that might limit toad and frog populations, the discussion is heavily focused on grazing with the assumption that shade is limiting, again made without supporting data. While the Cooperators understand that legal challenges demand a hard look at grazing-related impacts, as a purportedly science-based conservation strategy, the DeLong Paper should have taken an unbiased look at all potential limiting factors. For example, research conducted in cool climates suggests that toads seek out openings during cool weather. Understanding the relationship of shaded areas to openings in terms of what toads and frogs require during local weather events is critical to identifying limiting factors (Maxell 2000; Wind and Dupuis 2002). The Cooperators contend that this	The opening paragraph of the herbaceous retention section of the 01-09-2013 version of the report answers the comment about the “heavy focus on grazing.” Before outlining this (see quoted paragraph below), it must be noted that the focus of the report is not on livestock grazing, and moving the detailed analysis of herbaceous retention to Appendix A should help alleviate this misinterpretation of the report. Reasons for getting into more detail on livestock grazing are as follows: “This section of the report is substantially longer than preceding sections for several reasons, including (1) livestock grazing directly affects more acres of spotted frog and boreal toad habitat than any other activity on the BTNF especially compared to activities like timber harvest which affect such small acreages, (2) wetlands and meadows are important for both amphibians and for livestock, (3) areas favored by foraging cattle overlap to a large degree with habitat of spotted frogs and boreal toads, (4) minimum herbaceous retention levels have not been worked out for these species in the literature, (5)

			analysis is lacking in the DeLong Paper.	several of the habitat elements summarized previously in this report are addressed in more detail in this section, and (6) there is considerable resistance to any objectives that could lead to reductions in herbaceous utilization levels and discussions on this topic routinely lead to statements that scientific information is needed before any such objectives are adopted. With these considerations in mind, not to mention the professional need to use scientific information to develop objectives, this section outlines in some detail the scientific information that supports the assessment that 70% retention of total herbaceous vegetation would maintain suitable habitat for spotted frogs and boreal toads" (pg. 23 of the 01-0902014 version of the report). Comments from ERG is one more demonstration of point number 6, above. It is important to note that the more extensive treatment of herbaceous retention in the report (now in Appendix A), compared to other habitat and survival elements has been influenced by pressure against making any changes to livestock grazing based on the needs of sensitive amphibians (noting also that there is also ongoing pressure against making any changes to livestock grazing on the BTNF in order to meet the needs of sage grouse, grizzly bears, and bighorn sheep, among other wildlife species). Objective 4.7(d), as well as Objective 3.3(a) and the requirement in the Forage Utilization Standard to prescribe utilization limits that meet Forest Plan objectives, have been in place since 1990 for the BTNF, but the agency has just recently begun looking at making adjustments to livestock grazing use to ensure that affected objective will be met. As such, pressure against efforts to meet this Forest Plan direction and associated controversy is probably partly due to the these efforts being new to livestock interests. Regarding the third to the last sentence of the comment (i.e., "For example, research conducted in cool climates…"), this is addressed in response to Overview Comment A.2, section a. Regarding the last two sentences of the comment, a considerable amount of space in the report discussed and analyzed relationships between forested and non-forested areas (pgs. 56-62 of the report), and the need for areas with herbaceous cover to meet several needs of the species (pgs. 69-72, 76-81, 89-94, and 99-103) compared to open patches providing basking sites (pgs. 11, 12, 19, 20, 57, 95, and 96).
45	8		The untested assumption that shade is limiting strongly affects recommendations for retaining coarse, woody debris. Conifer size class data strongly suggests that presumably due to long-term fire suppression, coarse, woody debris occurs at substantially higher than historic levels. Thus, measures to retain coarse, woody	Treating shade-as-a-limiting-factor as an untested assumption, specifically with respect to large woody material, is erroneous for the following reasons. First, ERG mix landscape-level habitat factors with fine-scale habitat factors. Just because large woody material is abundant across the landscape due to the recent pine bark beetle epidemic, this does not mean that elimination of large woody material from parts of forestland within the range of

			debris are not only DeLong's answer to something that is not a problem, but those measures would likely unnecessarily restrict well-intended fuels reduction projects that if accomplished could ultimately reduce risks to toads and frogs.	a local population of boreal toads will not negatively impact them. Second, several scientific studies, including one from the Caribou-Targhee National Forest, were cited in the report showing the importance of large woody material in clear-cuts within the range of local boreal toad populations.
46	9		The focus of the DeLong Paper on grazing may inadvertently ignore other bigger threats to toads and frogs. For instance, Pilliod, et al. concludes that introduced fish in north central Idaho "may eventually result in the ***extirpation*** of amphibian populations from entire landscapes, including sites that remain in a fishless condition." (emphasis added) (Pilliod and Peterson 2001). The DeLong Paper, however, devotes one-half of a page to this topic, whereas it devotes 31 pages to comparing the effects of different grazing utilization intensities on ground level wind speed and humidity, as they might lead to toad dessication, a concern that may not even be valid given the BTNF's elevation and predominate mix of shade-bearing cover types. The Cooperators would be unlikely to support fish removal from high lakes to protect spotted frogs without access to more reliable information. Nonetheless, any species conservation strategy needs to address all the potential risks in an unbiased manner, regardless of the controversy that might be associated with those risks.	The report does not focus on livestock grazing, although — for reasons reiterated in the Response to Comment 44 — it is recognized that livestock grazing is addressed in more detail than the other factors. Compared to the effects of introduced fish, effects of livestock grazing is addressed in greater detail because (1) it is understood that, once fish are introduced into a given lake, the potential exists for certain impacts to occur and these appear to be well established with respect to amphibians; and (2) livestock need to be managed to minimize effects on amphibians and there are a large number and variety of ways in which livestock grazing use can impact amphibians, and many of the mechanisms of impacts have not been summarized sufficiently in the scientific literature to apply to management. Less than 5 pages of the report addressed wind speed and humidity, and the other 10 habitat and survival elements were addressed on the remaining 26 pages (with respect to the 31 pages identified in the comment). Pilliod and Peterson (2001) had been added to the "C.3. Habitat Effectiveness and Survival with Respect to Fish" section of the 9-26-2014 version of the report, and the quote ("may eventually result in the extirpation of amphibian populations from entire landscapes, including sites that remain in a fishless condition") was added to the revised report, as this may apply to the Wind River Range on the BTNF. The "C.3. Habitat Effectiveness and Survival with Respect to Fish" section was greatly expanded in the 09-26-2014 version of the report. Again, the importance of retaining 70% of the annual production of herbaceous vegetation does not boil down to maintaining suitable conditions for "on ground level wind speed and humidity," as stated in the comment (see response to Overview Comment B.1). The following sentence in the comment is noteworthy: "Nonetheless, any species conservation strategy needs to address all the potential risks in an unbiased manner, regardless of the controversy that might be associated with those risks." Implications of meeting sensitive species requirements for boreal toads and spotted frogs has certainly elicited controversy. Thus far, the focus of the controversy has come from livestock grazing interests not wanting any changes to livestock grazing management that may result from implementing sensitive species requirements for boreal toads and spotted frogs. Some permittees, range

				management specialists, and the Sublette Conservation District (see comments earlier in this Appendix) argue that no changes should be made to current livestock grazing management unless it can be demonstrated that current management is unduly impacting sensitive amphibian populations. This is addressed in further detail in the response to Overview Comment E.
47a	9		The DeLong Paper seems to intentionally handpick some of the research findings. For instance, it focuses on papers (Semlitsch et al. 2009) and (Rittenhouse et al. 2008) that support adverse effects of timber harvest on toads, but ignores a paper (Wind and Dupuis 2002) that concludes timber harvest can be beneficial to toads – within British Columbia, which is arguably more similar to the BTNF in terms of climate and disturbance regimes.	ERG's claim that studies cited in the report were handpicked to show that commercial activities like timber harvest adversely affect boreal toads is unfounded for several reasons. The report shows there to be net benefits of logging to boreal toads and spotted frogs on the BTNF so long as measures are implemented to minimize the negative aspects of logging (e.g., roads, potential of crushing toads with skidders). The response to Overview Comment A.3 addresses this comment in more detail.
47b	9		Another paper found no relationship between grazing and toad density in the Sierra Nevada range, where elevations, if not latitude, are somewhat more comparable to the BTNF than other papers cited (Allen-Diaz et al. 2010). It could be expected that some discussion would appear on what the local conditions were that might have explained Allen-Diaz's findings, and whether any useful information had been found that might be applicable to the BTNF.	The Response to Comment 18 outlines reasons why Roche et al. (2012b) (the final version of Allen-Diaz et al. 2010) did not detect a relationship between livestock grazing and Yosemite toad occupancy. Additional detail was added to the 09-26-2014 version of the report on the applicability of their study to the BTNF. As with the previous comment, no legitimate support is provided for the contention that "The DeLong Paper seems to intentionally handpick some of the research findings" (see Comment 47a).
			3. DeLong Paper Review	
			3.1 Extent of Literature Addressed in the DeLong Paper	
48	10		Over 200 individual references are shown in the Literature Cited section of the DeLong Paper. An additional 64 references appear in the text of the Paper but are not listed in the Literature Cited section. A wide array of types of information appear: • Journal articles • Governmental agency technical reports • Non-governmental organization technical reports • Educational textbooks • Reports from foreign countries • Theses • Dissertations • Workshop proceedings • Websites • Unpublished reports	Comment noted. The list of "types of information," albeit partial, helps demonstrate the effort that was undertaken to obtain as much information from as wide a breadth as possible. This is addressed in some detail in the response to Overview Comment F.3.
49	10		While the sheer number of references is impressive, a closer look reveals major problems within the individual uses of them. The following is a sorting and accounting of	While the large number of references missing from the Literature Cited section of the 01-09-2013 version of the document may have made some parts of the document more difficult to critically review, recognizing that copies

