Defenders of Wildlife • Rocky Mountain Wild • Rocky Smith • Quiet Use Coalition
Grand Junction Area Chapter – Great Old Broads for Wilderness
Western Colorado Congress • Northern San Juan Broadband – Great Old Broads for Wilderness Sheep Mountain Alliance • The Wilderness Society • Colorado Native Plant Society
Western Environmental Law Center

Forest Planning Team
GMUG National Forest
2250 Highway 50
Delta, CO 81416

June 1, 2018

Dear GMUG Planning team,

Please accept the following scoping comments submitted on behalf of the undersigned organizations in response to the April 3, 2018 notice of public comment opportunity on the Proposed Action for the Grand Mesa, Uncompahgre, and Gunnison national forests management plan revision (83 Fed. Reg. 14243). Comments were requested by June 2, 2018, making these comments timely. We appreciate the time and effort required for the plan revision process. We request that you consider the issues and information, outlined below, as you continue through planning and on to develop the Draft Environmental Impact Assessment.

Sincerely,

Lauren McCain
Federal Lands Policy Analyst
Defenders of Wildlife
535 16th St Suite 310
Denver, CO 80202
(970) 349-7104
LMCCAIN@defenders.org

Alison Gallensky
GIS and IT Director
Rocky Mountain Wild
1536 Wynkoop St., Suite 900
Denver, CO 80303
(303) 546-0214
Alison@rockymountainwild.org

Tom Sobal
Director
Quiet Use Coalition
POB 1452
Salida, CO 81201
(719) 539-4112
quietuse@gmail.com

John R. Mellgren
Staff Attorney
Western Environmental Law Center
120 Shelton McMurphey Blvd., Ste 340
Eugene, OR 97401
(206) 487-7225
mellgren@westernlaw.org

Sherry Schenk
Leader
Grand Junction Area Chapter
Great Old Broads for Wilderness
379 Ridge View Drive
Grand Junction, CO 81507
sherryleeschenk@gmail.com

Steve Allerton
President
Western Colorado Congress
134 N. 6th St.
Grand Junction, CO 81501
(970) 256-7650
leah@wccongress.org

Vera Smith
National Forest Planning and Policy Director
The Wilderness Society
1660 Wynkoop Street, Suite 850
Denver, CO 80202
(303) 650-5942
vera_smith@tws.org

Karen Tuddenham
Executive Director
Sheep Mountain Alliance
PO Box 389
Telluride, CO 81435
(970)728-3729
lexi@sheepmountainalliance.org

Bayard Ewing
Chair,
Conservation Committee
Colorado Native Plant Society
P. O. Box 200
Fort Collins, CO 80522
conpsoffice@aol.com

Linda Smith
Co-Chair, Conservation Committee
Colorado Native Plant Society
P. O. Box 200
Fort Collins, CO 80522
(970) 663-4085
conpsoffice@aol.com

Robyn Cascade
Co-leader
Northern San Juan Broadband
Great Old Broads for Wilderness
POB 2924
Durango, CO 81302
(970) 385-9577
northernsanjuanbroadband@gmail.com

Rocky Smith
Forest Management Analyst
1030 Pearl St. #9
Denver, CO 80203
(303) 839-5900
2rockwsmith@gmail.com

I. Introduction

The Grand Mesa, Uncompahgre, and Gunnison ("GMUG" or "Forest") national forests support an array of strongholds for vulnerable native flora and fauna. Habitats range from lower elevation sagebrush, grassland, and open woodland to high-elevation alpine peaks. The GMUG provides homes for such iconic species as Canada lynx (lynx), Rocky Mountain bighorn (bighorn), Colorado River cutthroat trout, purple martins, and Gunnison sage-grouse.

Now is the time for bold action in forest planning; robust, science-based forest plan decisions will enable effective conservation actions, integrated landscape-level decision making and more efficient project-level implementation. To that end, the purpose of National Forest System (NFS) land planning is to develop plans that "guide management of NFS lands so that they are ecologically sustainable and contribute to social and economic sustainability; consist of ecosystems and watersheds with ecological integrity and diverse plant and animal communities; and have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future, …includ[ing] clean air and water; habitat for wildlife, and plant communities; and opportunities for recreational, spiritual, educational, and cultural benefits" (36 CFR 219.1(c)). These are the overall, broad-scale desired conditions set forth in the 2012 Planning Rule (36 CFR 219.1-219.19) ("planning rule" or "rule").

To achieve these broad goals, a system has been developed to assess current conditions and trends, identify the need to change the forest plan based on the Assessment, develop a plan to meet desired conditions, and monitor conditions to test if the plan is working. Each element of the system is integral to the whole. The planning phase for forest plan revision begins with a "review of the relevant information from the Assessment and monitoring to identify a preliminary need to change the existing plan and to inform the development of plan components and other plan content" (36 CFR 219.7(c)(2)(i)). The planning process must also be driven by review, incorporation, and analysis of best available scientific information (BASI) (36 CFR 219.3).

The planning rule is a federal regulation implementing the National Forest Management Act (NFMA) (1600 U.S.C. § 1600 et seq.). NFMA was enacted in 1976 in large part to elevate the value of ecosystems, habitat and wildlife on our national forests to the same level as timber harvest and other uses. NFMA codified an important national priority to ensure forest management plans "provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area" (16 U.S.C. § 1604(g)(3)(B) (2012)). NFMA established a process for integrating the needs of wildlife with other multiple uses in forest plans. Most important, the law set a substantive threshold Forest Service management actions must comply with for sustaining the diversity of ecosystems, habitats, plants and animals.

For these comments, we have drawn from a range of documents including papers and reports that represent best available scientific information (BASI), the assessment reports and March 18 GMUG scoping document that outline various need for change (NFC) statements, policy and law, and assessment and scoping comments. We appreciate the GMUG's informative wildlife overviews. We incorporate prior comments to the Forest by Defenders of Wildlife et al., "Re: Comments on the Draft Assessment Report," submitted on December 8, 2017 and Defenders of Wildlife et al., comments on Draft At-risk Species Assessment Report, submitted on January 29, 2018. Below are some abbreviations for cited documents.

- GMUG Forest Plan Revision: Scoping, dated March 2018 (Scoping Report)
- GMUG REVISED DRAFT Forest Assessments: Terrestrial Ecosystems: Integrity and System Drivers and Stressors, dated March 2018) (Terrestrial Ecosystems Assessment)
- GMUG REVISED DRAFT Forest Assessment: Aquatic, Riparian and Wetland Ecosystems, dated March 2018 (Aquatic, Riparian and Wetland Assessment)
- GMUG REVISED DRAFT Forest Assessments: Watersheds, Water, and Soil Resources, dated March 2018 (Water and Soil Assessment)
- GMUG Supplemental Forest Plan Assessment: Groundwater, dated March 2018 (Groundwater Assessment)
- GMUG REVISED DRAFT Forest Assessments: Identifying and Assessing At-Risk Species, dated March 2018 (At-risk Species Assessment)
- GMUG REVISED DRAFT Forest Assessments: Aquatic Species Overviews, dated March 2018 (Aquatic Species Overviews)
- GMUG REVISED DRAFT Forest Assessments: Terrestrial Species Overviews, dated March 2018 (Terrestrial Species Overviews)
- GMUG REVISED DRAFT Forest Assessments: Plant Species Overviews, dated March 2018 (Plant Species Overviews)
- Rocky Smith et al., GMUG management plan scoping comments on the topics of: "a) Timber and Vegetation Management, b) Fire Management, and c) the need for management areas and strong forest-wide standards and guidelines in the revised plan," dated May 24, 2018 (Smith et al. 2018a)
- Rocky Smith et al., GMUG "Scoping Comments on Livestock Grazing and Rangeland Management for the Revised Plan," dated June 1, 2018 (Smith et al. 2018b)
- High Country Conservation Advocates and The Wilderness Society et al., GMUG management plan scoping comments, dated June 1, 2018 (HCCA-TWS et al. 2018)

The following comments focus on the ecological sustainability and species diversity aspects of management planning. Appendix 1: Management Plan Revision Guidance outlines specific policy issues associated with planning for species diversity under the planning rule, and we hope this is helpful as the GMUG continues through the next phases of plan revision.

II. Distinctive Roles and Contributions of the GMUG

A revised plan must reflect:

> … the unit's expected distinctive roles and contributions to the local area, region, and Nation, and the roles for which the plan area is best suited, considering the Agency's mission, the unit's unique capabilities, and the resources and management of other lands in the vicinity. (36 CFR 219.2(b))

It must also "[d]escribe the plan area's distinctive roles and contributions within the broader landscape" (36 CFR 219.7(f)(1)(ii)). We believe the Scoping Report did not sufficiently emphasize the distinctive role the GMUG plays in protecting a wide diversity of ecosystems and in managing at-risk and iconic wildlife and plants for their conservation and for non-consumptive values to people.

A. Ecosystem Diversity

The GMUG supports a great diversity of ecosystems, which provide habitat for a host of at-risk species. The assessment reports identify over 22 ecosystems that include high-elevation alpine uplands down to lower elevation sagebrush shrublands and aquatic and wetland systems. This diversity makes the Forest unique.

B. At-risk Species Recovery, Conservation, and Viability

The Forest Service should emphasize the distinctive role and contribution of the GMUG to contributing to the recovery of federally threatened and endangered species, conserving ESA proposed and candidate species, and maintaining SCC viability. The GMUG provides a home for numerous federally protected species such as the lynx, Gunnison sage-grouse, Uncompahgre fritillary butterfly, Colorado River cutthroat trout (green lineage), DeBeque phacelia, Colorado hookless cactus, and others. Contributing to their recovery is an important new requirement in the planning rule (36 C.F.R. 219.9(b)(1)), and fulfilling this requirement will also help the GMUG meet its Endangered Species Act (ESA) duty to develop conservation programs for threatened and endangered species under Section 7(a)(1). Other at-risk species associated with the GMUG's varied habitats include the wolverine (proposed as threatened under the ESA), bighorn sheep, Gunnison's prairie dog, Brewer's sparrow, flammulated owl, northern goshawk, boreal toad, western bumblebee, Great Basin silverspot butterfly, and Grand Mesa penstemon.

C. Habitat Connectivity

The GMUG serves as a vital federal land nexus, given its location among other national forests: the Rio Grande, White River, and San Juan; Bureau of Land Management land; state lands; and key private lands for wildlife. Wildlife that need unimpeded landscapes to facilitate movement are becoming increasingly isolated in "habitat islands" surrounded by a human-development. Linking protected areas ensures larger, cohesive landscapes of high biological integrity that allow for the migration, movement, and dispersal of wildlife and plants. Any comprehensive strategy for conserving biological diversity requires maintaining connected habitat corridors both on land and within waterways. Connectivity is especially important for adapting to stressors, including climate change. The planning rule and directives includes explicit requirements for managing for ecological connectivity (36 C.F.R. 219.8(a)(3)(i)(E); 36 C.F.R. 219.8(a)(1)) and facilitating connectivity planning across land ownerships (FSH 1909.12, Ch. 20, 23.23m)—the first such requirement in the history of U.S. public land management. Plan revision offers a special window of opportunity to protect wildlife corridors within the Forest, across matrix habitat, and between protected areas. The Forest's wilderness and roadless areas provide expanses where ungulates and large carnivores can move. Nine linkage areas enable lynx to travel to and from the GMUG. The revised plan should provide protections for wildlife corridors that prevent habitat fragmentation and restore contiguity through, for example, land designations and special management areas.

D. Non-consumptive Wildlife and Plant Enjoyment

The GMUG also has distinctive role as a haven for non-consumptive enjoyment of plants and wildlife, such as birding, photography, research, and rare plant identification. Around 300 wildlife species occur in the Forest, several only known to the region. Visitors delight in seeing such iconic animals as bald eagles, elk, bears, pikas, and prairie dogs. Well over 200 bird species can be viewed in the GMUG. Potential Conservation Areas identified by Colorado Natural Heritage Program and Audubon Society's Important Bird Areas are located within the GMUG.

Recommendation: *Include provisions for retaining and enhancing the distinctive roles and contributions of the GMUG described above in the revised plan. These roles and contributions deserve greater emphasis.*

III. Needs for Change

We agree with many of the NFC statements in the Scoping Report. For example, the revised plan should include direction for maintaining and restoring ecosystems at a landscape-scale, restoring ecosystem functions, avoiding environmental impacts of water storage projects, adapting to climate change, maintaining and restoring key ecosystem characteristics that benefit groups of species, protecting rare ecosystems, and reducing livestock conflicts. However, in other cases, we have concerns about NFC statements and about absence of identified needs for change suggested by information in the assessment reports. Below are comments based on the topics selected in the Scoping Report.

A. Strategic, Adaptive Direction

We recognize the planning rule framework "creates a responsive planning process" that "allows the Forest Service to adapt to changing conditions" (36 CFR 219.5(a)). However, there is also a need for management certainty and prescriptive direction. There is nothing in the rule that provides authority to build uncertainty into the plan components themselves. We caution the GMUG against developing an excessively adaptive or flexible plan—a problem we have seen in other plan revisions.

It's helpful to think of the eventual decision document supporting the forest plan at the outset of the process. That decision will require "An explanation of how the plan components meet the sustainability requirements of § 219.8, the diversity requirements of § 219.9, the multiple use requirements of § 219.10, and the timber requirements of § 219.11" (36 CFR 219.14(a)(2)). Every plan component developed at this stage of the planning process should be evaluated through the lens of that requirement: Does it allow the forest plan to meet the rule's requirements?

The forest plan cannot simply be a blank check for any agency action anywhere at any time. Plan components must "guide the development of future projects and activities" (FSH 1909.12 Ch. 20, 22.1). It is important that this step of providing a longer-term context for project decision-making be taken seriously. Where future determinations are necessary, failure to at least provide criteria for making those determinations amounts to including no plan components that would meet species-diversity and other requirements.

There are perils associated with relying too heavily on desired conditions, a pattern we've seen in other plan revision efforts. For example, the requirement for determining consistency of projects and activities with the plan's desired conditions is inherently much more flexible than for mandatory standards (36 CFR 219.15(d)(1) versus (d)(2)), and potentially allows no progress to be made towards achieving them. Recognizing that such outcome-oriented plan components alone would not provide sufficient certainty, the planning rule indicates that mandatory standards and guidelines that act as constraints on projects be used where needed to meet applicable legal requirements.

The NFMA diversity requirement requires a similar degree of certainty. There should be desired conditions for the ecological conditions needed by the at-risk species, and these need to be accompanied by standards and guidelines to ensure that those ecological conditions are achieved. It may be helpful to list all of the at-risk species, their necessary ecological conditions, and the set of plan components that apply to each, recognizing that plan components can meet the needs of more than one species. Structuring the plan components this way makes it much simpler to evaluate the effectiveness of the draft plan.

The plan cannot substitute "management approaches or strategies," referred to as "optional content in the plan" by 36 CFR 219.7(f)(2), for plan components by including substantive plan provisions in optional content. Management approaches must not be written like a plan component (FSH 1909.12, Ch. 20, 22.4). Only "plan components" provide necessary ecological conditions for at-risk species, because optional plan content carries no legal weight and is unenforceable (projects need not be consistent with them).

There also may be an allure to postpone plan decisions to another time and place, whether it be under the auspices of "flexibility," "adaptive management," or some other reason. This will not work. A plan that provides discretion for future decisionmakers to adopt programmatic decisions on a project-by-project basis would provide the Forest with the ability to essentially change or create plan direction in the future without public involvement. This is counter to the fundamental purpose of NFMA of providing integrated and strategic direction for future projects (NFMA Section 6(f)(1)). It would also bypass the substantive requirements of the planning rule, (including the requirement for use of BASI), which explicitly does not apply to projects (36 CFR 219.2(c)). In the case of at-risk species, it would allow the Forest to avoid its statutory obligation for forest plans to provide for diversity of plant and animal communities.

Recommendation: *Develop meaningful plan components that provide management certainty and clear guidance for forest activities and projects. Plan components should avoid vagueness, ambiguity, and subjective language; a plan with vague or subjective desired conditions requires stronger plan standards. Desired conditions must meet the requirement of 36 CFR 219.7(e)(1)(i) in that they "must be described in terms that are specific enough to allow progress toward their* *achievement to be determined." Desired conditions should be linked with objectives, standards, and guidelines to increase the likelihood desired conditions will be achieved. Alternatives that rely more heavily on standards than desired conditions would achieve more certain and desirable outcomes for at-risk species because of their mandatory nature.*

B. Ecological Sustainability

The planning rule requires that plan components maintain or restore ecological integrity, which occurs (by definition, 219.19) when the dominant ecological characteristics (such as composition, structure, function, connectivity, and species composition and diversity) are within a range of reference conditions which would allow them to recover from disturbances, such as wildfire. This set of reference conditions is referred to as the natural range of variation (NRV). NRV is generally based on natural disturbance regimes during a historic reference period, but may also include any additional information that indicates that something other than this historic range may be more appropriate as a future reference condition (See FSH 1909.12, section 23.11a). It is important to note that BASI related to current or likely foreseeable impacts from climatic changes should be incorporated into the discussion, modeling, and planning related to NRVs for forest ecosystems. Climate change and associated changes in water availability, vegetative structure, and species composition should not merely be framed as a separate challenge needing separate planning, but rather as a necessary and critical component of the NRV. NRVs cannot merely be based on arbitrary, point-in-time historical reference conditions.

The status of ecological integrity is determined by comparing the expected future conditions under proposed plan components for selected integrity characteristics to the NRV for those characteristics. In determining the status, the responsible official must consider the effects of all plan components on the characteristics; not just those intended to be beneficial. Departures from NRV indicate that the ecological integrity of the ecosystem is not sustainable as required (219.8(a)), and therefore diversity will not be achieved (219.9(a)).