			the information DeLong used in arriving at his conclusions.	of specific documents could have been requested from the Forest Service, this shortcoming (as detailed in comments 50-54) did not have any bearing on the quality of the analysis and did not affect the defensibility of the objectives and suitable conditions. This is discussed in more detail in the responses to Overview Comments F.1, F.2, and F.3.
50	10		Fifteen sources are listed in the bibliography but are never cited in the draft Paper. These include references to information about a variety of topics, including timber harvesting, livestock grazing, defoliation of grasses, entomology, road impacts, heavy metals, fire, introduced aquatic vertebrates in Mexico, absorption by vegetation, wildlife habitats in the Blue Mountains of Oregon and Washington, the 2012 US Fish & Wildlife Service's Threatened and Endangered Species 90-day finding on the eastern and southern Rocky Mountain populations of the boreal toad, leaf photosynthesis, Wyoming bird conservation plan, and a Wyoming State species abstract of the boreal toad. While the relevance of some of the topics is questionable, their presence in the bibliography could suggest that DeLong used their information without citing them in the Paper, that he intended to use their information but inadvertently left it out, or that the extra citations were in the bibliography for an unknown reason.	Having 15 of more than 200 cited references not cited in the report provides little support for Comment 49. As explained in the Response to Comment 6, the literature cited section of another report was cut-and-paste into the draft report, and sufficient care was not taken to delete all references that were not cited in the subject document.
51	10		Sixty-four references appear in the Paper but not in the bibliography, in a total of 109 individual citations. One citation in particular ("BLM et al. 2008") appears in 11 separate places within DeLong's discussion of live herbaceous vegetation, thatch and litter – a key point in his arguments of limiting factors. Without knowing what exactly is discussed in a referenced document, the reader can only assume that it relates to his argument.	Missing 64 citations in the Literature Cited section was a major short-coming of the 01-09-2013 version of the report. Considerable effort was made to ensure that all documents cited in the 09-26-2014 were cited in the Literature Cited section. Additional checks were made to ensure this to be the case for the revised report.
52	10-11		Approximately 50 publications, referenced in over 250 individual citations, have been identified for their questionable relevance to the topic of sensitive species objectives and the bases for recommended conservation actions, as the draft DeLong Paper purports to address. Topics are wide-ranging, and include: • A handbook for wildlife refuge management • Urban herpetology	The 50 publications that the reviewers felt were inappropriate were not identified and no explanation was given as to why reviewers felt the publications were inappropriately used. The list of "topics" compiled by ERG helps demonstrate the length to which author of the report went to track down scientific information from a wide range of disciplines that addressed specific issues involved in determining suitable individual aspects of suitable conditions, risk factors, conservation actions, and (especially suitable conditions). This is addressed in some detail in the responses to Overview Comments F.1, F.2, and F.3.

			• Microclimate in soybean canopies • Mediterranean pine voles • Southeastern Idaho • Western Montana • Fishes of Wyoming • Couch's spadefoot toad in the deserts of southeastern California • Pacific northwest forest • South-central Utah • Mice in Medicine Bow Mountains • Northeastern Oregon • Columbia River Basin • Tennessee • Colorado • Highway noise in Cairns, Australia • Gray-tailed voles • Southwestern Idaho • Rodents and lagomorphs • Canadian prairie wetlands • Netherlands • Massachusetts • Shortgrass prairie site • South-central Montana • Crop density and microclimates of cereal fields • Southern Alberta, Canada • Effects of mulch on grassland environments • Scottish upland estate • Sagebrush-steppe and juniper woodland in California • British grasslands • Artificial night lighting in an urban environment • New Mexico • Douglas-fir forests of northwestern California • Nevada range landscape • Sierra Nevada meadows • Klamath County, Oregon • Blue Mountains of Oregon and Washington • Mount Carmel, northern Israel	
53	11		Nine reports cited in the draft DeLong Paper which appear in 62 individual citations are from unpublished reports and were not provided with the draft Paper, nor can they be located online. Of the nine, five of the unpublished reports were written by DeLong himself, and comprise 23 of the individual citations.	Given then number of times these 9 reports were cited, reviewers not having ready access to these report may have been another large shortcoming of the 01-09-2013 version of the report. On the other hand, ERG could have made a request to the BTNF for copies of these specific documents, but this was not done.
54	11-12		It should also be noted that identical	Comment noted. Information in the 01-09-2013 version of

			portions of the DeLong Paper were found in the Hams Fork Vegetation Project Environmental Assessment (EA), coordinated by Anita DeLong for the Kemmerer Ranger District, Bridger-Teton National Forest, suggesting that either 1) the language was borrowed from the EA, or 2) information within the DeLong Paper was used as policy for the EA.	the report was cited in the Biological Evaluation and Wildlife Report (BEWR) for the Hams Fork Vegetation Project, and the BEWR was cited in the Hams Fork Vegetation Project EA. Pulling material from specialist reports (e.g., BEWRs) into environmental documents (e.g., EAs) is the way environmental documents are typically written. Furthermore, part of the intent of preparing conservation assessments for sensitive species (and in this case, the technical analysis supporting a conservation assessment) is to use the information in Biological Evaluations. As such, it is unclear why concern is being raised about this process. In this case, the author of the "DeLong Paper" is the author of the BEWR, and Anita DeLong coordinated the preparation of the EA. Three design features were added to the Hams Fork Vegetation Project, upon approval of the District Ranger, to mitigate impacts of roads, motorized use, and heavy equipment to sensitive amphibians. In contrast, 7 design features were added to the LaBarge Vegetation Project EA to mitigate effects of roads, motorized use, and heavy equipment on sensitive amphibian species, and this project had no involvement by Anita DeLong. The concern expressed in the comment is unclear.
			3.2 Importance of Local Research	
55	12		Since toads and frogs lack waterproof skin and are cold-blooded, factors limiting toad and frog populations can differ drastically by local climate and disturbance regimes. For instance, Maxell (2000) concludes: "In order to ensure the presence of habitats critical to the survival of amphibians, management plans need to consider the disturbance regimes that create and maintain them. Disturbance regimes that create and drive the succession of breeding, foraging, and overwintering habitats used by amphibian species include glaciation, flooding, fire, and the dam building, wallowing, and foraging activities of beaver and other large mammals."	The response to this comment is covered in Overview Comments C.4 and F.
56	12		Despite Maxell's emphasis on understanding local conditions, DeLong cites the findings of numerous nationwide papers without making any rigorous attempt to evaluate whether the climatic conditions or disturbance regimes in those areas studied are pertinent to the BTNF. For instance, whereas Semlitsch found logging in Missouri to be detrimental to amphibians, Wind and Dupuis found logging to be beneficial in western Canada (Maxell 2000; Semlitsch et al. 2009; Wind and Dupuis 2002). Given that	The response to this comment is covered in Overview Comment F. In summary, concerns expressed by ERG are unfounded. Additional explanation had been added to the 09-26-2014 version of the report on the use of scientific information from other locations, and more explanation was added to the revised report based on this and similar comments. ERG cite Wind and Dupuis (2002) as demonstration that logging is beneficial to western toads and reasoned that conditions in western Canada are more similar to conditions on the BTNF than conditions in Missouri. However, they ignored the study by Bartelt et al. (2004), which was conducted on the Caribou-Targhee National

			the climate and disturbance regimes of western Canada are much more similar to the BTNF, the findings of Semlitsch should have been determined to be irrelevant.	Forest (which adjoins the BTNF on the west) and which found detrimental effects of logging on boreal toads. This study was cited numerous times in the 01-09-2013 version of the report.
57	12		Interestingly, in one of the very few examples where DeLong actually discussed whether or not a paper was relevant to the BTNF, he concludes from another study in Missouri that “(t)heir study area receives an average of about 17 inches of rain from March through May…This means principles found in their study are generally applicable to the BTNF.” (Rittenhouse et al. 2008) Of course, combinations of summer temperature and humidity in Missouri (lethal to sun-exposed toads) are unlike anything the BTNF will ever experience. We suspect that anyone who had spent time in Missouri’s summer temperatures and humidity would beg to differ with DeLong’s conclusion.	This comment was addressed in the response to Overview Comment F.1.b.
			3.3 Research Misinterpretations	
58	12		DeLong misinterprets his sources in places, rendering them irrelevant as reliable research cited. The following are a few examples:	This is addressed in response to Overview Comment F.3.
59	12-13		• In a discussion of USFS Forest Plan DFCs, he states “if in these DFCs there is a conflict between a commercial activity and a wildlife habitat objective that is supported by a reasonable analysis of available scientific and natural history information — even if it lacks definitive “scientific proof” — the burden of proof is on demonstrating that the adjusted objective (adjusted to better accommodate the activity) still meets desired conditions defined by Forest Plan objectives and higher-level direction since there is an affirmative requirement to meet Forest Plan objectives. This is particularly important for sensitive species, and any elevated status of sensitive species in other DFC areas needs to be considered.” This statement is not in the forest plan, nor is it apparently inferred (Owings 2014).	Part of the quoted material comes from the Forest Plan. While the entire statement is not in the Forest Plan, there are two sets of requirements that support the statement: • The Forest Plan requires the Forest Service to defer to resource objective emphasized in a particular DFC area when there is a conflict between objectives: “…some objectives will not be met on all areas of the Bridger-Teton National Forest… The conflicts are resolved by application of the different Desired Future Conditions to different areas of the National Forest” (USFS 1990b:93). Similarly, “That the DFCs exist at all is in recognition that not all the Goals and Objectives can be achieved at the same time from the same land areas. Therefore, 17 DFCs… have been developed to accomplish multiple, compatible Goals and Objectives” (USFS 1990b:145). • The Forest Service has an affirmative requirement to meet Forest Plan objectives: ▫ “…the first and most important part of the [Forest] Plan is…. Goals and Objectives” (USFS 1990a:6-7). The Sensitive Species Management Standard is important, but the role of standards is to support Forest Plan goals and objectives (USFS 1990a). ▫ FSM 2670.22.3 (WO Amendment 2600-2005-1) states: “Develop *and implement* management objectives for populations and/or habitat of sensitive

				species" (emphasis added). ▫ One of the responsibilities of Forest Supervisors is to "… Develop quantifiable objectives for managing populations and/or habitat for sensitive species" (FSM 2670.45.2). See response to Overview Comment E for more explanation.
60	13		• In a general discussion of range and status of Columbia spotted frogs, DeLong quotes Keinath and McGee (2005) as to their status, however, their report is about boreal toads (Owings 2014).	Keinath and McGee (2005) was erroneously cited in the report; Patla and Keinath (2005) is the correct citation. Both are Region 1 conservation assessments. This was corrected earlier based on comments from the Sublette County Conservation District. This is the same as Comment 8.
61	13		• DeLong states: "Dumas (1964) reported that relative humidity of 65% at about 80°F is lethal to adult spotted frogs in approximately two hours. Therefore, for those that migrate from their breeding site when humidity is low and/or temperatures are high, survival may depend on migration habitat that retains higher moisture/humidity at ground level and protection from the sun and predators (e.g., herbaceous and shrub cover) or that otherwise provides micro-sites with these qualities." This is possible but cannot be deduced from Dumas (1964). There is no indication whether the temperature/humidity/time tests in the study were conducted in the wild or a lab. The purpose was to examine differences in how species respond to their environment (Owings 2014).	See responses to Overview Comments B.2 (section d.vii) and F.1 (section c).
62	13		• DeLong states "Sedges and other emergent vegetation appears [sic] to be an important component of breeding habitat, and there appears to be a propensity for toads to lay their eggs in the in [sic] or near the marshy parts of wetlands (Keinath and McGee 2005)." The cited document actually states, "within 6m of shore, in marshy areas with emergent sedges or shrubby willows, or even bare substrate" (Owings 2014).	See response to Comment 10 for detailed response. It is also similar to Comment 44 from the Sublette Conservation District.
63	13		• When discussing Forest Plan objectives, he dismisses FSM 2670.32, WO Amendment 2600-2005-1, No. 4, as "not applicable." That Objective reads: "4. Analyze, if impacts cannot be avoided, the significance of potential adverse effects on the population or its habitat within the area of concern and	This is similar to Comment 5 of the Sublette County Conservation District. Policy item number 4 was not deemed applicable because it deals with effects analyses (as part of the NEPA process), and the report focuses on the development of objectives, which occurs before the NEPA process. The preceding sentence in the report set the context: "Forest Plan Objective 3.3(a) is based on Forest Service policy requirements, including those listed below, and meeting

			on the species as a whole. (The line officer, with project approval authority, makes the decision to allow or disallow impact, but the decision must not result in loss of species viability or create significant trends toward federal listing.)” This item is indeed applicable and should be included (Owings 2014).	these are required to meet wildlife requirements of the Multiple-Use Sustained Yield Act” (pg. 2 of report). No changes were made to the report. No specific reasons were identified in the comment as to why the suggested addition was applicable despite the context of the discussion in the report and the purposes of the report.
64	13		• DeLong relies heavily on the report to the Forest Service (Allen-Diaz et al. 2010) and the Rangeland Ecology and Management journal article (Roche 2012) to make his assertions concerning herbaceous vegetation retention, humidity retention, temperature moderation, and suitable shading and sun protection attributes. A simple search of the texts shows that the word “retention” does not appear in either of these studies. The studies were therefore not relevant to his conclusions (Owings 2014).	This is the same as Comment 11. While the word “retention” did not appear in the cited report and paper, retention of herbaceous vegetation is the exact opposite of utilization of herbaceous vegetation, and it is retained vegetation that provides habitat. Effects of utilization of herbaceous vegetation was a key variable in their research; it provided a direct measure of the proportion of herbaceous habitat that remained.
65	14		• DeLong explains the establishment of a 100-foot buffer zone around riparian zones and wetlands by stating, “The recommendation by Goates et al. (2007) to extend the buffer area to something greater than 100 feet for boreal toads was based on addressing the annual habitat needs of boreal toads.” In fact, Goates et al. (2007) did not recommend this. They recommended groundtruthing proposed buffers to see if an extension of the distance was appropriate or beneficial. In some cases it was, in some it was not (Owings 2014).	It is correct that Goates et al. (2007) did not recommend extending buffer zones to something greater than 100 ft., but they did conclude that implementation of a 100 ft. buffer was not sufficient in their study and that 100 ft. buffers in other areas would not necessarily include all habitat used by boreal toads in other places. ERG, in Comment 71 (below) made a similar mistake in identifying a “maximum recommend buffer width of 1.5 miles of capable habitat” from the 01-09-2013 version of the report. The report did not recommend any buffer widths for general use, and the 1.5-mile buffer was around breeding habitat, not around capable habitat. ERG, in Comment 65 (to left) also misinterpreted recommendations of Goates et al. (2007). Their recommendations to ground truth prior to establishing buffers did not have to do with buffer widths or distances, contrary to the last two sentences of the comment; Goates et al. (2007) recommended ground truthing to make sure that all perennial streams and seeps are included in maps prior to the application of buffers. Goates et al. (2007) also did not identify any situations in which a 100 ft. buffer was appropriate. The text in the report was revised to read as follows: “Goates et al. (2007:480) found that ‘The standard method of creating 30.5m [100 ft.] buffers [around all aquatic habitat, not just breeding sites] does not protect all critical habitats for boreal toads… Toads moved up to 100 m into upland areas, more commonly in late July and August.’ Goates et al. (2007:478, 481) also found that ‘…important portions of breeding sites, overland dispersal routes, upland habitats frequented by toads, and small unmapped streams and seeps used for hibernation were still not covered by the

				current [100 ft.] buffer zones at six of the seven sites,' and that '…ground truthing and implementation of a 30.5m buffer will not necessarily include all habitats used.' Their results indicate that buffers larger than 100 ft. are needed for boreal toads. Goates et al. (2007) stressed the importance of ground-truthing to make sure all breeding wetlands, perennial streams, and seeps are taken into account when setting buffers for particular activities since they found that seeps and some perennial streams did not show up on GIS layers."
66	14		The importance of proper citation in scientific research cannot be overstated. The USDA and subsequently the USFS require that information provided to the public is reliable, accurate, and presented clearly. They require "all scientific manuscripts to be reviewed by qualified personnel, including written reviews by at least two peers competent in the subject matter and with demonstrable objectivity." The DeLong Paper does not meet these standards.	One reason for having documents reviewed is to reduce the extent to which citations and references are incorrect. The Sublette County Conservation District provided extensive input on this, and corrections were made to the 09-26-2014 version of the report based on their comments. The report was reviewed internally as well in hopes of catching any remaining mistakes in citations and references. Mistakes made by reviewers (e.g., wrong citation and misinterpretation of a citation in Comment 4, misinterpretation of a citation in Comment 65) in citing scientific papers further demonstrates the propensity for making these types of mistakes. The report is not a scientific manuscript, and the Forest Service does not have any requirements for reports like the "DeLong Paper" to be peer reviewed.
	15		**4. Methods**	
67	15		**4.1 Coarse Filter Analysis**	A coarse-filter *approach* to wildlife conservation was taken in the report (as per USFS 2012), not an *analysis* of coarse-scale or broad-scale habitat variables. See response to Overview Comment D.
68	15		The Cooperators understand and support the concept of using a coarse-filter approach to both simplify analysis and avoid problems associated with seemingly endless single species analyses. DeLong quotes the 2010 Proposed Planning Rule, and states: "The coarse-filter should provide ecological conditions for the long-term persistence of the vast majority of species within the plan area. The fine-filter would identify specific habitat needs of species with known conservation concerns or whose long-term persistence in the plan area is at risk, and for which the coarse-filter protection is insufficient." In his own words, DeLong further explains on page 4, "…the starting point of objective development is the natural11 habitat conditions of the area. Restoring and perpetuating the conditions under which native wildlife-communities developed or formed in an area is the best possible way	Comment noted.

			to ensure that habitat is provided for all species…”	
69	15		Despite the discussion on how coarse filter analyses work, the Paper provides no coarse filter analysis data for the BTNF. The list of mappable data is extensive: • Capable habitat (standing water or low gradient streams) • Designated buffers • Distribution of cover types or size class distribution • Fire history • Information on Historic Range of Variability (HRV) • Discussion of departure from HRV	The parts of the report quoted above (in Comment 68) address a coarse-filter *approach* to wildlife conservation, not a coarse-scale *analysis* of ecological information, results of which may or may not be used in a coarse-filter approach to conserving wildlife. The perceived insufficiency of the analysis of existing conditions, including mapping of existing capable habitat, is addressed in “C.4 Existing Conditions on the BTNF and Analysis of Local Data,” above. Note that the 01-09-2013 version of the report, in the “Mapped Habitat and Adjoining Uplands” section, stated that “A map showing… capable wetland habitat for spotted frogs and boreal toads will be created incorporated into the final report.” Mapping capable habitat, which is substantially more involved than mapping “standing water or low gradient streams,” is in progress. Two of the six parameters identified in the comment (the last two bullets) are not readily mappable.
70	15		The Cooperators asked ERG to conduct the following GIS analysis to identify broad-scale habitats that may have changed dramatically since historic periods as a means of identifying coarse-filter risks to amphibians. ERG designed the coarse filter analysis to specifically address the risks identified in the DeLong Paper. For example, to address concerns that increasing forest cover had potentially reduced streamflows, ERG assessed forest cover by cover type and size class. Coarse filter GIS queries included:	ERG did not provide any basis for only identifying broad-scale habitats that may have changed *dramatically*. There are some changes that can affect amphibians well before changes are dramatic. Note again that coarse-scale data is not the same as a coarse-filter approach to wildlife conservation. In applying these to risks, coarse-scale risks (addressed in the comment) are different than coarse-filter risks. See response to Overview Comment D.
71	15		• Within DeLong’s maximum recommended buffer width of 1.5 miles of capable habitat, defined for this exercise as streams and water bodies <2% gradient, what is the coverage and size class distribution of conifers, aspen, dry shrub, riparian shrub, and grassland (summarized and mapped using GIS-based LANDFIRE data)?	The response to this comment is outlined in the response to Overview Comment B.2 (sections d.i and d.ii). Similarly, no support was provided in limiting vegetation types to those listed.
72	16		• What is the overlap between known amphibian populations and capable habitat (GIS-mapped using the Digital Elevation Model overlaid with WYNDD-provided occupancy data?	This is a valid assessment, except for short-comings of their definition of capable habitat (see response to Overview Comment B.2, section d.iv for a more detailed response).
73	16		• What is the inventoried stream class condition within 1.5 miles of capable habitat (GIS-mapped using BTNF data)?	This can contribute to our understanding of existing conditions of amphibian habitat, so long as the information is understood and so long as model assumptions are recognized. The response to this comment is outlined in the response to Overview Comment B.2 (section d.v).
74	16		• What is the road density within 1.5 miles of capable habitat (GIS-mapped using	The response to this comment is outlined in the response to Overview Comment B.2 (section d.vi).