1. Landscape-scale Management Direction

One of the GMUG's proposed needs for change is: "Provide direction for ecosystem-based management at a landscape-scale. Emphasize maintenance and restoration of ecosystem function" (Scoping Report, p. 4). The planning rule acknowledges that ecosystems do not conform to forest boundaries, that forest resources and processes affect human and non-human communities beyond the edges of the forest, and that forest management has effects on the broader landscape. For example, the planning rule states,

> Land management plans guide sustainable, integrated resource management of the resources within the plan area in the context of the broader landscape, giving due consideration to the relative values of the various resources in particular areas" (36 CFR 219.1(b)).

And the revised plan must take into account "[c]ontributions of the plan area to ecological conditions within the broader landscape and ecosystems within the broader landscape influenced by the plan area" (36 CFR 219.8(a)(1)(ii)).

However, for at-risk species, it must be clear that ecological conditions will be provided at the scale at which they are relevant to the species. This may require plan components for fine-scale site conditions, as well as larger-scale ecosystem conditions. The scale of historic disturbance regimes (based on the assessment) should also be considered in determining plan components.

Recommendation: *Guidance on when and how the GMUG would apply "landscape-scale" management approaches must be described in the revised plan and be clear in plan components. The revised plan should offer stepdown guidance on applying a landscape approach to at-risk species. Contributing to the recovery of threatened and endangered species recovery, conserving ESA candidate and proposed species, and maintaining the viability of SCC depend on management at appropriate and relevant spatial scales.*

2. Habitat Connectivity

We were surprised not to see a NFC statement in the Scoping Report pertaining to connectivity. The planning rule requires planning and management for connectivity to achieve ecological integrity and the persistence of wide-ranging wildlife species. The forest plan should identify key linkage areas as management areas, given that they have discrete management direction. Which areas will be managed for connectivity is a decision that must be made in the forest plan.

For more information regarding the importance of landscape connectivity and mechanisms to protect habitat connectivity and wildlife corridors see: HCCA-TWS et al. 2018 scoping letter. Please also see Appendix 2, *Planning for Connectivity*. For more information on the scientific basis for wildlife corridors see Appendix 3.

Recommendation: *Desired conditions should be developed to promote habitat connectivity and prevent fragmentation, and we suggest the following.*

- *Long-term connectivity and integrity of habitat utilized for wildlife movement and plant* *pollination through and beyond the plan area is maintained and, where necessary, restored to provide for ecological integrity.*

- *Special connectivity and wildlife corridor areas are managed for wildlife movement and habitat connectivity and for the enjoyment of the public as they recreate, study, and observe wildlife. Natural conditions prevail in the area while providing an opportunity for interpretation, education, and research.*
- *Wildlife habitat connectivity provides an essential ecological condition for supporting viable populations of at-risk species and offers educational and research opportunities.*
- *Interpretive signing is used to explain major features of the area and explain protection of sensitive ecosystems.*
- *The Forest Service in cooperation with permittees, Colorado Department of Transportation, Colorado Department of Parks and Wildlife, and other stakeholders implement projects to reduce and minimize barriers to wildlife movement such as fences and dangerous road crossings.*

Recommendation: *Utilize the following suggestions as a starting point to develop plan standards.*

- *Authorized activities shall be harmonious with the primary values of wildlife movement, habitat connectivity, and habitat condition for at-risk species.*
- *Do not construct new permanent travel routes in specially designated wildlife corridors in order to maintain un-fragmented habitat for wildlife migration and dispersal.*
- *Temporary travel routes will only be constructed if necessary, and with the smallest impact possible, and will be reclaimed and obliterated within one year of the termination of the project for which they were authorized to avoid fragmenting habitat, protect watershed conditions, minimize wildlife disturbance, and prevent illegal motorized use.*
- *New or reconstructed fencing shall allow for wildlife passage and prevent wildlife entrapment, taking into consideration seasonal migration and access to water resources (except where specifically intended to exclude wildlife -- e.g., elk exclosure fence -- and/or to protect human health and safety).*
- *New rights-of-way for energy development that would negatively impact wildlife, their habitat and its connectivity will not be issued.*
- *Projects will consider the cumulative impacts of ground-disturbance that are occurring or will occur on adjacent lands and will strive to minimize as much as possible the spatial, temporal, or other design features can mitigate impacts to connectivity.*
- *Special wildlife corridor designations or management areas are not suitable for timber production.*
- *Special wildlife corridor designations or management areas are not suitable for oil and gas leasing with no surface occupancy.*

- *Management activities in special wildlife corridor designations or management areas will limit the surface disturbance footprint temporally and spatially to minimize adverse impacts to wildlife.*
- *Do not exceed a motorized route density of one mile per square mile generally, or a threshold determined by best available science for specific at-risk species. (c.f., Trombulak and Frissell 2000)*

Recommendation: *We suggest the following serve as a starting point for developing guidelines.*

- *Where motorized route densities exceed one mile per square mile, develop and implement a strategy to reduce the densities to below this threshold level.*
- *In coordination with the Colorado Department of Transportation, develop and implement a strategy for mitigating highway related barriers to wildlife movement.*
- *As possible, augment wildlife values through purchase from willing sellers, exchange, transfer, or donation of additional acreage of crucial wildlife habitat for their migration, movement and dispersal.*
- *Work with livestock permittees to identify fencing that is not critical for livestock operations. Remove fencing that is not critical for livestock operations and that is impeding wildlife movement. Where possible, modify existing fencing that is not wildlife friendly.*

3. Climate Change

The planning rule adopts an intentional approach to planning for climate change. In fact, the rule was explicitly designed to be a vehicle for adaptation planning and the implementation of strategies to make national forests more resilient to the stresses of climate change (77 Fed. Reg. 21164). The planning rule states that the intent of the rule is to allow "the Forest Service to adapt to changing conditions, including climate change…" (36 CFR 219.5(a)). The planning rule establishes adaptation to climate change as a primary consideration within the three phases of planning (assessment, planning and implementation/monitoring). Please refer to Appendix 4, *Planning for Climate Change*.

4. Watersheds and Aquatic, Riparian, and Wetland Ecosystems

Given the extent of degradation of water resources on the GMUG described in the assessment reports (Water and Soil Assessment; Aquatic, Riparian and Wetland Assessment), we were surprised not to see more specific statements regarding needs for changing plan direction to guide forest uses and management that affect watersheds and aquatic, riparian, and wetland ecosystems beyond the NFC focus on water storage (Scoping Report, p. 4). The GMUG Scoping

Report (p. 6) acknowledges the planning rule requirement to identify priority watersheds for restoration. One NFC statement for ecological sustainability is: "Provide direction for ecosystem-based management at a landscape-scale. Emphasize maintenance and restoration of ecosystem function" (Scoping Report, p. 4). And we were surprised that a key characteristic to evaluate ecosystem function of aquatic systems were not explicitly included in the Aquatic, Riparian and Wetland Assessment.

As the assessment reports note, roads/trails, water diversions, recreation, non-native invasive species, and degraded rangeland vegetation contribute to degraded conditions, reduced ecological integrity, and increased ecological risk. These management-based risks to ecological integrity and conditions are exacerbated by the forest's vulnerability to climate change. The GMUG has the mandate and the opportunity to improve watersheds and aquatic, riparian, and wetland conditions on the forest by meaningfully addressing management-based stressors within the revised forest plan.

Recommendation: *The revised plan must include plan components, including standards and guidelines, to maintain or restore water resources in the plan area (219.8(a)(2)(iv)). The Aquatic, Riparian and Wetland Assessment (p. 5) noted information gaps, for example: "The GMUG would benefit from a comprehensive and consistent GIS effort focused on mapping riparian, wetland, and other groundwater-dependent ecosystems" and also the lack of information about ecosystem function.*

- *We support plan direction that would address these information gaps.*
- *Plan components for water, watersheds, and aquatic ecosystems should be developed using the key water resource characteristics, and as information becomes available, key characteristics that better measure ecosystem function.*
- *Plan components for at-risk aquatic species should be based on the ecological conditions necessary for their persistence, and may take the form of ecosystem or species-level plan direction, or a combination of the two.*
- *Critical habitat for federally listed aquatic at-risk species should be designated as management areas within the plan, as those areas will have unique plan direction, thus meeting the definition of a management area.*

Recommendation: *The Aquatic, Riparian and Wetland Assessment (pgs. 6, 20, 21, 22, 28-29) affirms that roads and trails negatively affect the integrity of these systems. According to this Assessment, based on the "roads and trails functional condition," more of the riparian and wetland ecosystems are functioning at risk or are impaired than functioning properly for all ecosystems: "fens," "montane-alpine wet meadow & marsh," "montane-subalpine riparian woodland," and "cottonwood riparian." Given this, we recommend the following.*

- *The revised forest plan should prioritize reductions in route densities within these ecosystems.*
- *Watersheds at risk due to road and trail maintenance and proximity to water should be prioritized for restoration.*

Recommendation: *For watersheds, Watershed Condition Classification indicators should be used to develop plan components and the monitoring program, with reference conditions/Functioning Properly serving as the desired condition. The Forest has identified 76 watersheds (about 32%) of 235 that are "functioning at risk" within the watershed condition framework (WCF) (Water and Soil Assessment, p. 8-9). For some WCF attribute categories, the Water and Soil Assessment (p. 6) shows a significant number of watersheds are performing only fair or poor, for example, including for aquatic habitat: "habitat fragmentation" (114 fair, 15 poor), "large woody debris" (110 fair, 68 poor), "channel shape and function" (122 fair, 7 poor); aquatic biota: "native species" (22 fair, 149 poor) and "exotic and/or aquatic invasive species" (6 fair, 192 poor); riparian and wetland: "vegetation condition" (121 fair, 8 poor); roads and trails: "road and trail maintenance" (89 fair, 43 poor) and "proximity to water" (57 fair, 141 poor); and terrestrial forest health: "insects and disease" (22 fair, 185 poor). The Assessment does not specifically identify stressors associated with these conditions.*

- *Desired conditions for aquatic habitat should be modeled on the rating of Functioning Properly: Each watershed should support large continuous blocks of high-quality aquatic habitat and high-quality stream conditions. The revised plan should define "high-quality" within this context.*
- *There should be objectives to restore blocks of continuous/contiguous habitat and stream channel conditions in watersheds and subwatersheds that are deficient in this condition*.

Recommendations: *The planning rule specifically authorizes and requires identification of priority watersheds for maintenance or restoration (219.7(f)(1)(i)).*

- *In identifying these watersheds, the urgent need to both maintain and improve/restore ecological integrity and conditions for aquatic and riparian at-risk species should be integrated with other needs, such as road and trail maintenance and decommissioning.*
- *Prioritization should be done for both maintenance and restoration using the watershed condition framework, and considering the distribution and ecological needs of at-risk species, particularly those whose persistence is associated with watershed/aquatic/riparian conditions.*
- *Watersheds and subwatersheds with properly functioning conditions/low risk should be designated as functional areas and receive direction to maintain and protect those conditions from management-based stressors through the use of desired conditions for*

maintenance, and standards/guidelines to constrain actions that may lead to the loss of maintenance of those conditions.

- *Watersheds/subwatersheds with high concentrations of at-risk riparian/aquatic at-risk species should be recognized as "strongholds" and efforts should be made to retain/restore ecological connectivity throughout an aquatic network. Areas with these conditions/characteristics will have unique plan direction and thus qualify as management areas.*
- *Moderate and highly departed/at-risk watersheds and subwatersheds should receive plan direction for restoration to the desired/reference condition. Plan direction should be tailored to the specific conditions/risks within those areas; objectives should be used to prioritize the restoration of specific conditions/indicators, and standards and guidelines should be developed to reduce the recognized stressors that are contributing to risk and the departure from reference/desired conditions.*
- *There should be desired conditions and other plan components for streamflow at the watershed scale.*

Recommendations: *Management of water controls and diversions can be addressed to some degree within the revised forest plan. The revised plan should contain plan direction for defining desired streamflows as well as complementary direction (objectives/standards/guidelines) to maintain and restore those conditions.*

The revised plan must include plan components for water quality (219.8(a)(2)(iii).

- Plan components that constrain the effects of livestock grazing, non-fire vegetation treatments (timber and fuelwood), roads and trails, mining, recreation, invasive species and pesticide use that impede the achievement of desired/reference conditions for water quality within target watersheds/sub-watersheds will be necessary. Watersheds departed from NRV that include these management activities should be prioritized for protection and restoration.
- The planning rule also requires that plan components must "ensure implementation of (best management) practices" for water quality (219.8(a)(4)). The revised plan will need plan components to meet these requirements.

Recommendation: *The revised plan can address ecological conditions at the ecosystem and/or species-level at the necessary scales, to recover/maintain the species.*

- *Desired conditions should be described for aquatic integrity in terms of conditions of aquatic habitat at the stream or reach level as necessary.*

- *Plan components must provide for the maintenance and restoration of ecological conditions necessary for the recovery and persistence of at-risk native fish, including the Colorado River cutthroat trout (green lineage) and others.*
- *In developing plan components for these species, the Forest should clearly list the habitat and other ecological conditions necessary for their recovery/persistence, and align those with desired/reference conditions for key characteristics within watersheds, aquatic ecosystems and riparian areas.*

Recommendation: *The plan must address system stressors.*

- *Plan components must prohibit management practices that would seriously and adversely affect water conditions or fish habitat (219.8(a)(3)(ii)(B)).*
- *The revised plan must develop standards to effectively constrain the impacts of motorized roads/trails and livestock grazing, within riparian areas/riparian management zones and uplands, as they are primary stressors impeding achievement of desired/reference conditions necessary for the persistence of at-risk fish.*
- *Impaired streams must be closed to livestock grazing, and the GMUG must clarify which stream systems are excluded.*
- *Impaired and degraded streams need a program of fencing out herbivores, building checkdams, and planting and maintaining willows and other riparian vegetation. Such a program should include specific named creeks and specific goals, objectives, and timelines for each creek.*

Recommendation: *At the landscape scale, a desired condition for aquatic resources could include a network of watersheds that would support viable populations of target species. Such a network is typically designed in a plan using existing species strongholds as a foundation and connecting and restoring adjacent and tributary watersheds. These networks—often referred to as key watersheds or priority watersheds—should be identified as management areas where maintenance and restoration of aquatic integrity is an important management emphasis. (Connectivity is also likely to be important.)*

- *The plan components for riparian area integrity must take into account the seven factors listed in 219.8(a)(3). In addition, the influence of adjacent terrestrial and aquatic ecosystems on riparian areas and the role of riparian areas in the adjacent terrestrial and aquatic ecosystems, particularly connectivity, must be considered in identifying and developing plan components for riparian areas.*

Recommendation: *Under the planning rule, areas managed to benefit riparian resources are referred to as "riparian management zones." They are required for ecological integrity (219.8(a)(3)). Plan components—at either the landscape (i.e. desired conditions) or project* *(standards/guidelines) scale—must be included to maintain or restore the ecological integrity of riparian areas, including their structure, function, composition and connectivity.*

- *Plans must define the management area recognized as the riparian management zone subject to these plan components.*
- *Stressors that occur within the riparian areas must be considered when establishing riparian management zones.*
- *Riparian management zones should be determined to be unsuitable for timber production. The revised forest plan should take this information into account when determining widths of riparian management zones and plan components for them.*

Recommendation: *The rule suggests that there may be subsequent site-specific re-delineation of riparian zones (219.8(a)(3)(ii)(A)), but does not explicitly require a plan amendment or other public involvement. The plan should therefore include criteria that must be used for such future changes.*

- *At the ecosystem scale, plan components should be developed using the key characteristics from the Assessment.*
- *Plan components for at-risk species associated with riparian areas should be based on the ecological conditions necessary for their persistence, and may take the form of ecosystem or species-level plan direction, or a combination of the two.*
- *As the Forest develops plan components for riparian ecosystem integrity and at-risk species recovery/persistence, it should start by cross walking the ecological conditions needed by the at-risk species with the specific riparian ecosystems and their reference key characteristics.*

Recommendation: *The Assessment and wildlife overviews should be used to develop coarse filter/ecosystem-level plan components and to determine if fine filter/species-level components are necessary.*

- *As the forest develops draft plan direction for riparian ecosystems and associated at-risk species, it should make clear connections between the desired/reference key characteristics for integrity and the habitat/ecological condition needs of the at-risk species.*

C. Diversity of Plant and Animal Communities

Managing selected ecosystem characteristics for the diversity and integrity of ecosystems may not sustain populations of all native plant and animal species. The rule therefore requires species-specific plan components, if necessary, to provide the ecological conditions necessary to meet the various conservation requirements for individual at-risk species (219.9(b)).

Ecological conditions are not just the biophysical ecosystem and habitat features that the species needs to persist over time, but also other influences on species persistence, including human uses, invasive species, and structural developments such as travel routes.

To meet the requirements for the three types of at-risk species, forest plans must provide the ecological conditions necessary to meet the requirements of 219.9(b)(1):

- Contribute to the recovery of federally threatened and endangered species.
- Conserve federally proposed and candidate species.
- Maintain a viable population of each SCC within the plan area or, if that is not possible, contribute to maintaining a viable population of that species within its range.

Together, the ecosystem plan components and the species-specific plan components should provide ecological conditions to meet the NFMA requirement for diversity of plant and animal communities.

1. Federally Threatened and Endangered Species

The planning rule establishes an affirmative regulatory obligation that forest plans "provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened or endangered species" (36 C.F.R. § 219.9(b)(1)). The provision supports the "diversity requirement" of NFMA (16 U.S.C. § 1604(g)(3)(B)). Moreover, the preamble to the planning rule specifically links this requirement to its responsibility under the ESA for recovery of listed species, stating, "[t]hese requirements will further the purposes of Section 7(a)(1) of the ESA, by actively contributing to threatened and endangered species recovery and maintaining or restoring the ecosystems upon which they depend" (77 Fed. Reg. 21215).

Forest plans make conservation decisions and are vehicles to demonstrate compliance with ESA as well as NFMA. One key mechanism for implementing the affirmative conservation program is the ESA Section 7(a)(1) conservation review. The conservation review process provides a mechanism for the Services to make a determination that the forest plan met affirmative recovery obligations. There is an existing process for interagency coordination that should be used to answer the question that the planning rule poses: does a forest plan contribute to recovery of listed species? The Consultation Handbook used by the listing agencies describes "proactive conservation reviews" under ESA Section 7(a)(1).[1] According to this Handbook, such

[1] Endangered Species Consultation Handbook 1998. U.S. Fish & Wildlife Service and National Marine Fisheries Service, Section 5.1. (https://www.fws.gov/ENDANGERED/esa-library/pdf/esa_section7_handbook.pdf)

reviews are appropriate for major national programs, and they are also “appropriate for Federal agency planning.” They would be especially helpful in confirming that the plan has included the ecological conditions necessary for recovery of listed species.[2]

The planning directives call for coordination between the US Fish and Wildlife Service (USFWS) and the Forest Service to make decisions about selecting relevant federally protected species for the purposes of planning (FSH 1909.12, Ch. 10, 12.51). The SCC criterion, “must be known to occur in the plan area,” (FSH 1909.12 12.52c (1)) does not apply for selecting target threatened, endangered, proposed, and candidate species. Federally recognized species must be addressed by plan components if they “may be present” in the plan area (50 C.F.R. 402.12(c)(1), (d)) or if they are not present but would be expected to occur there to contribute to recovery. Thus, species including North American wolverine, yellow-billed cuckoo, southwestern willow flycatcher, Mexican spotted owl, and several fishes and plants may be relevant to the plan, though the At-risk Species Assessment indicates these species are not documented in the plan area (At-risk Species Assessment, p. 7-8, Table 1).

The Forest Service must consult with the USFWS under Section 7 of the ESA. The Forest Service should make its Biological Assessment available to the public as soon as it’s available and should also promptly post the Biological Opinion from USFWS on the GMUG’s plan revision website as soon as it is complete and received by the Forest. We look forward to seeing the result of this legally required consultation process.

a. Canada Lynx (*Lynx canadensis*)

The Distinct Population Segment (DPS) of Canada lynx (lynx) in the contiguous United States was listed by the USFWS in 2000 (65 Fed. Reg. 16053). New science indicates that existing direction in the Southern Rockies Lynx Management Direction (SRLMD) is likely insufficient to contribute to the recovery of lynx. While we recommend the Forest Service not go back to the drawing board, the Forest should modify existing SRLMD plan components to comply with 2012 planning rule plan component requirements (36 CFR 219.7(e)), strengthen existing direction, revise habitat definitions where necessary, and add standards based on changed ecological conditions and new BASI. See also, Smith et al. 2018a GMUG scoping comments.

For example, the plan must include desired conditions for the ecological characteristics necessary for lynx recovery in relation to structural, compositional, functional, and connectivity

[2] The Consultation Handbook also encourages consultation at broader scales such as “ecosystem-based” consultations.

elements of ecosystem integrity. Additionally, plan components in the SRLMD related to vegetation management focus on retaining quantities of high-quality snowshoe hare habitat. Standards VEG S1 and VEG S2 are intended to retain hare habitat distributed across lynx analysis units (LAUs) and VEG S5 and VEG S6 are meant to limit precommercial thinning impacts in hare habitat. The BASI available now demonstrates that the SRLMD direction is insufficient to allow for the restoration and retention of lynx winter habitat, especially mature forest. The SRLMD does not adequately protect lynx winter habitat from timber harvest and other vegetation management activities.

Recommendation: *Revise the forest plan to contribute to the recovery of the contiguous U.S. lynx DPS, not merely to limit adverse habitat impacts and avoid jeopardy under the ESA in the forest, based on the BASI on lynx conservation.*

<u>New BASI from the 2013 Canada Lynx Conservation Assessment and Strategy (LCAS)</u>

There are important conservation measures included in the LCAS (ILBT 2013: 86-96), based on BASI, that should be incorporated into the revised plan. For example, there is additional direction to prevent or limit: impacts of recreation (ILBT 2013: 94), forest/backcountry roads and trails (ILBT 2013: 94), and livestock grazing in riparian-willow areas (ILBT 2013: 94). The lynx overview summarized much of the new BASI, including new information about risk factors (Terrestrial Species Overviews, p. 48-49).

Recommendation: *Draw from new information and recommendations in the LCAS to inform the revised plan elements pertaining to lynx and lynx habitat.*

<u>Spruce Bark Beetle Outbreak</u>

The changed ecological conditions in the GMUG resulting from the recent multi-year, large-scale spruce bark beetle outbreak necessitate a precautionary approach to forest management, with a high priority on maintaining or restoring ecological conditions necessary to contribute to the recovery of lynx. Generally, viable populations of native wildlife species are resilient to natural disturbances, even large-scale changes. The Terrestrial Ecosystems Assessment acknowledged uncertainty as to whether the current forest conditions are outside of their NRV based on structure, composition, function, and connectivity characteristics. Now is not the time to make radical changes in management direction. The SRLMD framework is likely necessary to limit adverse effects to lynx habitat but we are concerned that the components are not sufficient, owing to the wide-spread spruce mortality on the forest due to the bark beetle outbreak over the last decade.

Though population estimates and trend data for the Southern Rockies' lynx population do not exist, there is no indication that numbers are sufficient to consider the population viable and recovered. Given the likelihood that the population has remained small, it may be more vulnerable to stochastic events, even those that occur naturally. The management actions and projects that are within the Forest Service's control and have the potential to impact lynx and lynx habitat must only occur with extreme care and strict adherence to strong and clear direction from the forest's revised management plan.

The Forest Service was prudent to help support a study on the response of lynx to mass spruce tree mortality associated with the beetle outbreak in the Southern Rockies national forests, particularly the Rio Grande where the study was initiated. The progress reports (Squires et al. 2017; *Habitat Relationships of Canada Lynx in Spruce Bark Beetle-impacted Forests* 2018), providing preliminary results, should inform the revision and refinement of plan components as should final results, when these are available. The study results should be considered a significant part of the BASI informing lynx direction. The progress report noted that lynx depend on forest stands of value for salvage harvest. The Squires et al. (2017) progress report noted the following:

- "Lynx actively selected forest stands with high horizontal cover and high snowshoe hares density." At 11. They tended to prefer "areas with ≥50% horizontal cover in the summer and ≥40% in the winter." (p. 9).
- "Lynx selected forest stands with abundant ABLA [subalpine fir] in the understory." (p. 11).
- "Canopy cover (live + dead) is higher in stands selected by lynx relative to random…". (p. 11).
- "Lynx selected forest stands with high densities of trees ≥3 inches DBH [diameter at breast height] ; generally >400 trees/acre …". (p. 11).
- "Abundant large live trees, and medium, large, and very large dead trees appear to be important forest components selected by lynx." (p. 11).
- "Live ABLA [subalpine fir] and PIEN [Engelmann spruce] tree (i.e., ≥3 inches DBH [diameter at breast height]) densities as well as beetle-killed PIEN tree densities appear to be the species-specific components selected for by lynx." (p. 12).

Salvaging trees in significant areas of beetle-affected spruce-fir forest could have devastating effects on lynx habitat without a comprehensive set of plan components that fully account for the changed condition. Vegetation management is considered a "first tier" threat according to the GMUG's wildlife overview for the lynx (Terrestrial Species Overviews), which references the

LCAS 2013 (ILBT 2013). Vegetation management can include, for example, commercial timber harvest, salvage or sanitation harvest, precommercial thinning, and fuels treatment. The LCAS 2013 provides a compilation and synthesis of the BASI up to 2013. Vegetation management can create: forest openings that lynx avoid, forest fragmentation that presents barriers to movement, loss of important winter habitat, and risks to denning habitat and den sites from disturbance, for example.

Other anthropogenic stressors to lynx habitat include snow compaction resulting from over-snow vehicle use and roads and trails, livestock grazing—particularly in riparian-willow areas, and disturbance to lynx from recreational activities. Management can limit the impacts of these activities. Climate change is also a stressor. With climate change impacts already apparent on the forest, it is imperative that the forest plan provide protection to lynx and lynx habitat from threats it can control.

Recommendation: *Add a standard to the existing SRLMD that recognizes lynx are still using areas with substantial, or even complete, overstory mortality that have an understory that provides dense horizontal cover. The standard should limit vegetation management in areas with less than 40 percent canopy cover that still have enough understory to provide quality lynx habitat. The definition for what qualifies as "quality" or suitable habitat, given the new BASI, must be incorporated into the standard so there is no ambiguity as to the nature of the definition. Additionally, the relationship between this new or modified habitat definition and the SRLMD definition 24 for "Lynx habitat in an unsuitable condition" should be explained and reconciled. We believe that SRLMD definition 24 is outdated, given the new understanding of lynx habitat use under the conditions of significant beetle-induced tree mortality.*

Recommendation: *A standard must be developed to retain live trees in lynx habitat based on Squires et al. (2017).*

Recommendation: *SRLA Standard VEG S2 must be amended to reflect the modified definition for unsuitable habitat.*

Recommendation: *The SRLA Guideline VEG G5, which seeks to protect secondary prey habitat, should be a standard.*

<u>The Importance of Mature Forest and Lynx Winter Habitat</u>

Findings by Squires et al. (2010), Kosterman (2014), and Holbrook et al. (2017), based on studies in the Northern Rockies, support additional plan standards to restore or maintain mature forest, based on lynx habitat selection and usage and female denning success. Timber harvest, salvage logging, and precommercial thinning are management threats to mature forest (ILBT 2013), especially given the slow regeneration of spruce trees.

BASI indicates that Standard VEG S1, which allows up to 30% of young regenerating forest to occur in each LAU, is too high a value. Kosterman (2014) findings suggest that setting the limit at 10-15% would provide conditions more conducive to reproductive success. Holbrook et al. (2017) findings, based on habitat use by both sexes, support modifying VEG S1 to revise the threshold down.

Holbrook et al. (2017) suggests that more attention should be paid to which habitat types lynx tend to use—especially in winter. The study emphasizes the importance of mature forest to lynx in winter. Some key points Holbrook et al. (2017) included are that:

> … females exhibited additive use and consistent selection of advanced regenerating forest across the range of availability. Mature forest was used in proportion to its availability, although 66% of female home ranges contained ≥50% mature forest. Together, these results demonstrated that female lynx occupy home ranges of mostly mature forest during the winter, and within that context they reduce their use of open structure classes, but additively use advanced regeneration as these structures become more available. (p. 13)
>
> Canada lynx in the Northern Rockies use a gradient of forest structures and compositions, but they use more mature, spruce-fir forest than any other structural stage or species. (p. 16)
>
> … during the winter (i.e., the most constraining season for lynx; Squires et al. 2010) female and male Canada lynx exhibited increasing and additive use, respectively, for advanced regenerating forest as it became more available. (p. 17)
>
> … conservation planning should be focused on the needs of females when developing management plans. (p. 19). This mechanism received demographic support by Kosterman (2014), who demonstrated that female lynx with core areas of highly connected mature forest and intermediate levels of regenerating forests had the highest probability of producing a litter. (p. 20)

Squires (2010: 1657) noted,

> Recovery of high elevation, spruce-fir forests following harvesting or thinning tend to be slow due to short growing seasons, cold temperatures, high winds, and deep snow . . . Therefore, reducing horizontal cover within multistory spruce-fir forest through thinning or harvest may degrade lynx habitat for many decades.

The SRLMD is not sufficiently protective of mature forest and winter habitat.

Recommendation: *Retain and recruit mature, multilayer spruce-fir forest stands that provide important habitat for lynx by developing new standards to maintain and conserve winter habitat.*

Recommendation: *Modify SRLMD VEG S1 and other direction, based on Kosterman (2014), to provide habitat that maximizes reproduction success.*

<u>Denning Habitat</u>

Denning habitat is vitally important for lynx, and seems to be overlooked in many Forest Service planning processes in lynx habitat. The USFWS discussed the importance of denning habitat to lynx, and included denning habitat as a Primary Constituent Element "that provide[s] for a species' life-history processes and [is] essential to the conservation of the species" when determining which lands should be designated as Canada lynx critical habitat (79 Fed. Reg. 54782, 54811-2 (Sept. 12, 2014)). USFWS explained that "a feature or habitat variable need not be limiting to be considered an essential component of a species' habitat. Both denning and matrix habitats are essential components of landscapes capable of supporting lynx populations in the DPS because without them lynx could not persist in those landscapes" (79 Fed. Reg. 54786).

The USFWS identified "denning habitat to be a physical or biological feature needed to support and maintain lynx populations over time and which, therefore, is essential to the conservation of the lynx [distinct population segment]" (79 Fed. Reg. 54810). The LCAS (ILBT 2013) also notes: "Maintaining good quality and distribution of denning and foraging resources within a LAU will help to assure survival and reproduction by adult females, which is critical to sustain the overall lynx population" (ILBT 2013: 87). Given the clear and undeniable importance of denning habitat to lynx, standards should be added to the plan. Not only should the Forest do this of its own accord, but it is also required to do so given the 2012 planning rule's requirements related to recovery of ESA-listed species (36 CFR 219.9(b)(a)).

Recommendation: *Given the clear and undeniable importance of denning habitat to lynx,* *SRLMD Guideline VEG G11 should be converted to a standard (reword "should" to "must") in the revised Plan. Not only should the Forest do this of its own accord, but it is also required to do so given the planning rule's requirements related to recovery of ESA-listed species, as discussed above in these comments.*

Snow Compaction and Winter Use

Researchers have speculated that snow compaction by human uses would allow other predators access to areas where lynx have a competitive advantage: in deep, fluffy snow due to their large, snow-adapted paws. Buskirk et al. (1999) suggested potential competitors with habitat overlap include mountain lions, bobcats, and coyotes, all of which can kill lynx and/or compete with lynx for prey. Burghardt-Dowd (2010) did find that coyotes used spontaneous trails made by over snow vehicles (OSVs). Additionally, bobcats can displace lynx from snowshoe hare hunting grounds, a concern given changing snow conditions due to climate change (Peers et al. 2013).

Recommendation: *Limit snow compaction from OSV and other uses by upgrading SRLMD guidelines, including but not limited to, HU G4, HU G10, HU G11, and HU G12, to standards.*

Habitat Connectivity and Linkage Areas

Habitat fragmentation is a major risk factor for lynx (ILBT 2013; Terrestrial Species Overviews, p. 49). Lynx have large home ranges and move long distances. They tend to avoid forest openings greater than 300 feet (Aubry et al. 1999). The Terrestrial Species Overviews (p. 47) noted that lynx in Colorado tend to use "larger contiguous blocks of forest" and that:

> Forested conditions between foraging and denning habitat has also been shown to facilitate movement within the home range, particularly along ridgelines where lynx commonly travel (Ruggiero et al. 1994). Linkage areas may be provided by forest stringers that connect large forested areas, or by low, forested passes that connect subalpine forests on opposite sides of a mountain range (Ruediger et. al. 2000). (Terrestrial Species Overviews, p. 47)

The overview also highlighted that lynx recovery requires a landscape-scale and cross-boundary approach, well-connected lynx analysis units (LAUs), further defining and mapping connectivity attributes, and "[r]ecognition of important movement and dispersal areas that may require a management focus even when outside of existing linkage areas, LAUs or known occupied reproductive habitat" (Terrestrial Species Overviews, p. 47).

Recommendation: *Protect and preserve areas that provide connected habitat for lynx from the following activities: development, timber harvest (including thinning and mechanical fuels treatment), motorized use, and increased human access. Protect known linkage areas. Identify and protect other corridors, linkages, and least cost paths that enable lynx movement.*

Monitoring

We acknowledge that a proxy for actual lynx distribution, abundance, and population trends is necessary, given the small population of lynx. Snowshoe hare density can be measured (*c.f.*, Mills et al. 2005). It is also important to know the percentage of mature forest in each LAU (based on Kosterman (2014) and Holbrook et al. (2017)). A periodic sampling of hare density would not only provide information that gets closer to measuring recovery trends but would also help answer key about the impacts of vegetation treatments on lynx recovery. The response of hares to vegetation management, fire, and other stressors will not only help assess ecosystem conditions that affect lynx recovery but help answer highly relevant scientific questions. We recommend the snowshoe hare be designated as a focal species.

Recommendation: *The monitoring plan that must be part of the forest plan (c.f., 36 CFR 219.12(a)) must include measures to assess the effects of both management and natural disturbances on hare and lynx.*

b. Gunnison Sage-grouse (*Centrocercus minimus*)

The USFWS listed Gunnison sage-grouse as threatened under the ESA on November 20, 2014 (79 Fed. Reg. 69192) and designated 1.43 million acres of critical habitat to support the species recovery (79 Fed. Reg. 69312). The GMUG should include revised plan components that provide for Gunnison sage-grouse recovery. The GMUG's overview for the Gunnison sage-grouse provides a list of objectives from Gunnison Sage-grouse Rangewide Conservation Plan (CSRSC 2005) (Terrestrial Wildlife Overviews, p. 99-101). However, recommendations from CSRSC (2005) are outdated and require modification based on new BASI. Several of the following recommendations are based on greater sage-grouse information, but federal agencies have long accepted information on life history and habitat needs for greater sage-grouse as applicable to Gunnison sage-grouse (*see, e.g.,* 79 Fed. Reg. 69193; 75 Fed. Reg. 59805).