			BTNF data)?	
75	16		**4.2 Fine Filter Analysis**	Making fine-filter adjustments to a coarse-filter *approach* to wildlife conservation were considered in the report (as per USFS 2012), which is different than an *analysis* of fine-scale habitat variables.
76	16		In DeLong's section titled "Dealing with Limited Definitive Scientific Information" he states that: "[t]his is [a] different approach than starting with the conditions produced by current management and then adjusting these conditions (in objective statements) as definitive scientific studies show that specific, other conditions are needed to meet the needs of the particular wildlife species."	Comment noted. ERG did not suggest any changes to the wording in the quoted material.
77	16		He further states on page 5 that: "[t]he lack of any scientific studies examining the effects of a particular activity at a particular level on a given sensitive species – either directly or through changes in their habitat or prey-base – obviously provides *no evidence* that the activity at the level in question does not adversely affect the species. For example, while there does not appear to be any population data definitively demonstrating that livestock grazing has negatively affected spotted frog or boreal toad populations on the BTNF, no efforts have been undertaken to gather such data on the BTNF. Therefore, the argument that no changes are needed in herbaceous retention levels because no adverse effects of current retention levels have been identified is baseless."	Comment noted. ERG did not suggest any changes to the wording in the quoted material.
78	16		The Cooperators understand that coarse filter data (i.e., distribution of forest cover types at a landscape scale and/or comparison to historic conditions) does not address all the habitat variables that affect toads and frogs that depend on microsites in or near streams. It is therefore understood that there is a need to collect and evaluate data on a finer scale. Since concern over amphibians is somewhat of an emerging issue (compared to, say, wild ungulates) it can be understood that with regard to livestock and amphibian conflicts "no efforts have been undertaken to gather such data on the BTNF," as stated by DeLong. It is remarkable, however, that no list of fine	ERG viewed the terms coarse-filter and fine-filter differently than was used in the report, and this is discussed in some detail in the response to Overview Comment D. Fine-filter adjustments were considered for each of the habitat and survival elements in the report, but this is different than analyzing fine-filter data discussed by ERG.

			scale data needs and results were included in his Paper. For instance, reading through just some of DeLong's cited references, management questions that address the degree of risk to boreal toads include:	
79	16		• Where is capable habitat on the BTNF?	This is addressed in "C.4 Existing Conditions on the BTNF and Analysis of Local Data." A map depicting capable habitat for spotted frogs and boreal toads on the BTNF was added to the revised report.
80	16		• What is the condition of that habitat in terms of stream width, Rosgen channel profile, sinuosity, shrub density, and mix of palatable and non-palatable grasses, sedges, and rushes?	The level of detail addressed in the comment typically is analyzed at the project level on a project-by-project basis. See response to Overview Comments C.4 (section d) and C.5. Risks to stream and riparian conditions on the BTNF were generally described in the 01-09-2013 version of the report (see the "Extent (i.e., width, acreage) of Riparian Moist Meadow, Wet-Meadow, and Willow Vegetation" section, pgs. 26-27, and the "Wetland, Stream, and Riparian Habitat Retention" section, pgs. 32-34).
81	16		• What is the current level of utilization and/or stubble height by allotment within and adjacent to those riparian areas?	Data from measured and estimated actual use measures (e.g., percent utilization, stubble heights) across the BTNF are inconsistently collected from year to year and from allotment to allotment across the BTNF, and it likely is not possible to assess utilization or retention in a meaningful way across the BTNF given the low amount of available information. As discussed in responses to Overview Comments C.3, C.4, and C.5, information on current utilization and retention levels is not needed in the report. Also, because retention levels that would result from maximum allowable utilization levels are lower than suitable conditions in many cases on the BTNF, actual use levels are somewhat immaterial.
82	17		• What is the status of toads within that capable habitat in terms of percent occupancy, population density, and larvae survival?	Data to answer this question has not been collected, is not being collected under the newly established monitoring program, nor are there any plans to collect this data. See "C.4 Existing Conditions on the BTNF and Analysis of Local Data" for additional explanation. This information is not needed in the report given the main purpose of the report (see "C.1 Purposes of the Report" for more explanation).
83	17		No list of data needs is provided in the Paper and alarmingly, no data on those aforementioned items is provided. Rather, the fine filter analysis provided seems to be based on a perception that if grazing related effects on toads have been documented and published from other locales (Missouri, for example) they must exist at comparable levels on the BTNF. The Cooperators cannot argue, based on the data presented, or lack thereof, that there are not livestock-amphibian related problems on the BTNF. It is to be expected, however, that recommended mitigation measures to	Not having a list of data needs is a short-coming of the report. Although the report does not contain a list of data needs, additional monitoring needs, beyond elements already being monitored, were listed under the subheading "Indicators and Additional Monitoring Elements" in each of the 15 habitat and survival elements. This is not synonymous with data needs, however. The second sentence of the comment (regarding fine-filter analysis and effects of livestock grazing) is incorrect from at least two standpoints: • First, reviewers misinterpreted the concept of fine-filter adjustments to a coarse-filter approach to conservation, as used in the report (see response to Overview Comment D).1. Under the coarse-filter/fine-filter

			improve toad habitat would have been preceded by vegetation data showing significant departures between habitat needs and actual conditions, preferably with some toad population data that corroborated that departure.	approach, the needs of specific species are assessed to determine if fine-filter adjustments are needed. No scientific information was found to support an adjustment to coarse-filter conditions for herbaceous vegetation and for factors related to grazing intensity. • The report did not in any way apply research results to characterizing levels-of-effects on the BTNF or to otherwise define or characterize existing conditions on the BTNF (see response to Overview Comment F.1). Expectations of ERG presumably in regard to the 70% herbaceous retention threshold (last sentence) are misdirected for the following reasons: • 70% retention of herbaceous vegetation is not a mitigation measure, nor is it recommended. It is a component of suitable conditions (see response to Overview Comment C.3). • Defining suitable conditions and developing objectives that frame suitable conditions precedes the characterization of existing conditions. • The information needed to make the comparison identified in the last sentence, including a large number and variety of non-herbaceous factors that would need to be taken into account (i.e., factors that may be influencing boreal toad populations), currently is not available for the BTNF and it is likely this information will not be available in the foreseeable future. • See response to Overview Comment E.
	18		**5. Results**	
	18		**5.1 Comparison of Historic to Current Vegetation Data**	
84	18		The Methods section (4.1) within this review describes the importance of comparing current to historic conditions and describes data typically used to make those comparisons. DeLong makes numerous speculations regarding habitat conditions that have changed over time, but does not use any data to support these conclusions. The following are some examples of his deductions:	See "C.4 Existing Conditions on the BTNF and Analysis of Local Data" and "C.5 Identification of Limiting Factors and/or Risk Factors" for discussion of this comment. **Upshot of Comments 85-90, relative to assertion in Comment 84:** More information on existing conditions was provided in the 01-09-2013 version of the report than ERG recognized, and additional information had been added to the 09-26-2014 version of the report. Speculations were not made in the report, and ERG did not identify any instances of speculations being made. Where information is available for the BTNF, reports, published papers, and plans were cited that contain analyzed available data and other information. There was no need to analyze data on existing conditions for this report. The report was not intended to outline a strategy for resolving or mitigating resource problems like those identified in comments 85-90. The main purpose of the report was to define suitable conditions for spotted frogs and boreal toads and the basis for objectives and suitable condition statements, and secondarily to identify risk factors and conservation actions to consider to in correcting problems. Given the known occurrence of some risk factors

				(reservoirs, water developments) and reasonable likelihood of other risk factors due to limited management controls or placement before management controls (e.g., heavy grazing of streambanks in some places, altered hydrology due to roads), and given the potential for them to negatively affect spotted frogs and boreal toads (based on a large volume of scientific information), any shortage of data on the BTNF is no reason to not identify them as risk factors, particularly given the sensitive species status of spotted frogs and boreal toads.
85	18		**Heavy Grazing on Streambanks** – DeLong concludes that "[h]eavy grazing on streambanks causes them to erode at unnaturally high levels because sedges and other streambank plants that are heavily grazed cannot maintain the healthy, robust, and deep roots needed to hold streambanks in place." Numerous authors (Clary and Webster 1989; Hall and Bryant 1995; Thurow 1991) have documented such impacts. However, no data is provided to show if such impacts have occurred on the BTNF, and no disclosures as to the relative magnitude of such impacts are given.	Additional information was added to this subsection based on this comment. Whether altered streambanks due to heavy livestock grazing is a limiting factor in any given area will need to be examined at the project level (e.g., during allotment management planning).
86	18		**Depleted Ground Cover in Uplands** – DeLong concludes that "[d]epleted ground cover (especially when less than about 65%) contributes to elevated rates of overland flow, which can contribute to increased scouring of stream channels lower in the watershed, which in turn can result in lowered water tables." Numerous authors (Holechek et al. 2004; National Research Council 1994; Satturlund and Adams 1992; Thurow 1991; USFS 1997) have documented such impacts. However, no data is provided to show if such impacts have occurred on the BTNF.	Discussion in the revised report was expanded to point out that lower-than-desired ground cover is not uncommon in large portions of the BTNF, as supported by the following citations: USFS (1997), USFS (2001), O'Brien et al. (2003), USFS (2004a), USFS (2004b), USFS (2005), and USFS (2009). There is no need to provide and analyze data in the report since this has been done in other reports, papers, and plans.
87	18		**Road Effects on Water Tables** – DeLong concludes that "[r]oads constructed in riparian areas and even close to riparian areas can also alter hydrology sufficiently to affect water tables in some situations." Numerous authors (Forman et al. 2003; Satturlund and Adams 1992) have documented such impacts. However, no data is provided to show if such impacts have occurred on the BTNF.	It does not appear as though data has been collected to determine if roads have altered hydrology anywhere on the BTNF, but given the high likelihood that hydrology has been altered by some roads on the BTNF (based on scientific information including what is cited in the report) and the potential for this to negatively affect spotted frogs and boreal toads (and given their status), the lack of data on the BTNF is no reason to not identify this as a risk factor. The discussion of this risk factor was expanded in the revised report.
88	18		**Reduced Stream Flow Rates –** DeLong concludes that "[r]educed streamflow rates, including accelerated reductions in mid to late summer, contributed to accelerated	It is not clear whether data has been collected to determine the extent to which stream-flow volumes or timing of flow have been affected by water developments, reservoirs, overrepresentation of late-seral conifer forestland, and/or expansion of conifer forestland into non-forest types. Data