Sage-grouse are a landscape species (Connelly et al. 2011a). Migratory populations have large annual ranges that can encompass 1,042 mi^2 (667,184 ac) (Knick and Connelly 2011, citing Dalke et al. 1963; Schroeder et al. 1999; Leonard et al. 2000) (the species may use up to 2,500 mi2 per population (Rich and Altman 2001)). Large-bodied birds are generally more strongly affected by habitat loss and fragmentation (Winter et al. 2006). Developing and implementing conservation strategies at regional or landscape scales will have the greatest benefit for sage-grouse and their habitat (*see* Doherty et al. 2011). Given the importance of public lands to sagebrush conservation, the sensitivity of these lands to disturbance, longer recovery periods and variable response to restoration, and their susceptibility to invasion by exotic plants (Knick 2011), land uses that negatively affect these lands should be avoided or prohibited in key habitat areas to conserve sage-grouse habitat. Establishing a system of habitat reserves in sagebrush steppe will also help conserve essential habitat and ecological processes important to sage-grouse conservation. (See also, Winter et al. 2006; Connelly et al. 2011b; Manier et al. 2013: 25-26)

Recommendation: *Identify and protect sage-grouse essential habitat.*

- *Identify and conserve essential sage-grouse habitat (Connelly et al. 2011; Manier et al. 2013; COT 2013; Aldridge et al. 2008).*
- *Manage or restore essential habitat so that at least 70 percent of the land cover is sagebrush steppe sufficient to support sage-grouse (SGNTT 2011: 6, citing Aldridge et al. 2008; Doherty et al. 2010; Wisdom et al. 2011; also SGNTT 2011: 7; Karl and Sadowski 2005; Doherty 2008; Connelly et al. 2000: 977, Table 3; Knick et al. 2013: 5-6) with 15 to 40 percent sagebrush canopy cover (Connelly et al. 2000; SGNTT 2011: 26, citing Connelly et al. 2000; Hagen et al. 2007).*
- *Identify and protect sage-grouse wintering areas (SGNTT 2011: 21; Braun et al. 2005, citing Connelly et al. 2000 and others; Moynahan et al. 2007; Walker et al. 2007; Caudill et al. 2013).*
- *Identify and protect habitat connectivity corridors to prevent or redress population isolation (SGNTT 2011: 5, 7; Crist et al. 2015).*

Recommendation: *Limit development impacts.*

- *Restrict development to one site per section in essential habitat (SGNTT 2011: 21; Holloran 2005; Doherty et al. 2010; Doherty 2008), or an average of one site per section per analysis area where appropriate to support conservation goals (see, e.g., Miles City Field Office Approved Resource Management Plan for Greater Sage-Grouse: 2-5, Table 2-4).*
- *Limit surface disturbance to less than 3 percent per section in essential habitat (SGNTT 2011: 7; Knick et al. 2013; see also Baruch-Mordo et al. 2013: 237, Figure B).*
- *Prohibit noise levels associated with any anthropogenic activity to not exceed 10 dBA above scientifically established natural ambient noise levels at the periphery of sage-grouse mating, foraging, nesting, brood-rearing and winter habitat during each season of use by sage-grouse (Patricelli et al. 2013; Patricelli et al. 2012 (report); SGNTT 2011:*

64, citing Patricelli et al. 2010).[3]

Recommendation: *Avoid impacts from mineral development.*

- *Close and recommend for immediate withdrawal lands from location, leasing or sale (including coal) in essential habitat under federal mineral laws for the maximum period allowed under law (SGNTT 2011: 22, 24-25, 26).*
- *Require conditions of approval for existing fluid minerals leases in essential habitat as outlined in the National Technical Team report, including 4-mile no-surface-occupancy lek buffers (SGNTT 2011: 22-24). Larger buffers may be required to conserve the species.*[4]
- *Limit geophysical exploration on existing fluid minerals leases in essential habitat to helicopter-portable methods or vehicles confined to existing roads in priority habitat, and in accordance with seasonal and other applicable restrictions (SGNTT 2011: 21, 22).*
- *Prohibit surface storage of wastewater generated from fluid minerals development in essential habitat (SGNTT 2011: 64); breach and eliminate existing wastewater reservoirs (SGNTT 2011: 64).*

Recommendation: *Avoid impacts from renewable energy development.*

- *Prohibit renewable energy development in essential habitat (SGNTT 2011: 13).*

Recommendation: *Avoid impacts from rights-of-way.*

- *Exclude new rights-of-way in essential habitat (SGNTT 2011: 12).*
- *Develop valid existing rights-of-way in essential habitat in accordance with National Technical Team report prescriptions (SGNTT 2011: 13).*
- *Bury existing transmission lines in essential habitat, where possible (SGNTT 2011: 13).*

Recommendation: *Minimize impacts from livestock grazing.*

- *Require that grazing strategies maintain at least seven inches average grass height in nesting and brood-rearing habitat in sage-grouse range (Connelly et al. 2000).*
- *Restrict or prohibit grazing until the completion of sage-grouse breeding and nesting period, and seasonally remove livestock from late brood-rearing habitat to allow sufficient regrowth of native grasses to ensure adequate residual height. Limited winter grazing may be appropriate, as long as it leaves sufficient residual grass height for*

---

[3] Patricelli et al. (2012) recommend measuring compliance with noise objectives at the edge of areas critical for foraging, nesting and brood-rearing rather than at the edge of the lek.

[4] A 4-mile lek buffer may include an average of 80 percent of nesting females (SGNTT 2011: 21); larger buffers may be recommended to conserve the species (6.2 miles, Aldridge and Boyce 2007; 6.2 miles, Doherty et al. 2010; 5.3 miles, Holloran and Anderson 2005; 4.6 miles, Coates et al. 2013).

*nesting the next breeding season (W. Watersheds Project v. Salazar, 843 F.Supp.2d 1105, 1115 (D. Idaho 2012), citing Braun (2006, unpublished); W. Watersheds Project v. Dyer, 2009 WL 484438, at * 21 (D. Idaho 2009)).*

- *Control grazing to avoid contributing to the spread of cheatgrass in sage-grouse habitat (Reisner et al. 2013; Chambers 2008; Reisner 2010 (dissertation)).*
- *Manage riparian and wetlands to meet properly functioning condition; manage wet meadows to maintain native species diversity and cover to support sage-grouse brood-rearing (Connelly et al. 2000).*
- Avoid new structural range and livestock water developments in essential habitat; institute best management practices to prevent or limit and mitigate the potential spread of West Nile virus (SGNTT 2011: 17).

Recommendation: *Manage vegetation to meet Gunnison sage-grouse habitat requirements.*

- *Prohibit prescribed fire in sagebrush steppe with less than 12 inches annual precipitation (SGNTT 2011: 26, citing Connelly et al. 2000; Hagen et al. 2007; Beck et al. 2009) or areas with moderate or high potential for cheatgrass incursion (Miller et al. 2011).*
- *Prohibit vegetation treatments that reduce sagebrush canopy cover to less than 15 percent (SGNTT 2011: 26, citing Connelly et al. 2000; Hagen et al. 2007).*[5]
- *In areas of pinyon/juniper, avoid treating old-growth or persistent woodlands. In areas where sagebrush is prevalent or where cheatgrass is a concern, utilize mechanical methods rather than prescribed fire.*
- *Restore non-native seedings with native vegetation where it would benefit sage-grouse (SGNTT 2011: 16-17).*
- *Prohibit herbicide application within 1 mile of sage-grouse habitats during season of use; prohibit use of insecticides (Blus et al. 1989).*

Recommendation: *manage travel to minimize habitat impacts and avoid and limit travel infrastructure.*

- *Limit motorized and mechanized travel to designated routes in essential habitat (SGNTT 2011: 11).*
- *Implement appropriate seasonal restrictions on human travel to avoid disrupting sage-grouse during season of use (Holloran 2005; Aldridge et al. 2012).*
- *Seasonally close designated travel routes within 4 miles of sage-grouse leks between March 1-June 30.*

[5] Vegetation treatments may not be advised within 2 - 2.7 miles of sage-grouse leks (Beck and Mitchell 1997; Heath et al. 1997) or where sagebrush canopy cover is less than 20 percent (Beck and Mitchell 1997) or in sage-grouse winter habitat (Connelly et al. 2000; Eng and Schladweiler 1972).

- *Seasonally close designated travel routes and prohibit over snow vehicle travel in identified sage-grouse winter range between December 1 and March 15 (CPW 2016).*
- *Close existing trails and roads to achieve an open road and trail density not greater than 1 km/1km^2 (.6 mi/.6 mi^2) in essential habitat (Knick et al. 2013).*
- *Where valid existing rights-of-way are developed, restrict road construction within 1.9 miles of sage-grouse leks (Holloran 2005).*
- *Limit the construction of tall facilities and fences to minimize the number of new perches for Gunnison sage-grouse bird predators.*
- *Install anti-perching devices on transmission poles and towers (SGNTT 2011: 64, citing Lammers and Collopy 2007). Dismantle unnecessary infrastructure.*

Recommendation: *The Forest Service should also consider protecting sage-grouse habitat as a special management area to support long-term conservation of sage-grouse and other sagebrush-dependent species. The agency could apply additional measures to conserve grouse beyond those prescribed for essential habitat, including prioritizing the areas for land acquisition, habitat restoration, and retirement of lease rights and grazing privileges. All public land in important habitat should be retained in public ownership.*

Recommendation: *Include a standard that prohibits noise levels associated with any anthropogenic activity from exceeding 10 dBA above scientifically established natural ambient noise levels at the periphery of sage grouse mating, foraging, nesting, brood-rearing, and winter habitat during each season of use by sage-grouse (Patricelli et al. 2013; SGNTT 2011: 64, citing Patricelli et al. 2010). Patricelli et al. (2012) recommend measuring compliance with noise objectives at the edge of areas critical for foraging, nesting and brood-rearing rather than at the edge of the lek.*

2. Species of Conservation Concern (SCC)

Because the GMUG has not revised its SCC list, we provide the following recommendations for these select species as examples to provide a starting point for plan component development.

a. Boreal Toad

In 2001, the Boreal Toad Recovery Team believed that Boreal Toads occupied less than one percent of their historic breeding areas in the Southern Rocky Mountains (Loeffler 2001). Though the primary cause of boreal toad decline is chytrid fungus (*Batrachochytrium dendrobatidis*) (Bd), there are several management actions the GMUG could take to improve protection, conditions, and outcomes for the species. The Forest Service's Region 2 Boreal Toad

(*Bufo boreas boreas*): A Technical Conservation Assessment (Keinath and McGee 2005: 41-45) recommended the following management actions for managing disease, determining population status, monitoring known populations, delineating important habitat, and protecting suitable habitat and also recommended tools and practices to guide population and habitat management, all summarized below.

Recommendation: *Conduct disease management precautions.*

- *If newly evolved environmental stressors (e.g., increased UV radiation, chemical contamination, decreased water quality, human disturbance) facilitate chytrid 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.*
- *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.*
- *If some toads exhibit natural resistance to infection, then those animals should be the focal point of captive breeding and reintroduction programs.*

Recommendation: *Known breeding populations must be monitored to track changes in abundance and behavior and to evaluate impacts of management actions (see "Inventory and monitoring" section).*

Recommendation: *Protect important habitat.*

- *Managers should identify important terrestrial habitats (i.e., foraging areas, over-wintering sites, and movement corridors) and aquatic habitats (i.e., permanent ponds and river and stream habitats within 2.5 km of known breeding ponds). Managers should then assign priorities for protecting and monitoring boreal toad habitats, wherein the healthiest populations receive greater priority.*
- *To insure population persistence, important habitat must be protected from natural and human-caused disturbances that could potentially threaten the survival of boreal toads at the local, population, and/or landscape scale. This includes not only the breeding sites, but also the network of upland habitat and migration corridors. Habitats with chytrid-free populations should receive high priority for protection.*

Recommendation: *Habitats that may be suitable for breeding, foraging, over-wintering, or migration by boreal toads should be surveyed prior to any management activity that could impact the toads or their habitat. If the loss or deterioration of boreal toad habitat is inevitable,* *then design features and mitigation measures should be implemented to eliminate or minimize the adverse effects to habitat.*

Recommendation: *Limit impacts from timber harvest activities.*

- *Timber harvests that create uneven-age stands result in fewer disturbances to the understory and ground, which is preferred in boreal toad habitat.*
- *Fire and heavy equipment use can cause toad mortality, so post-sale treatments (e.g., scarification or fire) should be limited.*
- *Vehicle use of roads and skid trails in boreal toad habitat should be planned to avoid times of peak boreal toad activity, thus reducing road-kill mortality.*
- *Boreal toads disperse considerable distances (2.5 km) from breeding to upland forest sites (Bartelt 2000). Therefore, timber harvest within 2.5 km of known breeding sites should be limited during and immediately following the breeding season.*
- *Timber harvest can alter hydrologic patterns, and thus impact boreal toad breeding sites that may not be within the harvest boundaries. Therefore, managers should plan harvest activities designed to maintain water quality and quantity, and hydrologic functioning in proximate wetlands.*

Recommendation: *Maintain riparian areas and wetlands in proper functioning condition by conserving adequate vegetation, landform, or debris to:*

- *dissipate energy associated with stream flow, wind, and wave action*
- *filter sediment, capture bedload, and aid floodplain development*
- *improve flood-water retention and groundwater discharge*
- *develop root masses that stabilize stream banks against current action*
- *develop diverse pond characteristics to provide habitat, water depth, duration, and temperature to support diverse aquatic life.*
- *Maintain water quality and quantity at Clean Water Act standards as a minimum.*

Recommendation: *Limit impacts from livestock grazing.*

- *Maintain vegetative cover requirements necessary to meet the recovery needs of boreal toads.*
- *Locate toad movement corridors and protect them from the impacts of livestock grazing.*
- *Minimize incidences of trampling by livestock by fencing important habitat areas.*

Recommendation: *In areas where there are known boreal toad breeding sites, burning prescriptions should buffer habitats within 2.5 miles of the site and/or should be restricted to late fall through early spring, when boreal toads are less active. If prescribed fires cannot be avoided at these times and locations, then minimizing the rate of spread may allow toads to* *escape the flames. The use of fire retardants in or near boreal toad habitats, especially breeding sites or other aquatic habitats, should be avoided.*

Recommendation: *Residue from pesticide, herbicide, or fertilizer application can contain compounds detrimental to toads. Until the lethal and sublethal impacts of these commonly used chemicals are examined for all life history stages of the boreal toads, they should not be applied within at least 100 meters of wetlands.*

Recommendation: *Protect boreal toad populations from non-indigenous species.*

- *To protect boreal toad populations from the other potential threats posed by the presence of non-indigenous species, introductions of native and non-native fish and amphibians into occupied or suitable unoccupied boreal toad breeding habitats should be discouraged.*
- *Managers should keep the potential implications of nonnative species in mind when developing management or conservation strategies for mountain lakes and streams, and consider removal of these species where their presence is deemed detrimental to boreal toad populations or the larger native amphibian community.*

Recommendation: *Prevent habitat degradation and fragmentation.*

- *Water projects. Wetlands in occupied boreal toad habitat and suitable but unoccupied boreal toad habitats should not be drained or filled. If this is unavoidable, lost wetlands should be replaced at a minimum 2:1 ratio (i.e., two hectares of wetland should be created for each hectare lost). Development within at least 300 ft. (100 m) of known occupied and suitable but unoccupied boreal toad habitats should be avoided.*
- *Travel routes. Existing routes in occupied boreal toad habitats should be examined to determine whether they are a barrier to toad movement. Routes that represent a barrier to safe movement by toads between essential habitats (e.g., between ponds and uplands, or between neighboring ponds) should be modified, possibly by installing culverts or similar structures that allow toads to pass unhindered. Bridges and seasonal route closures may also be used to provide mitigation. Routes could be moved to avoid impact altogether. New routes should avoid suitable toad habitat and contain appropriate features to eliminate barriers to water flow and toad movement. Routes leading to sensitive wetlands may be seasonally or permanently closed to reduce use of those areas. Interpretive signs explaining modifications of travel should be posted in any area where modifications alter public access.*
- *Recreation. Campsites in or near occupied breeding ponds should be closed seasonally to protect breeding adults, egg masses, tadpoles, and toadlets. In unrestricted camping areas, fencing and signs should be used to seasonally restrict camping within at least*

100 ft. (34 m) of riparian areas. As with travel routes, interpretive signs explaining changes should be posted to improve the public's acceptance and compliance with these restrictions. The impacts from trail use should be evaluated annually in areas where they cross boreal toad breeding habitat. Trails that lead to or pass near occupied breeding sites should be closed seasonally, or permanently rerouted to avoid these areas. Newly constructed trails should avoid directing users to occupied breeding sites, and a buffer at least ½ mile (800 meters) should be placed between new trails and occupied breeding sites (CPW 2016). Off-road vehicle use should be managed to avoid riparian and wetland habitats.

b. Townsend's Big-eared Bat (*Corynorhinus townsendii*)

Townsend's big-eared bats depend on caves, mines, abandon buildings or the underside of bridges for general roosting, maternal roosting, and hibernation. Species persistence will depend on enabling continued access to caves, mines, and other roosting sites—both known, existing sites and potential habitable sites to promote the species' recovery. The Townsend big-eared bat has specialized habitat requirements that cannot be restored or maintained with ecosystem-focused, coarse-filter components alone. It is essential that management plan components protect roosting sites from human disturbance and minimize other threats and stressors. The Rio Grande National Forest 1996 LRMP includes a wildlife standard regarding the protection of caves and mines,

> Manage human disturbance at caves and abandoned mines where bat populations exist. When closing mines or caves for safety or protection reasons, reduce disturbance of residing bat populations and ensure bat access.

We recommend that this or a similar standard be retained in the revised management plan. The following recommendations have been adapted largely from the Forest Service's Region 2 Townsend's *Big-eared Bat (Corynorhinus townsendii): A Technical Conservation Assessment* (Gruver and Keinath 2006) and Colorado Parks and Wildlife State Wildlife Action Plan (CPW 2015).

Recommendation: *Protect roosts.*

- *Manage to eliminate or limit disturbance, such as from mining and recreation, of known and potential roost sites, especially to roost sites, maternity colonies, and hibernacula; human activity in and near roosts must be minimized or eliminated, particularly during reproductive and hibernal periods. (Gruver and Keinath 2006; CPW 2015)*

- *Assess of patterns of roost use and movement to better understand patterns of roost use and fidelity to adequately protect roosting habitat through time and to adequately assess population trends. (Gruver and Keinath 2006)*
- *Employ appropriate site-specific and/or species-specific techniques for closures and safety enhancements (CPW 2015: 224), such as, by using gates to enable bats access to caves while keeping people out. However, research has shown that gates can negatively affect Townsend's Big-eared Bats but that they may be adaptable in the long-term (Diamond and Diamond 2014). It is important when installing gates that the best available science be used to identify bat-compatible gates.*

Recommendation: *Manage recreation, research, management, and other human disturbances to control the spread of pathogens (CPW 2015: 224), i.e., to prevent white nose syndrome.*

Recommendation: *Timber harvest regimes, prescribed burns, and other vegetation management actions should maintain a mosaic of mature forest canopy that can be perpetuated through time. (Gruver and Keinath 2006)*

Recommendation: *Prevent chemical exposure.*

- *Elimination of exposure to toxins by remediating indirect sources of exposure to toxins and eliminate direct exposure will benefit this and other species of wildlife. (Gruver and Keinath 2006)*
- *Reduce or eliminate herbicide and pesticide use to prevent the reduction in prey from spraying or runoff. (CPW 2015: 224)*

c. Western Bumblebee (*Bombus occidentalis*)

Hatfield et al. (2012) described the following threats to North America bumble bees: habitat fragmentation, livestock grazing, insecticide and herbicide use, loss of genetic diversity, pests and disease, competition with honey bees, and climate change. An additional threat includes fire suppression (Defenders of Wildlife 2015). For a more detailed description of threats to help guide management, see: "A Petition to list the Western Bumble Bee (*Bombus occidentalis*) as an Endangered, or Alternatively as a Threatened, Species Pursuant to the Endangered Species Act and for the Designation of Critical Habitat for this Species," by Defenders of Wildlife (2015). The following management recommendations are adapted from the Forest Service's own recommendations in *Conservation and Management of North American Bumble Bees* (Schweitzer et al. 2012) and the Xerces Society's Conserving Bumble Bees: Guidelines for Creating and Managing Habitat for America's Declining Pollinators (Hatfield et al. 2012).

Recommendation: *Promote ecological integrity of bumblebee habitat and promote habitat connectivity.*

- *Provide habitat for nesting and overwintering sites. (Schweitzer et al. 2012: 3)*
- *When nesting sites are limited, consider providing artificial nest boxes. (Schweitzer et al. 2012: 3)*
- *Assure continuity of nectar and pollen resources when bumble bees are active from spring to late summer. (Schweitzer et al. 2012: 3)*
- *Increase abundance and diversity of native wild flowers to improve bee density and diversity. (Schweitzer et al. 2012: 3)*
- *Ensure that nesting habitat is in close proximity (500-800 m; 0.3-0.5 mi) to foraging habitat. (Schweitzer et al. 2012: 3)*

Recommendation: *Prevent toxic pesticide and herbicide exposure.*

- *Minimize exposure to pesticides. (Schweitzer et al. 2012: 3)*
- *When spraying is necessary, do so under conditions that promote rapid breakdown of toxins and avoid drift. (Schweitzer et al. 2012: 3)*
- *Use the least toxic and least concentrated application possible. (Hatfield et al. 2012: 15-16)*
- *Apply when bumble bees are not active: at night and in late fall or winter. (Hatfield et al. 2012: 16)*
- *Do not apply when plants are in bloom.*

Recommendation: *Use precautions when applying prescribed fire.*

- *Stagger the timing of prescribed burns to enable a continuous food supply. (Schweitzer et al. 2012: 3)*
- *Only burn a specific area once every 3-6 years. (Hatfield et al. 2012: 13)*
- *Burn from October through February. (Hatfield et al. 2012: 13)*
- *No more than one-third of the land area should be burned each year. (Hatfield et al. 2012: 14)*
- *Avoid high intensity fires. (Hatfield et al. 2012: 14)*

Recommendations: *Recommendations regarding livestock grazing include the following.*

- *Grazing on a site should occur for a short period of time, giving an extended period of recovery. (Hatfield et al. 2012: 14)*
- *Grazing on a site should only occur on approximately one-third of the land each year.*

d. Boreal Owl (*Aegolius funerus*)

In Colorado, boreal owls typically occur above 9,500 feet (2,900 meters) (Ryder et al. 1987), largely in spruce-fir forest (Hayward 1994b). They require at least 386 mi^2 (1,000 km^2) of suitable habitat (Hayward 1989; Hayward 1994a), given large home ranges and low populations densities (NatureServe 2015, *Aegolius funereus*). Male home ranges have been recorded up to 618 mi^2 (1,600 km^2) (Hayward 1994b, citing Palmer 1986). Given that boreal owls are secondary cavity nesters, the presence of primary cavity nesters (particularly woodpeckers) is essential for the owl. In Colorado, boreal owls tend to occur in mature, older, multilayered spruce-fir forest with trees of large diameter and high basal area (Hayward 1994a; NatureServe 2015, *Aegolius funereus*). They need large snags and large trees, including aspen, for nesting: a minimum of nine snags per acre greater than 13 inches in diameter at breast height (dbh) with some snags that must be at least 25 in dbh (Hayward 2008). To enable retention of sufficient snags for boreal owl nesting, projects cannot manage to the minimum. Post-disturbance salvage logging may not be a management practice that supports sufficient snag retention and density for a variety of snag-dependent species, including flammulated owls (Hutto 2006; Hutto et al. 2016).

Natural disturbance processes, such as fire and tree mortality due to insects and disease, help create forest heterogeneity preferred by boreal owls. A mosaic forest pattern tends to support a diversity of prey, particularly small mammals. Boreal owls likely assemble in a metapopulation structure (Hayward 1994b). While long-distance dispersing juveniles and emigrating adult owls are believed to be nomadic and can travel long distances, environmental changes may threaten species viability if they inhibit linkage between populations and reduce the size of habitat islands (Hayward 1994a).

Recommendation: *Protect habitat from adverse timber harvest effects.*

- *Silvicultural prescriptions must provide for large diameter trees well dispersed over space and time. The roosting, nesting, and foraging ecology of boreal owls in the western United States also suggests that mature and older forest must be well represented in the landscape to support a productive boreal owl population. (Hayward 1994b)*
- *Maintain existing habitats and enable development of subalpine forest conditions within stands that are currently in mid-seral structural stages. (Wisdom et al. 2000)*
- *Avoid extensive use of clearcuts, which may reduce habitat quality for 100 to 200 years. Small patch cuts implemented on long rotations may be compatible with maintenance of habitat quality for boreal owls. Thinning from below may provide for development of nest structures. (Wisdom et al. 2000)*

- *Retain large-diameter snags at greater than 13 in dbh, on average, and some snags and greater than 25 in dbh in suitable habitat areas and provide for snags at a minimum of nine per acre. (Wisdom et al. 2000; Hayward 2008)*
- *Determine potential snag densities for suitable and restoration habitats by conducting surveys. Use these baseline data to determine whether snags are below potential in other areas. Provide measures for snag protection and recruitment in all timber harvest plans. (Wisdom et al. 2000)*

Recommendation: *Provide for connectivity. Provide or develop linkages among subpopulations. Evaluate linkages among subpopulations and use that information to identify areas that are highest priority for retention and restoration of habitat. This is of particular concern, where reduction in the extent of source habitats has increased the isolation of remaining habitat patches. (Wisdom et al. 2000)*

Recommendation: *Include boreal owl conservation within a larger, ecosystem context that addresses management of primary cavity nesters, small mammals, and forest structural components (Hayward 1994a).*

e. Flammulated Owl (*Otus flamineolus*)

Flammulated owls tend to prefer Ponderosa pine forest and also use aspen forest and mixed conifer-aspen forest, which is apparently typical in the GMUG. They are secondary cavity nesters and need a high density of large snags. Given a decline of large ponderosa pine trees range-wide, available snags may be a limiting factor for flammulated owl persistence and recovery.

Recommendation: *Retain large snags at sufficient densities. They may prefer snags >25 in dbh, and the low threshold may be 2-8 snags/ac at >13 in dbh (Manley et al. 2004). Nelson et al. (2009) found that a minimum threshold for snag dbh may be 12 in but average at 20 in dbh. Post-disturbance salvage logging may not be a management practice that supports sufficient snag retention and density for a variety of snag-dependent species, including flammulated owls (Hutto 2006; Hutto et al. 2016).*

f. Prairie Dogs, Gunnison's (*Cynomys gunnisoni*) and White-tailed (*C. luecurus*)

Stressors and threats to prairie dogs and habitat include shooting, poor range condition, energy and mineral development, plague, poisoning, poor habitat connectivity, and destruction of habitat through motorized use and other activities (Pauli and Buskirk 2007; Seglund and Schnurr 2010). Several of these cannot be addressed with coarse-filter, ecosystem plan components. Thus, it is important to incorporate fine-filter plan components to maintain and restore viable populations of prairie dogs and well-distributed prairie dog colonies to promote grassland integrity.

Preservation of prairie dog colonies and associated ecological benefits cannot be limited to merely protection of existing colonies. Studies of population dynamics of prairie dog towns have resulted in the following management recommendation: creation and preservation of "a network of native prairie reserves strategically located across the historical range of this species," which would include "clusters ('complexes') of large towns, as well as large, but isolated prairie dog towns" (Lomolino and Smith 2003). This approach necessitates a landscape-level approach to grassland conservation and habitat, including the elimination of barriers to prairie dog movement and expansion that may exist. Prairie dogs are not only indicators of grassland integrity but grassland restoration management tools and should be considered as a focal species for monitoring. We recommend the following as a starting point for developing plan components (see Seglund and Schurr 2010).

Recommendation: *At least one desired condition should be developed that is specific to maintaining and restoring occupied prairie dog colonies. It should include, at a minimum, providing for viable populations of prairie dogs and an increasing trend in populations; maintaining and restoring colonies that are well-distributed throughout the Forest's grasslands and shrublands; establishing sufficient prairie dog numbers and colonies to enable the persistence of obligate prairie dog species including burrowing owls, ferruginous hawks, kit foxes, and mountain plovers, with a goal of creating the capacity to support a self-sustaining population of black-footed ferrets; and enabling connectivity between colonies and complexes to maintain genetic diversity.*

Recommendation: *Develop plan standards that address the following threats.*

- Prohibit recreational shooting of prairie dogs.
- Prohibit lethal control of prairie dogs.
- Close and obliterate roads and motorized activity in and around prairie dog colonies and re-introduction sites to minimize disturbance and discourage shooting.
- Prevent plague by implementing a plague management and reduction programs that includes the use of insecticide dusting and vaccination. (see Seglund and Schnurr 2010).
- Minimize impacts of energy and/or mineral development on prairie dogs. (adapted from Seglund and Schnurr 2010).

Recommendation: *Consider the following for developing guidelines.*

- Identify and implement feasible and effective techniques to assist in prairie dog population recovery following plague epizootic events. (adapted from Seglund and Schnurr 2010).
- Develop a public education program to expand the understanding and appreciation of the prairie dog's role in grass- and shrubland ecosystems.
- Reintroduce and translocate prairie dogs to augment the Forest's prairie dog populations.
- Work with other public land agencies and stakeholders to identify management emphasis areas where intensive management can focus on landscape scale conservation for the entire prairie dog ecosystem. (adapted from Seglund and Schnurr 2010)
- Develop a plague surveillance program to enable immediate management of plague outbreaks (adapted from Seglund and Schnurr 2010).

IV. Monitoring

A. General Comments

It is important not to think of monitoring as an afterthought to the planning process. In fact, monitoring should be foremost in mind when developing the plan. For example, when drafting a desired condition, it is useful to think: How will we measure this? "Monitoring information should enable the responsible official to determine if a change in plan components" may be needed (36 CFR 219.12(a)(1)). Monitoring within a planning framework should provide for accountability to support a legitimate adaptive management program.

Much thought should be given to the "select set of ecological conditions" (219.12(a)(5)(iv)). Those ecological conditions that are most heavily dependent on assumptions should be prioritized for monitoring, in that they carry the most risk for at-risk species; cases where that risk of uncertainty is compounded by management effects are highest priority.

We recommend that the Forest Service refer to: *Applying the 2012 Planning Rule to Conserve Species: A Practitioner's Reference*, when developing a monitoring approach (and other approaches) to at-risk species (Hayward et al. 2016: 43). The report correctly points out that monitoring of ecological conditions alone "is less useful when habitat and population dynamics are poorly linked…" (p. 45). Monitoring ecological conditions alone carries some risk for those types of species and thus the authors point out that "[neither] the rule nor the directives explicitly preclude measuring the occurrence, distribution, abundance, or other population parameters of at-risk species as an indicator of plan effectiveness" (p. 46). Fiscal realities must be considered as well, and priority for population monitoring should be given to cases of high risk.

B. Focal Species

The planning rule addresses focal species in conjunction with the plan monitoring program developed by the responsible official (36 CFR § 219.12(a)(5)(iii)). The purposes of focal species are to permit "inference to the integrity of the larger ecological system to which it belongs" and provide "meaningful information regarding the effectiveness of the plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area" (36 CFR. § 219.19). The rule also includes requirements for the use of focal species. Focal species are employed in the plan monitoring program to evaluate the effectiveness of the forest plan in meeting the diversity requirements (36 C.F.R. § 219.12(a)(5)(iii)). Effective monitoring may require that some SCC be selected as focal species. The Forest should track the status of focal species throughout the life of the management plan. Species that are either known or hypothesized to be particularly sensitive to climate disruptions should be strongly considered. A great resource for selecting and monitoring focal species is, *Technical Reference on Using Surrogate Species for Landscape Conservation* (USFWS 2015). Below are just a few examples of potential focal species for the GMUG.

1. American Beaver (*Castor canadensis*)

The ecological benefits beavers provide cannot be overstated. By building dams that impound water, beavers alter the surrounding environment to the benefit of a wide variety of plants, fish, and wildlife. We strongly recommend that the GMUG design plan components to protect and restore beaver to the forest and select the beaver as a focal species to help monitor integrity of aquatic and riparian ecosystems on the forest. The Forest Service and USFWS have guides for restoring beavers and the ecosystem services they provide (USFS undated; USFWS et al. 2015).

Beavers are considered keystone, or strongly interactive, species. A technical conservation assessment of beavers prepared for the Rocky Mountain Region (Region 2) acknowledged the interactive role of the rodents in riparian systems (Boyle and Owens 2007). Studies have demonstrated the negative consequences of beaver losses as well as the ecosystem services beavers provide through their dam building (Naiman et al. 1994; Gurnell 1998; Wright et al. 2002; Butler and Malanson 2005; Westbrook et al. 2006; Stevens et al. 2007; Bartel et al. 2010; Westbrook et al. 2011). Miller et al. 2003: 188, citing Naiman et al. (1988) and Gurnell (1998), presented a long list of documented ecological impacts of beaver engineering:

> stabilization of stream flows; increased wetted surface area (i.e. benthic habitat); elevation of water tables causing changes in floodplain plant communities; creation of forest openings; creation of conditions favoring wildlife that depend upon ponds, pond edges, dead trees, or other new habitats created by beavers; enhancement or degradation of conditions for various species of fish; replacement of lotic invertebrate taxa (e.g., shredders and scrapers) by lentic forms (e.g., collectors and predators); increased invertebrate biomass; increased plankton productivity; reduced stream turbidity; increased nutrient availability; increased carbon turnover time; increased nitrogen fixation by microbes; increased aerobic respiration; increased methane production; reduced spring and summer oxygen levels in beaver ponds; and increased ecosystem resistance to perturbations.

Allowing beavers to play their role as natures engineers will result in a variety of other benefits to the surrounding ecosystem including reconnected and expanded floodplains; higher summer base flows; expanded wetlands; improved water quality; greater habitat complexity; more diversity and richness in the populations of plants, birds, fish, amphibians, reptiles, and mammals; and overall increased complexity of the riverine ecosystems. These attributes are the hallmarks of properly functioning and resilient ecosystems. Beaver ponds provide winter habitat for cutthroat trout (Pritchard and Cowley 2006) and breeding habitat for boreal toads (Keinath and McGee 2005), two potential species of conservation concern that occur on the GMUG. Additionally, the presence of beaver dams and the functional populations of beaver in suitable habitats contribute to resilience in the face of climate change (Bird et al. 2011). Indeed, beavers are often precisely the prescription that scientists and agencies identify as necessary to improve habitat conditions for degraded habitats and imperiled species. The Aquatic, Riparian and Wetland Assessment (p. 6) benefits of beaver “engineering” and that beavers likely played a significant role in helping establish wetlands and riparian areas.

We strongly encourage the Forest Service to develop the desired condition, objectives, standards, and guidelines for Aquatic Ecosystems and Native Animals directed at: 1) protecting existing beaver populations and 2) identifying areas that would benefit from the addition of beavers into the watershed, and establishing the mechanisms for seeing that beavers return to those areas.

As discussed above, focal species have two primary functions in the planning process, as indicators of integrity and as measures of effectiveness of plans in providing ecological conditions for diversity and species persistence, including the persistence of at-risk species.

There is also sufficient interest and concern in the health of the watersheds and riparian areas to justify the beaver being selected as a focal species. The rising temperature due to climate change has water supplies becoming increasingly scarce, leading to conflict between competing uses of water resources. There has been a negative transformation of the landscape due to the increased frequency of drought, wildfire, flooding, and invasive species. Clearly, as described above, beavers are indicators of ecological integrity, and should be selected as focal species for this reason. They should also be selected as focal species based on their ability to provide ecological conditions needed for at-risk species, including increased habitat and habitat heterogeneity for at-risk fish species in the forest planning areas.

Designating beavers as focal species, and identifying beaver habitat characteristics as key/desired ecological conditions, would result in the monitoring of beaver populations and habitat conditions in the watershed and riparian areas of the GMUG. This monitoring information would be a reliable source to measure and study trends in the health of these ecosystems through variations of climate change.