			reductions and larger reductions in water table elevations. Several things contribute to reduced streamflow rates including water developments, upstream reservoirs, overrepresentation of late-seral conifer forestlands, and expansion of conifer forestlands into non-forest vegetation types. Numerous authors (McNabb and Cromack Jr. 1990; Pilliod et al. 2003; Satturlund and Adams 1992) have documented such impacts. However, no data is provided to show if such impacts have occurred on the BTNF or the magnitude of those impacts.	does not need to be collected to determine if water developments have been constructed or if reservoirs have been constructed on the BTNF. Information exists on the existing mix of succession stages compared to natural conditions, and several sources were cited in the report showing there to be an overrepresentation of conifer forestland and expansion of conifer forestland into other vegetation types. As quoted in the comment (along with additional citations added to the revised report), scientific information demonstrates these factors have a high likelihood of contributing to reduced flow rates on the BTNF. For the purposes of identifying risk factors, the magnitude and locations on the BTNF are not important. They present risk factors that need to be addressed at the project level, both in terms of proposals that directly affect them and in terms of cumulative effects. Any shortage of data on the BTNF is no reason to not identify this as a risk factor.
89	18		**Reduced Occurrence and Extent of Beaver Pond Complexes** – DeLong concludes that "[b]oth short-term and long-term effects of beaver pond complexes greatly benefit spotted frogs and boreal toads." However, no Wyoming Game & Fish Department data is provided to show beaver occurrence or trend.	Except possibly in limited situations, the WGFD does not collect data on beaver occurrence and does not collect population or occurrence data that can be used to periodically assess population or occurrence trends. The lack of historic and existing data on the distribution or occurrences of beaver pond complexes on the BTNF does negate the reduced occurrence and extent of beaver pond complexes as a risk factor.
90	18		**Grazing-Induced Headcuts and Down-Cut Trails in Meadows** – DeLong concludes that "[d]eep, non-stream channels running the length of some meadows, typically resulting from head-cuts caused by years of heavy or severe grazing or from entrenched recreation and livestock trails, act similarly to agricultural drain ditches that are constructed in areas that would otherwise be too wet to grow agricultural crops." No scientific references or data is provided to show if such impacts have occurred on the BTNF or the magnitude of those impacts.	One example of a series of headcuts was cited in the report, and headcuts exist in many other places on the BTNF. Down-cut trails in meadows are also not uncommon on the BTNF. However, it is not clear whether data has been collected on headcuts and down-cut trails on the BTNF. The occurrence of headcuts and down-cut trails on the BTNF, combined with the potential to contribute to diminished quality of spotted frog and boreal toad habitat, shows this to be a risk on the BTNF, particularly given the status of these species.
	19		**5.2 Lack of Coarse Filter Data**	
91	19		The aforementioned risks to amphibians were all documented by research conducted in locations with environmental features much different than the BTNF. Whether or not any or all of these risks apply to the BTNF has not been determined in the DeLong Paper by any coarse filter data analysis. Nonetheless, the Cooperators agree that a coarse filter analysis is valuable and should be evaluated at the forest scale.	This assertion has been made many times in the Review Document and no new information is provided in this comment. It is addressed in responses to Overview Comments B.2, C.4, C.5, D.1, and E.
	19		**5.3 ERG's Coarse Filter GIS Analysis**	
92	19		The Cooperators asked ERG to conduct the following GIS analysis to identify broad-scale	This worded the same as Comment 70 (see response to Comment 70).

			habitats that may have changed dramatically since historic periods as a means of identifying coarse filter risks to amphibians. ERG designed the coarse filter analysis to specifically address risks identified in the DeLong Paper. For instance, to address concerns that increasing forest cover has potentially reduced streamflows, ERG assessed forest cover by cover type and size class. Coarse filter GIS queries included:	
93	19		• Within 1.5 miles of capable habitat, defined for this exercise as streams and water bodies <2% gradient, what is the coverage, size class, and spatial distribution of conifers, aspen, dry shrubs, riparian shrubs, open water, barren ground, and grasslands?	The response to this comment is outlined in the response to Overview Comment B.2 (sections d.i and d.ii).
94	19		• Of the aforementioned cover types, what is the distribution of shade-producing versus open cover types?	The response to this comment is outlined in the response to Overview Comment B.2 (section d.iii). See also response to Comment 19.
95	19		• What is the overlap between inventoried amphibian populations and capable habitat?	The response to this comment is outlined in the response to Overview Comment B.2 (section d.iv).
96	19		• What is the inventoried stream class condition within 1.5 miles of capable habitat?	The response to this comment is outlined in the response to Overview Comment B.2 (section d.v).
97	19		• What is the road density within 1.5 miles of capable habitat?	The response to this comment is outlined in the response to Overview Comment B.2 (section d.vi).
98	19		• What is the distribution of different elevation zones within the BTNF?	The response to this comment is outlined in the response to Overview Comment B.2 (section d.vii).
99	20		**5.3.1 Distribution and size class of conifers, aspen, dry shrubs, riparian shrubs, barren, open water, and grassland/sedge within 1.5 miles of capable habitat.**	See Response to Comment 71.
100	20		Table [sic] 1 – Distribution and size class and open habitats.	Presenting graphed information like this can provide useful information.
101	20		Table 1 summarizes the distribution of cover types that provide shade (conifers, aspen, dry shrubs, and riparian shrubs) and open grassland/sedges that do not provide shade if heavily grazed. Note that 60.3% of the area is shaded by conifers, aspen, or shrubs. Only 39.7% of the area is within grasslands or sedge communities where sunlight would reach the ground. These findings provide insight into whether available shade (for thermoregulation on hot days) or sunlight (for absorbing heat on cool days) might be most limiting to adult boreal toads or migrating spotted frogs. The findings also	The response to this comment is outlined in the response to Overview Comment B.2 (section d.iii). At a finer scale, it is entirely possible for some or many riparian corridors occupied by either species to not have any "shaded cover types" or to have them concentrated in particular areas with an absence in other areas.

			provide insight as to whether wildfires and logging or continued fire suppression creates the greatest risk to amphibians in terms of sustaining stream flows.	
102	20-21		Table 2 shows the distribution of conifer size classes and provides insight into the magnitude of recent disturbances from wildfires, insect outbreaks, and logging, or the lack thereof. Advanced age conifers could both predispose the forest to severe wildfires and/or insect outbreaks, and limit the availability of surface water from excessive conifer transpiration. Conifer coverage and size class distribution also allows us to assess the relative abundance of coarse, woody debris (likely at higher than historic levels), which, as discussed in the DeLong Paper, is an important habitat component for adult toads.	Results of this analysis as it applies to evapotranspiration are consistent with findings in the report. Nothing in this comment conflicts with information in the report. See also response to Overview Comment B.2 (sections d.i and d.ii).
103	21		Table 2 – Distribution of forest-wide conifer size classes based upon LANDFIRE (ver. 120).	This information does not conflict with information cited in the report. See also response to Overview Comment B.2 (sections d.i and d.ii).
104	21		Note the disproportionate amount of mature forest and nearly total lack of seedling-sapling forest, suggesting that the forest is at risk of higher-than-normal severity wildfire and insect attacks, and that surface water may be less available due to transpiration.	This information does not conflict with information cited in the report. Additional information was added to the revised report on the subject of the overrepresentation of late-seral forestland contributing to a higher risk of higher-than-normal severity wildfire and insect epidemics.
105	21		No discussion of HRV is provided in the DeLong Paper. Other published findings for interior lodgepole pine-dominated forests suggest that nearly half of lodgepole pine forests would have been in un-stocked or seedling-sapling size classes during historic periods (Losensky 1995). This suggests that DeLong's concern that streamflows may be impacted by excessive late seral age classes (and exacerbated by global warming) is likely correct. Given that careful logging could rectify the age class disparity, DeLong's concerns over logging-related effects in his Paper have no basis in the coarse filter findings. DeLong is fixing a problem that has not been demonstrated to exist.	Base conditions for the coarse-filter approach are analogous with historic (or natura) range of variability (Aplet and Keeton 1999, Haufler 1999b). Additional discussion was added to clarify this. As noted, the first half of the comment is consistent with the report (e.g., mix of succession stages, stream flow). Regarding the comment about careful logging providing a means to rectify the age-class disparity," the report shows that logging operations can be designed and carried out to help remedy age-class disparity, but the report also qualifies this by showing that mitigation measures must be built into logging operations. One of ERG's authors is well versed in the need to incorporate mitigation measures into logging to make it beneficial for elk (e.g., Hillis et al. 1991). Incorporating these mitigation measures into logging operations is what makes them "careful." Hillis et al. (1991:38) stated that "We define security area requirements for land managers so that timber harvest decisions can reflect elk security needs." Regarding the last sentence, two of the major risks of logging with respect to boreal toads are the removal of too much large woody material and the crushing of toads by heavy equipment, regardless of existing conditions on site and across the landscape. These risks are well documented

				in the scientific literature, including in a study on the adjoining Caribou-Targhee National Forest. Other problems with logging exist and need to be taken into account on a site-by-site basis. If logging is designed to adequately remedy the two risks identified above (and other risks), then logging would be deemed to be "careful logging" from the standpoint of boreal toads.
106	21		**5.3.2 Overlap between inventoried amphibian populations and capable habitat.**	
107	21		Figure 2 shows the overlap between inventoried amphibian populations and identified capable habitat based on stream gradient (>[sic]2%). Note the strong correlation between low gradient streams and known boreal toad populations. This suggests that the GIS query for identifying vegetation within the 1.5 mile zone adequately represents actual amphibian habitat.	This is addressed in the response to Overview Comment B.2 (section d.iv).
108	21-22		The DeLong Paper provides no maps showing capable habitat or any estimate of acres within the buffer zones described in the report. Understanding where and at what magnitude capable habitat occurs is critical for identifying the overlap with potentially conflicting activities and assessing whether or not those activities constitute a significant threat to toads and frogs. ERG identified capable habitat using Digital Elevation Models (DEMs) based on the presence of standing water and stream gradients less than 2%. Note in Figure 2 that toad and frog presence correlate well with identified capable habitat, suggesting that the query reasonably identifies capable habitat.	The lack of maps showing capable habitat in the report is being remedied. A map showing various aspects of capable habitat is being developed (see "C.4 Existing Conditions on the BTNF and Analysis of Local Data"). Assessing potential conflicts with activities can be done to some degree using GIS, but (1) there are many parameters that cannot be fully evaluated at this broad scale, especially given available information; (2) this level of analysis is not needed given the purposes of the report; and (3) this level of analysis will be done at the project level, project-by-project. See Responses to Comments 21 and 71 for the response to the perceived correlation between frog/toad occurrences and their modeled capable habitat.
	24		**5.3.3 Road Density**	
109	24		Table 3 – Road density for potential frog/toad habitat	Road density is not so much the issue as it is the presence of roads in crucial habitat and roads bisecting movement corridors.
110	24		Table 3 shows roads within 1.5 miles of capable habitat. Road density is summarized by miles per square mile. Note that the largest category of forest acreage falls within the zero road density class. Only 26% of the forest has road densities exceeding 1.5 miles per square mile. While short segments of roads may indeed impact toads on the BTNF, further fine scale data is needed to address whether or not the issue of roads is significant enough to be worthy of protective	This is addressed in the response to Overview Comment B.2 (section d.vi).