2. Woodpeckers

Woodpeckers are indicators for a range of ecosystem conditions, especially snag densities, sizes, decay rates (Hilty and Merenlender 2000; Haggard and Gaines 2001; Bate et al. 2008; Nappi et al. 2015). Woodpeckers are keystone species in conifer-dominated forests as primary cavity excavators that benefit a range of secondary cavity-using wildlife (Tarbill et al. 2015). The GMUG should consider designating woodpecker species to serve as focal species. Candidates include, among others, the hairy woodpeckers (*Picoides villosus*), which are associated with unlogged burned habitats with high snag densities; they avoid areas with low snag densities (Haggard and Gaines 2001; Saab et al. 2009) and the northern flicker (*Colaptes auratus*), which are associated with green, unburned forests (Tarbill et al. 2015).

3. Snowshoe Hare (*Lepus americanus*)

Research by Thornton et al. (2012) and Holbrook et al. (2017) indicates the snowshoe hare would make a suitable focal species for forest horizontal cover and vegetation management effects. Snowshoe hare density can be measured as a monitoring procedure (*c.f.*, Mills et al. 2005). A periodic sampling of hare density would not only provide information that gets closer to measuring lynx recovery trends, but would also help answer key about the impacts of vegetation treatments on forest cover.

4. Northern Goshawk (*Accipiter gentilis*)

We suggest the use of northern goshawk as a focal species in assessing management effectiveness in achieving desired conditions in forested ecosystems. We consider designation as a focal species a timely opportunity for the GMUG to gain a better understanding of management actions on the species. Northern goshawks use a variety of forest types, but tend to nest primarily in ponderosa pine and Douglas fir forests (Boyce et al. 2006). However, they also use aspen forest and mixed conifer-aspen forest, which is apparently characteristic for the species in the GMUG. They prefer mature forest structure with high canopy cover, large trees, and relatively high trees per acre (Greenwald et al. 2005). They are indicators of the integrity of mature, old growth forest structure and composition and a sufficient forest prey base of small mammals and birds and have been recommended as indicator species in several studies (Hilty and Merenlender 2000).

Threats include timber harvesting, in particular, and severe fires as well as fuel treatments. Home range size is estimated to be 2,000-3,000 ha (Boyce et al. 2006). Territories average being within 1.6 km from nest sites and goshawks have strong nest site fidelity. Long distance movements should be considered in scale consideration for management (Graham et al. 1999) and the need for large areas of connected habitat. The Forest Service has a monitoring guide for the Northern goshawk (Woodbridge and Hargis 2006). Over 70 percent of the goshawk's prey species depend upon mid-aged forests or older for nesting, foraging or both, making their population levels and viability an excellent indicator for forest conditions generally. More science is needed to determine which management practices actually benefit the goshawk, and what its population trajectories are. This species should be closely monitored through the focal species monitoring program.

5. Prairie Dogs

We encourage the Forest Service to consider the Gunnison's and white-tailed prairie dogs as focal species, whose presence is an indicator of grassland health. Biologists consider prairie dogs keystone species (Miller et al. 1994; Kotliar et al. 1999; Davidson and Lightfoot 2006). A multitude of species benefit from prairie dogs and their colonies (Miller et al. 1994; Kotliar et al. 1999). The Forest Service may be considering at least three of these species—burrowing owl, mountain plover, and ferruginous hawk—as SCCs These species are at-risk across their range, and their ranges overlap with the GMUG.

6. Brewer's Sparrow (*Spizella breweri*)

Research of the sagebrush ecosystem indicates the Brewer's sparrow as a useful focal species (Chalfoun and Martin 2007; Haegen 2007)

V. Land Designations

We endorse the Citizens' Wilderness and Designations Proposal for the GMUG, posted at: https://www.gmugrevision.com/. Each proposed area is described in Appendix 1 of the HCCA-TWS et al. 2018 scoping comments.

Designating protected areas across the landscape is one of the best ways to protect species strongholds: important habitat areas for endangered, threatened, rare, and other vulnerable species that play an essential role in contributing to at-risk species recovery and viability. Management planning can support species conservation and recovery by identifying, designating, and protecting species strongholds on the GMUG. The Forest can play a vital role as a reserve network of species strongholds that can conserve core habitat areas and wildlife movement corridors by reducing threats, maintaining and restoring biodiversity, and enabling species to better adapt to climate change impacts.

The protected reserve concept is grounded in the BASI for establishing a network of protected and connected key habitats for species across federal public lands at the plan area scale. This approach is based on years of research on systematic conservation planning (Margules and Pressey 2000; Noon et al. 2009), reserve design (Carroll et al. 2010), and protected area strategies (Loucks et al. 2003; Dickson et al. 2014).

VI. Meeting National Environmental Policy Act (NEPA) and ESA Requirements

Please see Appendix 1 regarding NEPA requirements for the Environmental Impact Statement and meeting ESA requirements.

VII. Conclusion

We appreciate the time and effort the GMUG planning team has put into the plan revision process, requiring a multitude of hours on research and other tasks and after-hours work conducting public meetings. We look forward to continuing our engagement with the Forest on the plan revision. We are confident the revised plan will provide a strong framework for conserving the Forest's great diversity of wildlife and habitat.

VIII. Literature Cited

Habitat Connectivity

Trombulak, S.C., and C.A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1): 18-30.

Canada Lynx

Aubry, K.B, G.M. Koehler, and J.R. Squires, 1999. Ecology of Canada lynx in southern boreal forests. In: Ecology and Conservation of Lynx in the United States. USDA Forest Service General Technical Report RMRS GTR-30WWW, October.

Buskirk, S.W., L.F. Ruggiero, and C.J. Krebs. 1999. Habitat fragmentation and interspecific competition: implications for lynx conservation. In Ecology and conservation of lynx in the United States. Ruggiero, L.F et al. (eds) 83-100.

Burghardt-Dowd, J.L.B., 2010. Coyote diet and movements in relation to winter recreation in northwestern Wyoming: implications for lynx conservation. Utah State University.

Holbrook, J.D., J.R. Squires, L.E. Olson, N.J. DeCesare, and R.L. Lawrence. 2017. Understanding and predicting habitat for wildlife conservation: the case of Canada lynx at the range periphery. Ecosphere 8(9): 1-25.

Interagency Lynx Biology Team. 2013. Canada lynx conservation assessment and strategy. 3rd edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication R1-13-19, Missoula, MT. 128 pp.

Kosterman, M.K. 2014. Correlates of Canada Lynx Reproductive Success in Northwestern Montana. Master of Science, Thesis. University of Montana, Missoula, MT. December.

Mills, L.S., P.C. Griffin, K.E. Hodges, K. McKelvey, L. Ruggiero, and T. Ulizio. 2005. Pellet count indices compared to mark–recapture estimates for evaluating snowshoe hare density. Journal of Wildlife Management 69(3): 1053-1062.

Peers, M.J.L., D.H. Thornton, and D.L. Murray. 2013. Evidence for large-scale effects of competition: niche displacement in Canada lynx and bobcat. Proc R Soc B 280: 20132495.

http://dx.doi.org/10.1098/rspb.2013.2495.

Squires, J.R., N.J. Decesare, J.A Kolbe, and L.F. Ruggiero. 2010. Seasonal resource selection of Canada lynx in managed forests of the northern Rocky Mountains. Journal of Wildlife Management 74(8): 1648-1660.

Squires, J., J. Holbrook, L. Olson, J. Ivan, and R. Ghormley. 2017. Response of Canada Lynx and Snowshoe Hares to Spruce-Beetle Tree Mortality and Wildfire in Spruce-fir Forests of Southern Colorado. May 9.

Gunnison Sage-grouse

Aldridge, C. L., S. E. Nielsen, H. L. Beyer, M. S. Boyce, J. W. Connelly, S. T. Knick, M. A. Schroeder. 2008. Range-wide patterns of Greater Sage-grouse persistence. Diversity and Distrib. 14(6): 983-994.

Aldridge, C. L., D. J. Saher, T. M. Childers, K. E. Stahlnecker, and Z. H. Bowen. 2012. Crucial nesting habitat for Gunnison sage-grouse: a spatially explicit hierarchical approach. Journal of Wildlife Management 76: 391-406.

Beck, J. L., J. W. Connelly, K. P. Reese. 2009. Recovery of greater sage-grouse habitat features in Wyoming big sagebrush following prescribed fire. Restoration Ecol. 17(3): 393-403.

Beschta, R. L., D. L. Donahue, D. A. DellaSala, J. J. Rhodes, J. R. Karr, M. H. O'Brien, T. L. Fleischner, C. Deacon-Williams, Cindy. 2012. Adapting to climate change on western public lands: addressing the ecological effects of domestic, wild, and feral ungulates. Environmental Management, available at http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/Beschta/Beschta _2012EnvMan.pdf.

Blickley, J. L., K. R. Word, A. H. Krakauer, J. L. Phillips, S. N. Sells, C. C. Taff, J. C. Wingfield, G.L. Patricelli. 2012. Experimental chronic noise is related to elevated fecal corticosteroid metabolites in lekking male greater sage-grouse (*Centrocercus urophasianus*). PLoS ONE 7(11): e50462. doi:10.1371/journal.pone.0050462.

BLM & USFS (Bureau of Land Management, U.S. Forest Service). 1994. Rangeland Reform ’94 Draft Environmental Impact Statement. U.S. Department of Interior, Bureau of Land Management; U.S. Department of Agriculture, Forest Service. Washington, DC.

Braun, C. E., J. W. Connelly, M. A. Schroeder. 2005. Seasonal habitat requirements for sage-grouse: spring, summer, fall and winter. Pages 38-42 *in* N. L. Shaw, M. Pellant, S. B. Monsen (compilers). Sage-grouse Habitat Restoration Symposium Proceedings; June 4-7, 2001; Boise, ID. RMRS-P-38. U.S. Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Carpenter, J., C. Aldridge, M. S. Boyce. 2010. Sage-grouse habitat selection during winter in Alberta. J. Wildl. Manage. 74(8): 1806-1814.

Caudill, D., T.A. Messmer, B. Bibles, and M.R. Guttery. 2013. Winter habitat use by juvenile greater sage-grouse on Parker Mountain, Utah: implications for sagebrush management. Human-Wildlife Interactions 7(2): 250.

Chambers, J. C. 2008a. Climate change and the Great Basin. Pages 29-32 in J. C. Chambers, N. Devoe, and A. Evenden (eds.). Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Chambers, J. C. 2008b. Fire and the Great Basin. Pages 33-37 in J. C. Chambers, N. Devoe, and A. Evenden (eds.). Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action. Gen. Tech. Rep. RMRS-GTR-204. USDAForest Service, Rocky Mountain Research Station. Fort Collins, CO.

Chester, C. C., J. A. Hilty, S. C. Trombulak. 2012. Climate change science, impacts and opportunities. Pages 3-15 *in* Climate and Conservation: Landscape and Seascape Science, Planning, and Action. J. A. Hilty, C. C. Chester, M. S. Cross (eds.). Island Press. Washington, DC.

CPW (Colorado Parks and Wildlife). 2016. Best Management Practices to Minimize Adverse Impacts to Wildlife Resources. https://nhnm.unm.edu/sites/default/files/nonsensitive/newsfiles/Colorado%20Final%20Species_Specific%20BMPs_Oct%2017_101716.pdf.

Connelly, J. W., E. T. Rinkes, C. E. Braun. 2011a. Characteristics of Greater Sage-grouse habitats: a landscape species at micro and macro scales. Pages 69-83 *in* S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Connelly, J. W., S. T. Knick, C. E. Braun, W. L. Baker, E. A. Beever, T. J. Christiansen, K. E. Doherty,

E. O. Garton, C. A. Hagen, S. E. Hanser, D. H. Johnson, M. Leu, R. F. Miller, D. E. Naugle, S. J. Oyler-McCance, D. A. Pyke, K. P. Reese, M. A. Schroeder, S. J. Stiver, B. L. Walker, M. J. Wisdom. 2011b. Conservation of Greater Sage-grouse: a synthesis of current trends and future management. Pages 549-563 *in* S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Connelly, J. W., M. A. Schroeder, A. R. Sands, C. E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. Wildl. Soc'y Bull. 28(4): 967-985.

Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, E. F. Schlatterer. 1963. Ecology, productivity and management of sage grouse in Idaho. J. Wildl. Manage. 27: 811-841.

Doherty, K. E., D. E. Naugle, B. L. Walker, J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. J. Wildl. Manage. 72(1): 187-195.

Doherty, K. E., D. E. Naugle, H. E. Copeland, A. Pocewicz, J. M. Kiesecker. 2011. Energy development and conservation tradeoffs: systematic planning for greater sage-grouse in their eastern range. Pages 505-529 in S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

GSGRSC (Gunnison Sage-grouse Rangewide Steering Committee). 2005. Gunnison sage -grouse rangewide conservation plan. Colorado Division of Wildlife, Denver, Colorado, USA. http://cpw.state.co.us/learn/Pages/GunnisonSagegrouseConservationPlan.aspx.

Hagen, C. A., J. W. Connelly, M. A. Schroeder. 2007. A meta-analysis of greater sage-grouse *Centrocercus urophasianus* nesting and brood-rearing habitats. Wildl. Biol. 13 (Suppl. 1): 42-50.

Holechek, J. L., R. D. Pieper, C. H. Herbel. 2010. Range Management: Principles and Practices. 6th ed. Prentice-Hall. Upper Saddle River, NJ.

Holloran, M. J. 2005. Greater sage-grouse (Centrocercus urophaisianus) population response to natural gas field development in western Wyoming. PhD Diss., Univ. of Wyoming. Laramie, WY.

Holloran, M. J., B. J. Heath, A. G. Lyon, S. J. Slater, J. L. Kuipers, S. H. Anderson. 2005. Greater sage-grouse nesting habitat selection and success in Wyoming. J. Wildl. Manage. 69(2): 638-649.

Howe, K. B., P. S. Coates, D. J. Delehanty. 2014. Selection of anthropogenic features and vegetation characteristics by nesting Common Ravens in the sagebrush ecosystem. Condor 116: 35-49.

Jones, A. L. (ed). 2012. Best Management Practices for siting, developing, operating and monitoring renewable energy in the intermountain West: a conservationist's guide. Special publication. Wild Utah Project. Salt Lake City, UT.

Knick, S. T. 2011. Historical development, principal federal legislation and current management of sagebrush habitats: implications for conservation. Pages 13-31 in S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Knick, S.T. and J. W. Connelly (eds). 2011. Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Knick, S. T., S. E. Hanser, K. L. Preston. 2013. Modeling ecological minimum requirements for distribution of greater sage-grouse leks: implications for population connectivity across their western range, U.S.A. Ecology and Evolution, available at http://onlinelibrary.wiley.com/doi/10.1002/ece3.557/pdf.

Leonard, K. M., K. P. Reese, J. W. Connelly. 2000. Distribution, movements and habitats of sage grouse *Centrocercus urophasianus* on the Upper Snake River Plain of Idaho: changes from the 1950s to the 1990s. Wildl. Biol. 6: 265-270.

Manier, D. J., D. J. A. Wood, Z. H. Bowen, R. M. Donovan, M. J. Holloran, L. M. Juliusson, K. S. Mayne, S. J. Oyler-McCance, F. R. Quamen, D. J. Saher, A. J. Titolo. 2013. Summary of science, activities, programs, and policies that influence the range-wide conservation of greater sage-grouse (*Centrocercus urophasianus*). U.S. Geological Survey, Open-File Report 2013–1098; available at http://pubs.usgs.gov/of/2013/1098/.

Manville, A. M. 2004 Prairie Grouse Leks and Wind Turbines: U.S. Fish and Wildlife Service Justification for a 5-mile Buffer from Leks; Additional Grassland Songbird Recommendations (briefing paper). U.S. Fish and Wildlife Service, Division of Migratory Bird Management. Arlington, VA. Available at www.environment.ok.gov/documents/OKWindEnergy/PrairieGrouseLeksWindTurbines.pdf.

Meinke, C. W., S. T. Knick, D. A. Pyke. 2009. A spatial model to prioritize sagebrush landscapes in the intermountain west (U.S.A.) for restoration. Restoration Ecol. 17(5): 652-659.

Miller, R. F., S. T. Knick, D. A. Pyke, C. W. Meinke, S. E. Hanser, M. J. Wisdom, A. L. Hild. 2011. Characteristics of sagebrush habitats and limitations to long-term conservation. Pages 145-184 *in* S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Moynahan, B. J., M. S. Lindberg, J. J. Rotella, J. W. Thomas. 2007. Factors affecting nest survival of Greater Sage-grouse in northcentral Montana. J. Wildl. Manage. 71(6): 1773-1783.

NFWPCAS (National Fish, Wildlife and Plants Climate Adaption Partnership). 2012. National Fish, Wildlife and Plants Climate Adaption Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, DC.

Patricelli, G. L., J. L. Blickley, S. L. Hooper. 2013. Recommended management strategies to limit anthropogenic noise impacts on greater sage-grouse in Wyoming. Human-Wildlife Interactions 7(2): 230-249.

Patricelli, G.L., J.L. Blickley, and S. Hooper. 2010. Incorporating the impacts of noise pollution into greater sage-grouse conservation planning. 27th Meeting of the Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee Workshop. Twin Falls, Idaho, USA.

Pyke, D. A. 2011. Restoring and rehabilitating sagebrush habitats. Pages 531-548 *in* S. T. Knick and J. W. Connelly (eds). Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats. Studies in Avian Biol. Series, vol. 38. Cooper Ornithological Society. Univ. Calif. Press. Berkeley, CA.

Reisner, M. D. 2010. Drivers of plant community dynamics in sagebrush steppe ecosystems: cattle grazing, heat and water stress. PhD Diss. Oregon State Univ. Corvallis, OR.

Reisner, M. D., J. B. Grace, D. A. Pyke, P. S. Doescher. 2013. Conditions favouring *Bromus tectorum* dominance of endangered sagebrush steppe ecosystems. J. Applied Ecol., available at http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12097/pdf.