			measures as described in the DeLong Paper in his various discussions of "Pertinent Activities and Facilities."	
	25		**5.3.4 Elevation on the BTNF**	
111	25		The DeLong Paper emphasizes the risk that toads face from dessication due to a lack of shade during hot weather. Zack Walker, non-game biologist for the Wyoming Game and Fish Department, suggested during the September 5, 2014, field trip that toads seek shade as temperatures near 80 degrees. Table 4 shows the distribution of elevation zones on the BTNF. Note that the majority of the forest is above 8,000 feet. While temperatures above 80 degrees no doubt occur on the BTNF, the frequency and duration of such high temperatures may be infrequent and of relatively short duration. National Weather Service data may provide some useful data in determining the relative degree that temperatures place toads or frogs at risk. No such data was provided in the DeLong Paper.	This issue has been outlined in two other comments (see responses to Comments 9 and 61), and it is addressed in more detail in responses to Overview Comments B.2 (section d.vii) and F.1 (section c)). The first sentence incorrectly identifies shade in hot weather as the singular factor affecting desiccation. The report identifies and addresses other factors, and is supported by scientific information.
	25		**5.3.5 Forest-wide Stream Condition Class with Identified Capable Habitat**	
112	25		Since stream condition class ratings are made somewhat qualitatively (Cottle, 2014) stream condition class ratings of "good" may not necessarily equate with good toad or frog habitat. Nonetheless, note in Figure 3 that the majority of streams on the BTNF are in good condition.	This is addressed in the response to Overview Comment B.2 (section d.v).
113	27		Discussions with Forest range personnel (Cottle, pers. comm.) suggest that stream condition class designations are assigned qualitatively rather than quantitatively. Thus, condition class may not adequately address the multiple in-stream threats that DeLong identifies, including down-cutting, channel widening, and loss of shrubs. To supplement condition class, the following satellite image provides additional information.	This is addressed in the response to Overview Comment B.2 (section d.v).
114	27		Figure 4 is within the Upper Horse Creek-Green River drainage (HUC6) which is assigned a condition class of Fair (score=1.7). The segment has a very low stream gradient (<2%) where slack water occurs within pools, beaver ponds, and oxbow lakes. The areas is within habitat occupied by boreal toads.	Comment noted. This examination is at a level that is too fine for the purposes of the report (see C.1 and C.4).
115	27-28		Note the high level of stream sinuosity including old channels and oxbow lakes in Figure 4. Note also the extremely wide	Comment noted. This examination is at a level that is too fine for the purposes of the report (see C.1 and C.4). Regarding assessment about the potential effects of

			floodplain that is fully occupied by dense riparian shrubs. While domestic livestock may utilize riparian shrubs and understory grasses and sedges from within the floodplain, there is no tangible evidence from this photo that livestock or wild ungulate grazing has measurably impacted shrub coverage or resulted in down-cutting, channel flattening or a loss in sinuosity. In terms of boreal toad habitat, including standing water, shade, and adjacent moist microsites, it is hard to visualize how toads could suffer high temperature-related stress even if the wet, sedge-dominated meadows were heavily grazed.	livestock grazing, While it is possible to ascertain long-term effects of livestock grazing from aerial photographs, not all long-term effects are discernable. Therefore, the conclusion made in the comment (i.e., no tangible evidence that grazing has measurably impacted stream attributes) is not supportable. Also, effects of livestock grazing on stream channel integrity is only one way that livestock grazing affects amphibians in riparian corridors. Regarding the last statement, see response to Overview Comment B.1.
116	28		**5.3.6 Identification of Habitats with Substantial Departure from Historic Conditions**	
117	28		The DeLong Paper contains no coarse filter data, only speculation that habitat may have been degraded dramatically from grazing, fire suppression, and road construction. DeLong bases his findings solely on research from other locales. He concludes that habitats may be at risk from wildfires, logging, and offroad vehicles, but again bases his hypotheses on research from other environments.	This assessment was identified in many previous comments. See response to Overview Comment D and response to Comments 42, 69, 91, 105. Concerns about using research from other areas was brought up in many comments (Comments 4, 17, 31, 44, 47a, 47b, 52, 55, 56, 61, and 91) and was addressed in responses to many of these comments and in response to Overview Comment F.
118	28		The ERG analysis suggests that DeLong was correct in inferring that fire suppression has resulted in older-than-normal forests, increased transpiration rates, and subsequent reduced water availability. Because older-than-normal forests are at increased risk from insect outbreaks and higher-than-normal severity wildfires, DeLong was also correct in inferring that severe wildfires could also place amphibians at increased risk. Prescribed burning, wildland fires for beneficial use, and logging, however, are tools to resolve those problems. Therefore, the long list of prescriptive measures DeLong recommends, which limit timber harvest and fuels management practices, are again fixes to problems that have not been demonstrated to exist. For example, DeLong concludes on page 60 that "[p]ossibly the largest impact to boreal toads and possibly spotted frogs resulting from changed habitat conditions after timber harvest is the reduction in large woody material." This assertion is again	Comment noted, for the first half of the comment. Contrary to the middle portion of the comment, "Prescribed burning, wildland fires for beneficial use, and logging" are specifically identified as "tools to resolve those problems" (with quoted material coming from the comment). The risks identified in the report, for which conservation actions were included to mitigate them, only take place when implementation of prescribed burning, wildland fires for beneficial use, and logging are carried out without mitigating potential negative effects. This is no different than prescribed burning and logging — which many times benefit elk but that can also negatively affect them — being designed to minimize negative effects to these species. As an illustration, Hillis et al. (1991) would not have been published if logging could not be done in a way that negatively impacts elk. Negative impacts were recognized throughout their paper, including the first sentence of the paper: "Timber harvest affects elk vulnerability by changing the structure, size, juxtaposition and accessibility of security areas;" and later in the paper: "This indicates that timber harvest decisions made over the next few years will potentially severely impact remaining security and, ultimately, hunter opportunity" (Hillis et al. 1991:38 and 42, respectively). They characterized existing and potential timber-harvest trends on some locations as

			based on research recommendations from other locales. The distribution of conifer size classes both forest-wide and within 1.5 miles of capable habitat, however, suggests that coarse, woody debris likely occurs at higher than historic levels (see Table 2). It is therefore not clear how this finding is pertinent to the BTNF.	"disturbing." Hillis et al. (1991:38) explained that "We define security area requirements for land managers so that timber harvest decisions can reflect elk security needs." Negative impacts of removing too much large woody material is well founded in the scientific literature (including a study in the adjoining Caribout-Targhee National Forest) and designing mitigation measures into timber sales (e.g., maintaining a minimum amount of large woody material) is common practice. Reviewers felt that conditions in western Canada were sufficiently similar to the BTNF to consider research findings from there. Surely the study from the adjoining Caribou-Targhee National Forest (Bartelt et al. 2004) is close enough!
119	28		DeLong acknowledges that "[g]razing by unnaturally high population levels and unnatural concentrations of elk likely has altered herbaceous species composition, including a reduction in ground cover, in some parts of the BTNF…" but then concludes that those populations "likely have no more than minor effects on water quality." DeLong does not address how those "unnaturally high populations" of elk might impact shade availability within grass/sedge communities, despite that issue being the focus of his entire Paper. Further analysis is needed on this topic to provide a fair, biologically defensible document.	These topics (effects of native ungulate concentrations on water quality and "shade") were expanded upon in the revised report. Concentrated grazing use by native ungulates, high enough to potentially impact water quality and shade, is much more limited on the BTNF than occurs with livestock grazing. Concentrations at elk feedgrounds likely impact water quality, but it likely has little effect on shade except before herbaceous vegetation begins to grow (elk likely contribute to compressing herbaceous vegetation). As was pointed out earlier, the focus of the paper was not on the effects of grazing on shade.
120	28		**5.4 Fine Filter Analysis**	Again, the coarse-filter / fine-filter approach to conserving wildlife is not synonymous with coarse-filter data and fine-filter data.
121	28		Many of the threats identified by DeLong are not detectable by coarse filter data (i.e., grazing utilization or beaver occurrence) and therefore warrant additional fine filter analyses. Local climate conditions can create limiting factors that vary dramatically between different locales. Disturbance regimes must also be analyzed and considered when characterizing limiting factors.	Yes, many of the risks identified in the report would not be detectable in a coarse-scale analyses. See response to Overview Comments C.4 and F.2 for additional discussion. Disturbance was discussed in the response to Comment 42 as well.
122	28		Several excellent research papers, based on studies conducted in the northern and central Rockies, are available. These were all cited by DeLong but with questionable results, as discussed in Section 3 of this review (Keinath and McGee 2005; Maxell 2000; Pilliod et al. 2002).	Concerns about Maxell (2000), Pilliod et al. (2002), and Keinath and McGee (2005) were addressed in responses to Comments 4, 8, 10, 23-30, 44, 46, 56, 60, and 62.
	29		**6. Conclusions**	
	29		**6.1 Status of Boreal Toads and Spotted Frogs on the BTNF**	
123	29		The Cooperators recognize the declining	Comment noted. Regarding the comment that no data on current status

			range-wide status of boreal toads and spotted frogs. ERG found no data, however, showing the current status (distribution, density, recruitment rates, etc.) of toads and frogs on the BTNF. The Cooperators generally do not object to measures that protect local populations, once they have been demonstrated to be at risk. The DeLong Paper's findings, which conclude that based on declining range-wide populations further protective measures are needed, are lacking local data showing local populations to be at risk. Please note that the ERG designation of capable habitat (low gradient streams and lakes) overlaid with inventoried populations (WYNDD data) suggests that a substantial amount of capable habitat is occupied (Figure 2). Of course that does not indicate anything about population density, recruitment rates, or trend, but neither does it suggest that populations are at risk. Given that toad and frog populations are relatively easy and inexpensive to inventory, compared to say, fisher or wolverine populations, the Cooperators contend that the DeLong Paper should have been written after a forest-wide inventory of toad and frog populations, density, recruitment, and trends.	(distribution, density, recruitment rates, etc.) of toads and frogs was not found, there is no known data on densities, recruitment rates, or population levels and trends on the BTNF, nor will this information become available in the foreseeable future. The new monitoring program for the BTNF will not provide population trend data, as explained in the report. Data and other information on distributions of spotted frogs and boreal toads is available and was presented in Figures 3-6 of the 09-26-2014 version of the report (Figures 3 and 5 were presented in the 01-09-2013 version of the report). See response to Overview Comment E for the comments about Cooperators not objecting to protective measures once populations have been demonstrated to be at risk, and associated comments. Regarding ERG's assessment that their modeled capable habitat overlaid with known occurrences of spotted frogs and boreal toads "suggests that a substantial amount of capable habitat is occupied" is in error. First, only a small proportion of their modeled capable habitat is overlaid by known occurrences in Figure 2. Second, Figure 2 encompasses only a small portion of the BTNF and this area has a larger number of occurrences than some other areas (e.g., higher elevation areas). Regarding the comment that "the DeLong Paper should have been written after a forest-wide inventory of toad and frog populations, density, recruitment, and trends," (1) there are no plans for a BTNF-wide inventory of these parameters, recognizing that WNDD, WGFD, and USFS completed additional inventories of breeding sites during 2012-2014; and (2) this information is not needed given the purposes of the report (see Overview Comments C.1 and C.4).
124	29		**6.2 Limiting Factors to Boreal Toads and Spotted Frogs on the BTNF**	Again, the report identified risk factors, not limiting factors (see more explanation of this in Overview Comment C.5).
125	29		The coarse filter analysis completed by ERG does not identify any obvious immediate threats to toads or frogs. Shade-dominant cover types within riparian buffers appear to be substantial. The higher-than historically normal conifer size class suggests that surface water availability is becoming increasingly compromised from transpiration by excessive large conifers. That size class distribution, presumably due to long-term fire suppression, also likely contributes to a downward trend in aspen vigor and coverage. The current conifer size class distribution predisposes the BTNF to higher-than-normal severity wildfires, all of which create long-term risks to amphibian habitat.	That the ERG analysis "does not identify any obvious immediate threats to toads or frogs" has little meaning. They relied on an analysis of a small number of coarse-scale habitat variables and, in their own words, "Many of the threats identified by DeLong are not detectable by coarse filter data…" (pg. 28). They also stated that "The Cooperators cannot argue, based on the data presented, or lack thereof, that there are not livestock-amphibian related problems on the BTNF" (pg. 17). ERG addressed a very small proportion and narrow range of a large number and wide range of risk factors. This is discussed further in the response to Overview Comment E. They placed considerable emphasis on the extent to which shade is available to frogs and toads, yet this is relatively minor factor and is only one of a large number and variety of factors (see response to Overview Comment B.1). The mix of succession stages (which is addressed for more than half of this comment) is an important factor and ERG recognizes it is in an altered condition.
126	29		None of ERG's coarse filter data conclude	As stated (ERG's analysis did not show that livestock

			that there are not grazing related effects on toads or frogs at the fine scale. To make that determination, substantial fine-scale, on-the-ground data is needed.	grazing was not having any effects), the first sentence does not conflict with the report. Examining these effects, for the purposes of the report, does not require "substantial fine-scale, on-the-ground data," as explained in responses to Overview Comments C.1, C.4, and C.5.
	29		**6.3 Fine Scale Data Needed to Determine Grazing-Related Conflicts**	
	29		**6.3.1 Local Weather Data**	
127	29		The fact that toads and frogs lack waterproof skin and are cold-blooded makes understanding local weather essential to identifying limiting factors (Maxell 2000). Therefore, the BTNF needs to review National Weather Service data to determine at what elevation and aspect temperatures occur, in both frequency and duration, which result in stress on toads and frogs. The Cooperators suspect that whereas 80-degree days do occur at 9,000 feet, they may be fairly infrequent and the duration may be relatively short. Collecting and evaluating such data would add some needed credibility to the conservation strategy. Doing so would also allow the BTNF to qualify how important shade is relative to other risks such as increased conifer size class that reduce surface water availability and thus make decisions that have the least negative effect on toads and frogs.	This comment addresses parts of Comments 4, 9, and 111. See responses to these comments. Regarding the last half of the comment, in which ERG stated that collecting and evaluating data on weather data relative to different elevations on the BTNF would add credibility to the conservation strategy: (1) the report is not a conservation strategy; (2) the need for shade is only one small component of suitable herbaceous conditions, as explained in the response to Overview Comment B.1; (3) elevation information and weather data was added to the revised report to address issues identified in this comment; and (4) the suitable condition component of 70% retention of herbaceous vegetation is consistent with the needs of native wildlife-communities as a whole and the needs of a large number of wildlife species dependent on herbaceous vegetation (DeLong 2009).
	30		**6.3.2 Data on Mix of Cover Types within Riparian Buffers**	
128			The Cooperators do not discount the value of shade within riparian grass/sedge meadows to toads or frogs. In terms of foraging habitat, escape habitat, or thermoregulation, the availability of other shade dominant cover types (riparian shrubs, etc.) must be considered when determining whether or not a given level of grazing utilization is detrimental or even pertinent to amphibians. Such data must be specific to individual grazing pastures so that if or when risks to amphibians are identified in a specific pasture, any management measures are specific to the identified problem, and not arbitrarily placed across the landscape.	The reason for ERG's focus on shade is unclear and they do not provide scientific information supporting this focus (see response Overview Comment B.1). The 01-09-2013 version and subsequent versions of the report show there to be more critical issues. Yes, as far as shade, humidity retention, and hiding and escape cover go, the availability of non-herbaceous vegetation should be considered where willow communities dominate wetland complexes and riparian zones. It also needs to be recognized that, beyond affecting shade, humidity, and hiding and escape cover, the level of livestock grazing use affects insect habitat, water quality, trampling rates, and the rate at which water level reductions in small pools is accelerated. Youngblood et al. (1985:71), for example, documented that annual production of herbaceous vegetation in willow communities in an area covering the western two-thirds of the BTNF can range from 250 pounds/acre to as much as 6,000 pounds/acre, depending on willow vegetation type, soils, hydrology, herbaceous understory, and other factors. Averages for the seven willow community types shown in Appendix C

				ranged from approximately 1,000 pounds/acre to about 2,100 pounds/acre. As such, Figures A.16(a-d) show the potential for trampling is still high in some willow communities relative to the potential in herbaceous communities. Also, the 80% threshold in the suitable condition statement for herbaceous retention takes willow communities into account (see revised report). Consideration of willow communities in addressing suitable conditions for herbaceous vegetation is addressed further in the revised report. The appropriate level of planning for examinations of data "specific to individual grazing pastures is allotment management planning.
	30		**6.3.3 Data on Spatial Arrangement of Cover Types within Riparian Buffers**	
129	30		Since adult toads are relatively mobile (Maxell 2000), it is logical to assume that they can and will move to shaded cover types to thermoregulate on hot days as the need arises. The Cooperators understand that if toads were forced to move large distances, say, within very a large heavily-grazed meadow on a very hot day, that movement itself could be lethal. Conversely, when such meadows are interspersed by shade-dominant cover types such as the one observed during the previously mentioned September 5th field trip, it has to be assumed that the risk to toads of dessication are minimal in riparian systems that contain a diverse mosaic of riparian shrubs and open water. Consequently, the Cooperators contend that any management measures should be flexible and based on site-specific situations. While all-purpose management recommendations such as are currently recommended in the DeLong Paper may be easier to administer for the BTNF, they are neither biologically defensible nor consistent with meeting other multiple economic and resource objectives.	Regarding the first sentence, shade needs to exist in close proximity to other habitat elements in order for the habitat to be suitable for boreal toads. Distances are on the order of feet to lows 10s of feet, not 100s of yards or more, based on the extent of movement within any given day, not including during migrations and emigrations. As examples, Bartelt et al. (2004) found daily distances moved by radio-tagged boreal toads in eastern Idaho to be about 42.8 ± 8.5 yards (males) and 42.4 ± 5.8 yards, and Schmetterling and Young (2008) found that radio-tagged boreal toads moved an average of about 105 yards during a period of 1-10 days. This means that a sufficient number and quality of shade sites, basking sites, foraging areas, and roosting sites need to be located within about 50 yards of where they exist at any given time. The second sentence of the comment recognizes this. However, the site visited on 09-15-2014 was dominated by willow communities; it was not an herbaceous meadow "interspersed by shade-dominant cover types." (See response to Overview Comment B.2, sect. d.iii). It is likely correct that "the risk to toads of dessication [sic] are minimal in riparian systems that contain a diverse mosaic of riparian shrubs and open water," primarily since water was well distributed on the site <u>and</u> the water table was high meaning that soil surfaces were wet in many places. However, to provide for all the habitat needs and to protect toads to some degree from trampling, reduced water quality, and accelerated in water-level declines (expanding the example more broadly), the combination of herbaceous and woody vegetation would need to be sufficient to meet their habitat needs and livestock grazing intensity would need to be low enough to not impact survival (as impacted by crushing), water quality, and natural water-level declines. This is discussed in more detail in the revised report. Conservation actions listed in the 01-09-2013 version of the report and subsequent revised versions are not required; they are listed as actions to consider on a case-by-case basis. It must be recognized that ease of administration is

				an important consideration given the small scope of monitoring that can realistically be maintained over time. The report documents that the listed conservation actions and the suitable conditions they support are biologically defensible. ERG did not demonstrate they are not biologically defensible. An important point — in this case specifically on the subject of livestock grazing — is that it was hard enough demonstrating that 70% retention of herbaceous vegetation is biologically defensible, much less 60% retention. Little scientific information exists to demonstrate that 60% retention of herbaceous vegetation is biologically defensible. See responses to Overview Comments A.1, A.3, and E.2 for additional discussion. Regarding the statement that the "Cooperators contend that any management measures should be flexible and based on site-specific situations," they should realize that suitable conditions defined by one of the ERG reviewers (Mike Hillis) are not applied with flexibility based on site-specific conditions (see response to Overview Comment C.3 for more discussion of this).
	30		**6.3.4 Data on Domestic Versus Wild Utilization**	
130	30		The DeLong Paper largely ignores the potential effect of higher-than-historically normal elk populations (due to artificial winter feeding programs). While the BTNF has no authority on the management of elk populations, the BTNF does have an obligation to disclose with hard data all biological factors responsible for the current condition of vegetation related to toad and frog viability. The Cooperators expect the BTNF to provide utilization data that segregates domestic livestock use from wild ungulate use.	Additional discussion had been added to the 09-26-2014 version of the report, and additional discussion was added to the revised report. Segregating utilization data from wild ungulate use is not needed in the report (see Overview Comments C.1, C.3, C.4, and C.5), nor is this information available. Actual use data is only sporadically collected on livestock allotments across the BTNF and it is not collected in relation to elk feedgrounds.
	30		**6.3.5 Data on Current Grazing Systems**	
131	30		In the last half century, grazing systems have evolved from season-long systems to a mix of primarily deferred and rest-rotation systems. Most grazing-related utilization within moist grass/sedge meadows occurs during late summer use. Thus, utilization that may reduce shade within those meadows is likely a one in three or four-year occurrence. The Cooperators expect the BTNF to disclose and reassess that factor while reevaluating whether and the degree to which grazing conflicts with toads and frogs.	Some allotments on the BTNF remain as season-long grazing systems. Note, however, the Forage Utilization Standard that states that "Season-long grazing only exists on a few allotments and will be changed to rotational grazing as Allotment Management Plans (AMPs) are revised." That utilization occurs only once every three or four years at a given time during the summer on any given pasture was identified as a conservation action in the 01-09-2013 version of the report (see pgs. 113 and 114). The pertinent level of planning to address this conservation action is during allotment management planning.
	31		**6.3.6 Data on Dynamics of Disturbance Associated with Burrowing Rodents**	