Rich, T. D., and B. Altman. 2001. Under the sage grouse umbrella. Bird Cons. 14: 10.

Rio Grande National Forest. Brewer's Sparrow (*Spizella breweri*). Fish and Wildlife Overview. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd534286.pdf.

Rio Grande National Forest. Gunnison sage-grouse (*Centrocercus minimus*). Fish and Wildlife Overview. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd534300.pdf;

Schroeder, M. A., J. R. Young, C. E. Braun. 1999. Sage grouse (*Centrocercus urophasianus*). Pages 1-28 *in* A. Poole and F. Gill (eds.). The Birds of North America, No. 425. The Birds of North America. Philadelphia, PA.

SGNTT (Sage-grouse National Technical Team). 2011. A Report on National Greater Sage-grouse Conservation Measures. Available at www.blm.gov/pgdata/etc/medialib/blm/wo/Information_Resources_Management/policy/im_fs/ 2012.Par.52415.File.dat/IM%202012-044%20Att%201.pdf.

Stiver, S. J., A. D. Apa, J. R. Bohne, S. D. Bunnell, P. A. Deibert, S. C. Gardner, M. A. Hilliard, C. W. McCarthy, M. A. Schroeder. 2006. Greater Sage-grouse Comprehensive Conservation Strategy. Western Association of Fish and Wildlife Agencies. Cheyenne, WY.

Walker, B. L., D. E. Naugle, K. E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. J. Wildl. Manage. 71(8): 2644-2654.

Winter, M., D. H. Johnson, J. A Shaffer. 2006. Does body size affect a bird's sensitivity to patch size and landscape structure? Condor 108(4): 808-816.

Wisdom, M. J., M. M. Rowland, R. J. Tausch. 2005b. Effective management strategies for sagegrouse and sagebrush: a question of triage? Trans. N. Wildl. Nat. Res. Conf. 70: 206-227.

Wisdom, M. J., M. M. Rowland, L. H. Suring, L. Schueck, C. W. Meinke, S. T. Knick, B. C. Wales. 2005a. Habitats for groups of species. Chap. 7 in part II: Regional assessment of habitats for species of conservation concern in the Great Basin. Pages 205-231 in M. J. Wisdom, M. M. Rowland, L. H. Suring (eds.). Habitat Threats in the Sagebrush Ecosystem: Methods of Regional Assessment and Applications in the Great Basin. Alliance Communications Group. Lawrence, KS.

Boreal Toad

Bartelt, P.E. 2000. A biophysical analysis of habitat selection in western toads (*Bufo boreas*) in Southeastern Idaho. Ph.D. Dissertation, Idaho State University, Pocatello, ID. 111 pp.

Keinath, D. and M. McGee. 2005. Boreal Toad (*Bufo boreas boreas*): A Technical Conservation Assessment. Prepared for USDA Forest Service, Rocky Mountain Region. May 25.

Townsend's Big-eared Bat

CPW (Colorado Parks and Wildlife). 2015. State Wildlife Action Plan.

Gruver, J.C. and D.A. Keinath. 2006. Townsend's Big-eared Bat (*Corynorhinus townsendii*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. October 25 Available: http://www.fs.fed.us/r2/projects/scp/assessments/townsendsbigearedbat.pdf.

Western Bumblebee

Defenders of Wildlife. 2015. A Petition to list the Western Bumble Bee (*Bombus occidentalis*) as an Endangered, or Alternatively as a Threatened, Species Pursuant to the Endangered Species Act and for the Designation of Critical Habitat for this Species. September 15.

Hatfield, R., S. Jepsen, E. Mader, S.H. Black. And M. Shepherd. 2012. Conserving Bumble Bess. Guidelines for Creating and Managing Habitat for America's Declining Pollinators. 32. Pp. Portland, OR: These Xerces Society for Invertebrate Conservation.

Schweitzer, D.F., N.A. Capuano, B.E. Young, and S.R. Colla. 2012. Conservation and Management of North American Bumble Bees. United States Department of Agriculture and NatureServe.

Boreal Owl

Hayward, G.D., 1989. Habitat use and population biology of Boreal Owls in the northern Rocky Mountains, USA (Doctoral dissertation, University of Idaho).

Hayward, G.D., 1994a. Conservation status of boreal owls in the United States.

Hayward, G.D., 1994b. Review of technical knowledge: Boreal owls.

Hayward, G.D. 2008. Response of Boreal Owl to Epidemic Mountain Pine Beetle-caused Tree Mortality Under a No-action Alternative.

Ryder, R.A., Palmer, D.A. and Rawinski, J.J., 1987, February. Distribution and status of the Boreal

Owl in Colorado. In Symposium proceedings: biology and conservation of northern forest owls (RW Nero, RJ Clark, RJ Knapton, and RH Hamre, eds). Gen. Tech. Rep. RM-142. USDA Forest Serv., Rocky Mt. Forest Range Exp. Sta., Fort Collins, CO (pp. 169-174).

Wisdom, M.J., Holthausen, R.S., Wales, B.C., Hargis, C.D., Saab, V.A., Lee, D.C., Hann, W.J., Rich, T.D., Rowland, M.M., Murphy, W.J. and Eames, M.R., 2000. Source habitats for terrestrial vertebrates of focus in the interior Columbia basin: broadscale trends and management implications. Volume 1—Overview. U.S. Forest Service. PNW-GTR-485. May.

Flammulated Owl

Hutto, Richard L. "Toward Meaningful Snag-Management Guidelines for Postfire Salvage Logging in North American Conifer Forests." Conservation Biology 20, no. 4 (2006): 984-993.

Hutto, R.L., Keane, R.E., Sherriff, R.L., Rota, C.T., Eby, L.A. and Saab, V.A., 2016. Toward a more ecologically informed view of severe forest fires. Ecosphere, 7(2)

Manley, I., P. Ohanjanian, and M-A. Beaucher. 2004. Inventory of Flammulated Owls Breeding in the East Kootenay 2003. October.

Prairie dogs

Buseck, R.S. D.A. Keinath, and E. Everett. 2005. Species Assessment for Black-tailed Prairie Dog (*Cynomys ludovicianu*) in Wyoming. United States Department of the Interior, Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming. February. https://www.uwyo.edu/wyndd/_files/docs/reports/speciesassessments/black- tailedprairiedog-feb2005.pdf.

Clippinger, N.W. 1989. Habitat Suitability Index Models: Black-tailed Prairie Dog. U.S. Department of the Interior, Fish and Wildlife Service, Research and Development, Washington, DC. Biological Report 82(10.156). July. https://www.nwrc.usgs.gov/wdb/pub/hsi/hsi-156.pdf.

Keinath, D.A. 2004. Species Assessment for White-Tailed Prairie Dog (Cynomys leucurus) in Wyoming. United States Department of the Interior, Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming. December. https://www.uwyo.edu/wyndd/_files/docs/reports/speciesassessments/white-tailedprairiedog-dec2004.pdf.

Kotliar, N.B., B.W. Baker, and A.D. Whicker. 1999. A critical review of assumptions about the prairie dog as a keystone species. Environmental Management 24(2): 177–192.

Lomolino, M.V. and G.A. Smith. 2003. Prairie dog towns as islands: applications of island biogeography and landscape ecology for conserving nonvolant terrestrial vertebrates. Global Ecology and Biogeography 12(4): 275-286.

Orabona-Cerovski, A. 1991. Habitat characteristics, population dynamics, and behavioral interactions of white-tailed prairie dogs in Shirley Basin, Wyoming. MS. University of Wyoming., Laramie, WY.

Pauli, J.N., and S.W. Buskirk. 2007. Risk-disturbance overrides density dependence in a hunted colonial rodent, the black-tailed prairie dog *Cynomys ludovicianus*. Journal of Applied Ecology 44(6): 1219-1230.

Seglund, A.E. and P.M. Schnurr. 2010. Colorado Gunnison's and white-tailed prairie dog conservation strategy. Colorado Division of Wildlife, Denver, Colorado, USA. https://cpw.state.co.us/Documents/WildlifeSpecies/Mammals/PrairieDogConservationPlan/ColoradoGunnisonsandWhite-tailedPrairieDogConservationStrategy_070910.pdf.

Tileston, J.V. and R.R. Lechleitner. 1966. Some comparisons of the black-tailed and white- tailed prairie dogs in north central Colorado. American Midland Naturalist 75: 292-316.

Focal Species

Bartel, R.A., N.M. Haddad, and J.P. Wright. 2010. Ecosystem engineers maintain a rare species of butterfly and increase plant diversity. Oikos. 119: 883-890.

Bird, B., M. O'Brien, M. Petersen. 2011. Beaver and Climate Change Adaptation in North America: A Simple, Cost-Effective Strategy. WildEarth Guardians. September.

Boyce Jr, D.A., R.T. Reynolds, and R.T. Graham. 2006. Goshawk status and management: what do we know, what have we done, where are we going? Studies in Avian Biology. 31: 312-325.

Boyle, S. and S. Owens. North American Beaver (Castor canadensis): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. February 6. Available: http://www.fs.fed.us/r2/projects/scp/assessments/northamericanbeaver.pdf.

Butler, D.R. and G.P. Malanson. 1995. Sedimentation rates and patterns in beaver ponds in a mountain environment. Geomorphology. 13: 255-269.

Chalfoun, A.D. and T.E. Martin. 2007. Assessment of habitat preferences and quality depend on spatial scale and metrics of fitness. Journal of Applied Ecology. 44: 983-992.

Davidson, A.D. and D.C. Lightfoot. 2006. Keystone rodent interactions: prairie dogs and kangaroo rats structure the biotic composition of a desertified grassland. Ecography. 29: 755-765.

Graham, R.L., R. Rodriguez, R.L., K.M. Paulin, R.L. Player, A.P. Heap, and R. Williams. 1999. The northern goshawk in Utah: habitat assessment and management recommendations. Gen. Tech. Rep. RMRS-GTR-22. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 48 p.

Gurnell, A.M. 1998. The hydrogeomorphological effects of beaver dam-building activity. Progress in Physical Geography 22(2): 167-189.

Haggard, M. and Gaines, W.L., 2001. Effects of stand-replacement fire and salvage logging on a cavity-nesting bird community in eastern Cascades, Washington.

Hilty, J., and Merenlender, A. 2000. Faunal indicator taxa selection for monitoring ecosystem health. Biological conservation, 92(2), 185-197.

Holbrook, J.D., J.R. Squires, L.E. Olson, R.L. Lawrence, and S.L. Savage. 2017. Multiscale habitat relationships of snowshoe hares (*Lepus americanus*) in the mixed conifer landscape of the Northern Rockies, USA: Cross-scale effects of horizontal cover with implications for forest management. Ecology and Evolution. 7: 125-144.

Keinath, D. and M. McGee. 2005. Boreal Toad (Bufo boreas boreas): A Technical Conservation Assessment. Prepared for USDA Forest Service, Rocky Mountain Region. May 25.

Kotliar, N.B., Baker, B.W., Whicker, A.D. and Plumb, G., 1999. A critical review of assumptions about the prairie dog as a keystone species. Environmental management. 24: 177-192.

Miller, B., G. Ceballos, and R. Reading. 1994. The prairie dog and biotic diversity. Conservation biology. 8: 677-681.

Miller, B., D. Foreman, M. Fink, D. Shinneman, J. Smith, M. DeMarco, M. Soule, R. Howard.

2003. Southern Rockies Wildlands Network Vision. Southern Rockies Ecosystem Project. July.

Mills, L.S., Griffin, P.C., Hodges, K.E., McKelveY, K.., Ruggiero, L. and Ulizio, T., 2005. Pellet count indices compared to mark–recapture estimates for evaluating snowshoe hare density. Journal of Wildlife Management, 69(3), pp.1053-1062

Naiman, J, G. Pinay, C.A. Johnston, J. Pastor. 1994. Beaver Influences on the long-term biogeochemical characteristics of boreal forests drainage networks. Ecology 75(4): 905-921.

Nappi, A., Drapeau, P. and Leduc, A., 2015. How important is dead wood for woodpeckers foraging in eastern North American boreal forests?. Forest Ecology and Management, 346, pp.10-21

Stevens, C.E., C.A. Paszkowski, and A.L. Foote. 2007. Beaver (Castor canadensis) as a surrogate species for conserving anuran amphibians on boreal streams in Alberta, Canada. Biological Conservation. 134: 1-13.

Tarbill, G.L., Manley, P.N. and White, A.M., 2015. Drill, baby, drill: the influence of woodpeckers on post-fire vertebrate communities through cavity excavation. Journal of Zoology, 296(2), pp.95-103

Thornton, Daniel H., Aaron J. Wirsing, James D. Roth, and Dennis L. Murray. "Complex effects of site preparation and harvest on snowshoe hare abundance across a patchy forest landscape." Forest ecology and management 280 (2012): 132-139.

U.S. Forest Service. Undated. Beaver Restoration Toolbox. http://www.martinezbeavers.org/wordpress/wp-content/uploads/2013/10/Beaver-Restoration-Toolbox-Karl-Malcolm-2013.pdf.

USFWS (US Fish and Wildlife Service), National Oceanic and Atmospheric Administration, Portland State University, and US Forest Service. 2015. The Beaver Restoration Guidebook. Version 1.0. June 30.

Vander Haegen, W.M. 2007. Fragmentation by agricultural influences reproductive success of birds in shrubsteppe landscape. Ecological Applications. 17(3): 934-947.

Westbrook, C.J., D.J. Cooper, and B.W. Baker. 2006. Beaver dams and overbank floods influence groundwater---surface water interactions of a Rocky Mountain riparian area. Water Resources

Research. 42.

Westbrook, C.J., Cooper, D.J. and Baker, B.W. 2011. Beaver assisted river valley formation. River Research and Applications. 27: 247-256.

Wright, J.P., C.G. Jones, and A.S. Flecker. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. Oecologia. 132: 96-101.

Land Designations

Carroll et al. 2010. Optimizing resiliency of reserve networks to climate change: multispecies conservation planning in the Pacific Northwest, USA. Global Change Biology. 16(3): 891-904.

Dickson et al. 2014. Systematic identification of potential conservation priority areas on roadless Bureau of Land Management lands in the western United States. Biological Conservation. 178: 117-127

Loucks et al. 2003. USDA Forest Service roadless areas: potential biodiversity conservation reserves. Conservation Ecology. 7(2): 5

Margules and Pressey 2000. Systematic conservation planning. Nature. 405(6783): 243-253.

Noon et al. 2009. Multispecies conservation planning on US federal lands. Models for Planning Wildlife Conservation in Large Landscapes. Elsevier. pp. 51-83.

Appendix 1

Defenders of Wildlife

Management Plan Revision Guidance
Meeting the Diversity Requirement Under the National Forest Management Act
(Working Draft)

Defenders of Wildlife

Management Plan Revision Guidance
Meeting the Diversity Requirement Under the National Forest Management Act
(Working Draft)

The National Forest Management Act (NFMA) requires that forest plans “provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives” (16 U.S.C. § 1604(g)(3)(B)). Court interpretations of the statutory requirement include a ruling that the NFMA diversity mandate not only imposes a substantive standard on the Forest Service, it “confirms the Forest Service’s duty to protect [all] wildlife” (*Seattle Audubon Society v. Moseley*, 1489). Courts have also recognized that the Forest Service’s “statutory duty clearly requires protection of the entire biological community” (*Sierra Club v. Espy*, 364).

The Forest Service has interpreted the diversity requirement of NFMA through the development of the 2012 Planning Rule. It incorporates an approach to diversity that first protects ecosystems by managing them for ecological integrity and then ensures that individual species are also protected. The rule’s two-tiered conservation approach (alternatively called the “ecosystem-species” or “coarse-fine filter” planning method) relies on the use of surrogate measures, or key characteristics, to represent the condition of ecosystems, and also on the identification of at-risk species and evaluation of whether those species will be sustained.

The agency and stakeholders should consider the following when developing and evaluating forest plan procedures, content, and the plan Environmental Impact Statement (EIS) related to NFMA’s diversity requirement.

<u>The NEPA Process</u>

The revised forest plan must tell the public how the Forest Service intends to manage the Forest for the next 10-15 years (or more). Under the National Environmental Policy Act (NEPA), the environmental impact statement (EIS) for the revised forest plan must evaluate the effects of that a in a way that will meaningfully inform decision makers about likely outcomes. The effects analysis must be more than a subjective, qualitative and comparative analysis.

The analysis must consider the effects of the management activities necessary to achieve the desired conditions, as well as those that may interfere with achievement of desired conditions. The proposed and possible actions required by 36 CFR § 7(f)(1)(iv) may be useful for effects analysis. The effects of standards, guidelines and suitability on constraining harmful activities are especially important to determining effects on ecological integrity and at-risk species. As measures that mitigate environmental effects, their effectiveness must also be considered. Track records for existing plan components may be helpful with this if they are retained.

It is important to recognize that the uncertainty created by the absence of binding components in the plan must be reflected in the effects analysis by showing a greater probability of adverse effects occurring. It was not the intent of the 2012 Planning Rule to build uncertainty into forest plans. It provides an adaptive management process through the planning framework (see 36 CFR 219.5) using forest plan amendments. Flexibility may also be provided by ranges of values in plan components, which lead to ranges of effects. Vague or discretionary plan components necessarily mean greater uncertainty and risk about the effects, which will make it more difficult to evaluate them and to show compliance with NFMA diversity requirements or to establish regulatory mechanisms recognizable under the Endangered Species Act (ESA). We will be looking at this aspect of the analysis closely.

The traditional approach to developing forest plan alternatives is to change the amount and locations of land allocated to different management areas. For each such area having different management requirements the plan should include a map showing where these plan components apply so they may be used in the effects analysis. The Ninth Circuit has held that it is important to know where important landscapes are located in order to consider how a forest plan affects them and to propose alternatives: "Without data on the location of the big game winter range, the public was severely limited in its ability to participate in the decision-making process" (*WildEarth Guardians v. Montana Snowmobile Association*, 2015). Note that the different desired conditions or other plan components for these areas will also require a unique analysis of timber suitability since that is based on compatibility with plan components.