132	31		The DeLong Paper discusses in detail the need for toads to have access to rodent burrows. No information was provided on the species of ground squirrels or their responses to disturbance. Management considerations seem to focus on measures used to control ground squirrels. Uinta, Wyoming, and Columbian ground squirrels all appear to do best in heavily disturbed areas, including heavily grazed, logged or recently burned areas. Consequently, it seems likely that DeLong's recommended measures to reduce grass utilization could decrease the density of ground squirrel colonies and subsequently reduce the density of burrows. The BTNF should further explore this relationship before any decisions are made regarding measures to increase shade and burrow habitat for toads.	Additional information was added on the ecology of burrowing rodents (not just ground squirrels!) and responses to vegetation and soil disturbance. The comment erroneously states that management considerations focus on measures to control ground squirrels. No control measures were identified in the report. A few factors that need to be considered on this subject are as follows. If it were determined, based on available information and possibly additional data collected on the BTNF, that the density of small mammal burrows would be too low where ≥70% of herbaceous vegetation is retained on ≥80% of meadow habitat, several things would need to be considered prior to adjusting the suitable condition statement to allow for more livestock grazing, including (1) what scientific information demonstrates a need to shift further from natural meadow conditions; (2) would burrow density increase with lower herbaceous retention levels; (3) would the increase in burrow density outweigh reductions in herbaceous cover and insect habitat, increases in the potential for metamorphs and adults to be crushed by livestock, increased potential for burrows to cave-in due to trampling, and reductions in water quality; and (4) if there is a net benefit to boreal toads (which there would not appear to be), does this net benefit outweigh the needs of other wildlife species that depend on or use meadow habitat?
	32		**7. Implication for Managers**	
	32		**7.1 Quality of Information**	
133	32		The U.S. Department of Agriculture (USDA), through its Office of the Chief Information Officer, strives to ensure and maximize the quality, objectivity, utility, and integrity of the information that its agencies and offices disseminate to the public. Toward this end, USDA agencies and offices have adopted basic standards of quality which include the features listed above, and they are charged with upholding and maintaining these standards throughout the development of information, including its creation, collection, maintenance, and dissemination.	Comment noted.
134	32		Objectivity is key to disseminating information that is substantively accurate, reliable, unbiased and presented in an accurate, clear, complete, and unbiased manner. Utility is assessed as to the usefulness of information to its intended users, including the public (USDA and Office of the Chief Information Officer 2014).	Efforts were made to compile information for the report and to write the report to provide substantively accurate information that is reliable, unbiased, and presented in an accurate, clear, complete, and unbiased manner. Adjustments were made and additional information added, based on ERG's comments (and other comments received on the 01-09-2013 version of the report), to better meet the identified criteria where they may not have fully been met.
135	32		The Office of Management and Budget issued a Final Information Quality Bulletin for Peer Review in 2004, the purpose of which is to "enhance the quality and credibility of the	Recognizing there is more to the issue than what is quoted in the comment, the report meets the quoted criteria for scientific assessments.

			government's scientific information." This bulletin outlines minimum requirements for scientific assessments, defined as: "…a body of scientific or technical knowledge that typically synthesizes multiple factual inputs, data, models, assumptions, and/or applies best professional judgment to bridge uncertainties in the available information."	
136	32		Minimum requirements for scientific assessments include: • Peer Review – Expertise, Balance, Independence • Conflict of Interest • Public Participation	Comment noted. The report was reviewed by three scientists and amphibian experts (see "Review by Amphibian Experts / Scientists," previously in this appendix), as well as by Forest Service employees and the Sublette Conservation District (see "Review by Forest Service" and "Review by Others," previously in this appendix). OMB (2004:2) explained that "We recognize that different types of peer review are appropriate for different types of information. Under this Bulletin, agencies are granted broad discretion to weigh the benefits and costs of using a particular peer review mechanism for a specific information product. The selection of an appropriate peer review mechanism for scientific information is left to the agency's discretion." "Public participation," in the context of ERG's comment, is limited to review and comment of scientific documents, not participation in the development of scientific documents (OMB 2004:21).
137	32		"Uncertainty is inherent in science, and in many cases individual studies do not produce conclusive evidence. Thus, when an agency generates a scientific assessment, it is presenting its scientific judgment about the accumulated evidence rather than scientific fact (Powell 1999)."	The quoted sentences were not found in the cited book. However, it was found on page 825 of Funk et al. (2008). It appears that the quoted material was in a draft of Powell et al., but did not show up in the final version. If ERG had cited the quoted material as Powell (1999), as cited by Funk et al. (2008), this would have help expedite the process of finding the quoted material. The 01-09-2013 version of the report addressed the first sentence of material quoted from Powell (1999); see the "Dealing with Limited Definitive Scientific Information" section, which had been expanded in the 09-26-2014 version of the report. It is also agreed that there are no absolute "facts" when dealing with science. ERG was not clear about their reason for their comment. References to Powell (1999) were added to the report. It appears as though ERG included this quote to support their contention that the 70% herbaceous retention threshold is questionable and not biologically defensible. However, it needs to be remembered that, if scientific information supporting 70% retention is too uncertain, this means that consideration will need to then be given to 80% (or possibly 75%) retention to determine if the scientific information supporting 80% retention (or 75%) is certain enough. If not, then incrementally higher retention levels would need to be assessed.

138	32		The USDA has developed procedures to allow the public to seek the correction of information which is used by the USDA that is believed to not comply with Information Quality Guidelines. These procedures include an explanation of the noncompliance with the guidelines, an explanation of the effect the information in question has had on an individual or the public, and recommendations and justifications for how the information should be corrected.	The source of this information is not clear.
139	33		**7.2 National Environmental Policy Act Requirements**	
140	33		Although it is assumed that sensitive species conservation strategies such as the DeLong Paper utilize the best available science and incorporate current coarse filter and fine filter analysis processes, there are no laws or court case precedents mandating such measures. When, however, conservation strategies are used for National Environmental Policy Act (NEPA) decisions, for example, the Hams Fork Vegetation Project EA and the upcoming Green River AMP, any conclusion based on recommendations made in a conservation strategy must meet the same rigor for using the best science and analyzing the biological variables as is mandated by NEPA. The USDA's lay explanation of "The Hard Look Doctrine" states:	Comment noted. Note that the report is not a conservation strategy (see Overview Comment C.1).
141	33		The courts' interpretation is that the agency has the "requirement of a substantial, good faith effort at studying, analyzing, and expressing the environmental issues in the EIS and the decisionmaking process, and a recognition that a rule of reason must prevail because an EIS which fully explores every relevant environmental detail could never be drafted" (Natural Resources Defense Council v. Morton, 458 F.2d 827, 838 (D.C. Cir., 1972)). If the EIS provides good faith analysis and sufficient information to allow a firm basis for weighing the risks and benefits of a proposed action, the court will find the EIS to be sufficient (County of Suffolk v. Secretary of the Interior, 562 F.2d 1368 (2nd Cir. 1977), cert. denied, 434 U.S. 1064 (1978))	Comment noted.
142	33		Based on aforementioned deficiencies in the DeLong Paper, NEPA decisions based on that	The approach taken by ERG is to start with (1) current management where this involves ongoing activities (e.g.,

			report would not meet the basic NEPA requirements for applying the best science or taking a hard look at the climate, vegetation, and disturbance regimes unique to the BTNF.	livestock grazing) and (2) proposed management for activities not yet occurring on a given site (e.g., future logging), and then tasking the Forest Service with proving with local data that sensitive species' populations have been impacted by current management (e.g., ongoing livestock grazing) or would be impacted by proposed management (e.g., logging) before changes are made to current management or to proposed management, respectively, to protect sensitive species. As outlined in the response to Overview Comment E, this conflicts with requirements for conserving sensitive species. The implication to this comment is that, while it may not be possible to demonstrate current management is impacting a given sensitive species on the BTNF or part of the BTNF, this is primarily due to the lack of data to even examine whether impacts have occurred. Viewed from the standpoint of affirmative requirements to provide suitable habitat and protect sensitive species from activities that can impact their populations, scientific information is needed to demonstrate that suitable conditions would continue to be provided and sensitive species would be sufficiently protected within incrementally greater movement away from conditions that would exist in the absence of the activity. The report provides moderate evidence that limiting livestock grazing use to 70% retention of herbaceous vegetation would meet this criterion, and provides no more than limited evidence that 60% retention would. This means that, where scientific information is insufficient, the retention threshold would necessarily need to be higher. Therefore, if the 70% retention threshold for suitable conditions does not meet "the basic NEPA requirements for applying the best science," then 80% retention of herbaceous vegetation would need to be identified instead as the threshold for maintaining suitable conditions.
	33		**7.3 Deficient Protection of Amphibians**	
143	33		Ironically, because of the report's focus on grazing without local data and without a top-down analysis of potential limiting factors, it may not address the factors that mostly place amphibians on the BTNF at risk. Advancing conifer age class and subsequent surface water lost to transpiration, for example, could be a much greater limiting factor than grazing. Game fish preying on eggs and tadpoles represent a significant threat to amphibians. These and other factors relevant to the protection of these animals should be researched for future decision making processes.	As discussed in the opening paragraph of the herbaceous retention section of the 01-09-2013 version of the report, the report does not "focus on grazing" (see responses to comments 44 and 46 for additional explanation and discussion). Advancing succession in forestlands and effects like increasing water loss to evapotranspiration are addressed in detail in the report. Similarly, effects of trout introductions on spotted frogs and boreal toads was also addressed in the report, with additional information added to the 09-26-2014 version of the report.

Appendix E

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