There also may be a need for alternatives that include changes in the language of forest-wide plan components (including additions or deletions). We would expect that alternatives that rely more heavily on standards than desired conditions would achieve more certain and desirable outcomes for at-risk species because of their mandatory nature.

It is important for the EIS analysis to recognize what is a plan component and what isn't, and it will be helpful to clarify that in the descriptions of alternatives. Only plan components have effects, and the sections of the plan document that contain plan components should be clearly identified and contain only plan components. Additional information may be useful in the plan but may also be confusing or misleading.

Plan components that refer to outside sources for direction raise questions about the NEPA process, as well as possible noncompliance with NFMA. We would like the EIS to describe how it analyzes effects of a plan component that may change. The public must know what that management is, its effects, and whether it would be adequate. The plan must explicitly incorporate those plan components that it intends to apply.

The EIS must recognize that the forest plan promotes continued activities that may be detrimental to ecological integrity and to some species. A rigorous analysis in the NEPA process must be employed to evaluate the effects on integrity and at-risk species of the plan components that promote such activities. While the forest plan need not single out specific species for attention, the EIS must do so because there are clearly concerns about how the plan would affect these species.

An especially thorough analysis of effects on at-risk species in the EIS will also be needed to demonstrate compliance with the substantive NFMA requirement that plan components must, "provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area" (36 CFR 219.9(b)(1)). We strongly recommend that listed species be evaluated in the same manner as SCC because once they are recovered they must be managed as SCC.

The Ninth Circuit has developed a set of principles applicable to viability analysis (*The Lands Council v. McNair*, 537 F.3d 981 (2009)):

> … the Forest Service must support its conclusions that a project meets the requirements of the NFMA and relevant Forest Plan with studies that the agency, in its expertise, deems reliable. The Forest Service must explain the conclusions it has drawn from its chosen methodology, and the reasons it considers the underlying evidence to be reliable.
>
> … when the Forest Service decides, in its expertise, that habitat is a reliable proxy for species' viability in a particular case, the Forest Service nevertheless must both describe the quantity and quality of habitat that is necessary to sustain the viability of the species in question and explain its methodology for measuring this habitat.

The 2012 Planning Rule has authorized and encouraged the use of the "coarse filter approach", which uses habitat as a proxy for species viability. Where it relies on the coarse filter for species viability it must therefore determine the necessary ecological conditions and explain its methodology. An important part of the methodology is establishing the relationship between a species and the ecological conditions being used as a proxy, based on the best available scientific information in accordance with 36 CFR 219.3. While *Lands Council* involved viability at the project level, courts have cited it and other project level viability cases in litigation involving forest plan decisions (See e.g. *Native Ecosystems Council v. Weldon*, 848 F.Supp.2d 1207 (D. Montana 2012).

The Planning Handbook (§12.13) requires that key ecosystem characteristics be identified in the Assessment for use in the planning process. It includes the following as a criterion for key ecosystem characteristics: "The characteristic includes ecological conditions needed for threatened, endangered, proposed, candidate, or species of conservation concern …" (§12.13(4)(b)). We believe that these key characteristics should also be used to determine the effects of the plan on at-risk species.

The effects analysis for at-risk species must be based on how the plan provides ecological conditions necessary for their persistence. For each at-risk species, we expect to see those conditions identified and projected into the future (quantitatively where possible) for each forest plan alternative.

In completing an effects analysis, it will be important to show how particular plan components affect ecosystem characteristics and species. In particular, where the Assessment identifies threats to a species, the analysis should consider those threats relevant in the plan area and how they are addressed by plan components. Plan components with both adverse and beneficial effects must be considered.

Plan components that provide ecological conditions for species persistence can either be ecosystem components or species-specific components. We agree that many species could be adequately addressed by carefully identified ecosystem plan components. The best available scientific information must demonstrate a strong relationship between the ecosystem characteristic and species persistence. The analysis of the effects of the plan must then project the likely occurrence of those characteristics into the foreseeable future. It must determine ecological integrity by comparing the projected future conditions to the natural range of variation (NRV), in accordance with 36 CFR 219.9(a) and the definition of ecological integrity.

Below are some guidance questions related to complying with NEPA during forest plan revision.

Does the NEPA process inappropriately commence before necessary prior steps have been completed? This could occur for such things as wilderness evaluation or identification of species of conservation concern. There could also be information that a forest recognizes is necessary for the decision that they say will be available later in the NEPA process. These kinds of approaches raise questions about needs to for supplemental NEPA documents and additional public participation. Documents that are cited during the NEPA process but are not available for public review may also indicate a timing problem, but in any case, may warrant addition comment opportunities.

Does the EIS recognize effects on at-risk species as significant issues that require analysis? Independent of substantive requirements for species persistence based on NFMA, NEPA requires that significant issues be analyzed in depth in an EIS (40 CFR §1501.7(a)(2)). This means effects on threatened, endangered, proposed or candidate species and species of conservation concern must be evaluated and disclosed in the EIS.

Does the EIS actually project the future conditions of key ecosystem components and compare that to desired conditions? It must provide an actual "result" in terms of ecological conditions relevant to the species. It cannot substitute qualitative or subjective judgments of sufficiency for actual analysis of effects. It is also not sufficient to simply assume that desired conditions will occur because they are desired conditions. Their likelihood of occurring and timeframe required, and associated uncertainty, should be disclosed. The absence of relevant meaningful objectives or standards and guidelines makes it less likely desired conditions would be achieved.

Does the documentation show how specific plan components affect each ecological condition needed by at-risk species? It is important to understand how the FS views the effects of each relevant plan component. While their interpretation is entitled to deference, sometimes interpretations by a forest planning team can be contrary to agency policy.

Does the EIS include references to the scientific basis for conclusions about effects? The 2012 Planning Rule requires the responsible official to use the best available scientific information to inform the planning process…" This requires these two things (36 CFR 219.3):

- The responsible official "shall determine what information is the most accurate, reliable, and relevant to the issues being considered" (the definition of "best available"), and document the "*basis* for that determination."
- The responsible official "shall document how the best available scientific information was used to inform the assessment, the plan decision, and the monitoring program as required in §§ 219.6(a)(3) and 219.14(a)(4)," by explaining *how* "the information was applied to the issues considered."

The italicized requirements are those that plan documentation tends to overlook. The Planning Rule does not specify where this must be documented. (move above to NFMA?)

The EIS is the primary vehicle for informing the planning process about the effects of plan components, and NEPA has its own requirements for scientific integrity of the discussions and analysis in environmental impact statements, including references to sources relied upon for conclusions in the EIS (40 CFR 1508.24). It is critical that the information used as a basis for conclusions in the EIS be disclosed there. This is especially true for the effects on at-risk species. In particular, the Forest Service has a burden of proving assertions important to selection of alternatives like logging or active restoration is better than passive, or long-term benefits outweigh short-term damage, or protective standards have adverse effects.

Is the information presented in the EIS based on and consistent with the assessment? While the effects analysis in the EIS is new, most or all of the information supporting that analysis should be provided in the assessment. In particular, assumptions and other statements in the EIS should not conflict with similar information in the assessment. Assessments may be a more honest look at the science because they can seem independent of the decision process when they are completed.

Is the use of analytical models transparent and is their science basis documented. To meet NEPA disclosure requirements a "black box" approach must be avoided. Documentation of model inputs and assumptions as well as outputs must be available for review**.**

Does the EIS properly cite the plan components as the basis for its effects analysis? Only plan components have effects. It is fundamental that the EIS properly characterize what the plan components say. It cannot add words that aren't there. The EIS itself (including appendices) should not make assumptions and interpretations of plan components that it then relies on as if they were the plan components themselves. Such assumptions must be distinguished from the plan components, and their rationale must be provided, including any uncertainty. An EIS may not be used to shore up weaknesses in plan components. The same is true for a biological evaluation or biological assessment. The reader needs to know what the actual plan components are that have the asserted effects.

Does the EIS "analysis" consist of simply restating the plan components and comparing them across alternatives? While NEPA requires a comparison of alternatives (typically in Chapter 2), it also requires a comparison of the effects of alternatives. There must be some attempt to determine the results of the plan components and then compare them.

Does the EIS improperly cite other material as if it were a plan component? It should not be based on plan content that is not plan components (such as "management approaches or strategies") or guidance found in other documents that are not properly included in the forest plan, including agency directives. Any assumptions about national forest management must be clearly traceable to plan components. Applicable "best management practices" cannot be assumed but must be imposed by plan components. Also, assumptions made for timber yield (usually in Appendix B) must be based on what the plan components actually say, not just on what a specialist thinks might occur.

Does the effects analysis distinguish between the certainty of standards and guidelines and the uncertainty of desired conditions and objectives? Standards and guidelines are mandatory regarding what may not occur, while desired conditions and objectives may never be achieved. Does the analysis include a determination of the likelihood of desired conditions being achieved, and analyze the most likely outcomes even if those are not the desired outcomes? As part of this analysis, the EIS should consider whether there are other plan components, especially standards and guidelines, that contribute to achieving the desired conditions.

Does the EIS analysis properly account for the effects of removing protective standards from the current plan? Some plans seem to have a core assumption that more flexibility is good, and therefore that standards are bad. However, standards provide greater certainty that activities having adverse effects will not occur. Reasoning that reaches the opposite conclusion should be carefully scrutinized and questioned. (See CBF cases.) Flexibility also requires more explicit assumptions in order to evaluate effects.

Does the analysis assume that no activities/effects would occur even though there are no plan components that prohibit them? In general, NEPA analysis concerns uncertain future effects, and it should recognize the possibility of low probability events occurring if they may have significant impacts. It is important to recognize that the uncertainty created by the absence of binding components in the plan must be reflected in the effects analysis by showing a greater probability of adverse effects occurring. What is not prohibited by plan components may occur, and an assumption that something will not occur must be thoroughly documented. Where the plan does not limit effects through plan standards and guidelines, the DEIS must disclose the maximum amount of effects that would be allowed by the plan, and should also disclose the most likely effects.

Does the EIS reflect the priorities represented by the plan components? While standards and guidelines (and unsuitability determinations) are mandatory and take precedence over other plan components, plan components may also include language that establishes priority by qualifying their application by making them subordinate to or requiring consistency with other plan components. Such prioritization must be reflected in the analysis. (Diversity requirements should be given priority.)

Does the analysis assume that active management produces has similar effects or fewer adverse impacts than passive management without an adequate scientific basis? This may include statements that mechanical treatments are comparable to natural disturbance, or that timber management intensity does not pose a risk to ecosystem integrity and resiliency. The Forest Service often has a pro-management bias, making it difficult for them to objectively concede that no management might be a better alternative. This leads to assuming things about the benefits of active management, or lack of environmental impacts, that actually need to be proven by analysis and reference to BASI.

Does the analysis assume that timber harvest creates positive effects for ecological restoration because it generates revenue that will be used for that purpose? This is a provocative, conjectural hypothesis that essentially just assumes the nature of the effects that are likely to determine the alternative selected – instead of analyzing them. Without extensive analysis and certainty that the hoped for results would occur, it could easily skew and bias the analysis, and should not be given much weight in the decision process.

Does the EIS properly account for the effects of wildfire? A key part of the analysis will be how the effects of wildfire are accounted for. They may be positive (accomplishing restoration) as well as negative in relation to the plan's purpose and need. Also, the effect of plan components on wildfire must be clearly described. Any statements about vegetation treatments increasing the amount of older forests by reducing wildfire should have strong scientific support. Fires may also reduce mid-aged forests that are in excess supply and thereby contribute to achieving NRV and possibly reducing the need for active management. The EIS should identify any BASI it relies on to conclude that active management is better than passive management for ecological integrity (or that restrictions on fire management lead to lack of integrity). Since this information is essential to making this decision, if it is incomplete or unavailable, compliance with 40 C.F.R. §1502.22 would be necessary.

Does the EIS properly account for the effects of fire suppression? If there are parts of the forest where suppression (no fire) is a desired condition, especially where that is not the historic ecological condition, the effects of limiting or eliminating fire should be disclosed. If it is expected that mechanical treatment will be needed to prevent fires, those effects must also be disclosed. If there are no plan components that address fire suppression, there is no basis for showing that alternatives have different amounts or effects. This is a subject that is prone to EIS language that is not based on what plan components actually say.

Does the EIS properly account for the effects of salvage logging? The demonstrated negative ecological effects associated with postfire salvage logging are probably the most consistent and dramatic of any wildlife management effects ever documented for any kind of forest management activity (Hutto 2006).

Does the analysis in the EIS properly account for spatial differences? It may be true that the future occurrence of projects in particular areas is not determined by the forest plan. However, the overall intent of management is determined by the plan, and the effects of that management on at-risk species may vary depending on whether it occurs in habitat important for a species (consider timber suitability or an emphasis on WUI as examples). The spatial aspects of plan components may also be important to effects analysis; it is necessary to determine and disclose where management stressors are likely to occur relative to areas important to wildlife (such as strongholds). This is especially important where areas are important to habitat connectivity. Failure to identify locations of important habitat and to base the effects analysis on that information may constitute ignoring relevant factors and thus be considered arbitrary. Failure of the plan to identify areas that would be managed differently cannot be corrected by the EIS making assumptions about where different kinds of management would occur and referring to areas not identified in the plan.

WildEarth Guardians v. Montana Snowmobile Association
9th Circuit (6/22/15): "Without data on the location of the big game winter range, the public was severely limited in its ability to participate in the decision-making process." While the Forest Service stated that it used a map provided by Montana Fish, Wildlife and Parks that showed specific locations, the court held that this map should have been disclosed to the public in the EIS.

Does the EIS use a relative comparison of alternatives without showing the actual effects on ecological conditions? NEPA requires effects of alternatives to be presented in a "comparative form." A narrative description does not facilitate comparison, and a relative comparison of alternatives by itself is usually inadequate to comply with NEPA. Moreover, if any indices used cannot be translated into absolute values, they can not be used to determine substantive compliance with NFMA.

Does the documentation leave gaps in the analysis? It is not sufficient to describe the process and display the results, without showing any of the actual data or assumptions used or explaining why or how they were used. Results of analysis are not "data." Often the input data or assumptions are the weak point in the analysis and may be subject to dispute based on BASI, especially if they are based on subjective judgments, ratings or scores.

Does the documentation include conclusory statements? A conclusory statement is one made without supporting evidence, underlying logic, or reasoning. All statements related to compliance with legal requirements should be substantiated with documented facts or analytical results. This is especially important with respect to conclusions about ecological integrity and species persistence. (While Mayo refers to the statement as "conclusory"—and, viewed only in isolation, it is—a court "will uphold a decision of less than ideal clarity if the agency's path may reasonably be discerned." *Bowman Transp., Inc. v. Ark.-Best Freight Sys., Inc.*, 419 U.S. 281, 286 (1974)).

Does the EIS explain the assumptions made and their importance? An EIS for a forest plan is likely to be replete with assumptions about effects, and often they are not disclosed. One clue to look for is statements preceded by "if."

Does the EIS properly consider the direct, indirect and cumulative effects of the forest plan? Courts have acknowledged that effects analysis for programmatic decisions may not have to be as detailed as for projects. The Forest Service may also claim that forest plans have no direct effects. Regardless of the terminology used, an EIS must always consider the reasonably foreseeable impacts. It cannot simply defer relevant effects analysis to projects. For years, the Forest Service has been avoiding addressing broad-scale effects during project analysis by saying that they are "beyond the scope" of that analysis. Now that it is time to consider those effects at the forest plan level. Also, while it is possible to think of forest plan effects analysis as a cumulative effects analysis, that does not excuse also looking at actions by others that may affect at-risk species. Cumulative effects would include all factors "beyond the authority of the Forest Service" (36 CFR §219.9(b)92)).

Does the EIS consider both the effects of the desired condition and the effects of management actions needed to restore and maintain them? (Mayo) In particular, the effects on at-risk species must consider plan components likely to cause adverse effects as well as those intended to benefit the species. There may be highly adverse effects on a species in the short-term to purportedly obtain long-term benefits for the same species. The forest plan EIS cannot claim an inability to analyze short-term effects or defer that to project-level analysis. There may also be a tendency to downplay the adverse effects where such tradeoffs are being made, so they should be examined closely.

Conversely, there may be an unwillingness to consider long-term adverse effects. Programmatic effects analysis for the purpose of NEPA is less demanding than project-level analysis, but they must make some effort to forecast the future. Moreover, purely qualitative and subjective analysis is not sufficient to demonstrate compliance with diversity requirements.

Does the EIS consider the adverse effects of plan components that are included in the plan to promote non-wildlife uses, as well as those that are intended to benefit wildlife? Forest plans must integrate management for all multiple uses; NFMA requires "one integrated plan." That means that plan components must not be mutually exclusive. However, they can sometimes work at cross-purposes, and it is important that the effects analysis take into account plan components that are not favorable to at-risk species as well as those that are. The adverse environmental effects are the most important aspect of the NEPA process, and they may have been downplayed. It is important for the DEIS to first describe the ways in which plan components that promote other uses may have adverse effects, before describing how other plan components would mitigate those effects.

Does the EIS adequately disclose the effectiveness of mitigation measures? In a forest plan, these are the standards and guidelines. To use them in demonstrating persistence of species, there must be evidence of their effectiveness and achieving that outcome. If plan components in the revised plan resemble those from the current plan, there should be some discussion of what monitoring has revealed about their effectiveness.

Is the no-action alternative properly described? The no-action alternative is sometimes difficult to work with for programmatic decisions. The Forest Service has always interpreted "no-action" to mean the current plan as written and amended, in accordance with CEQ's "Forty Most Asked Questions" #3. This would not include other things that may be characterized as "commitments" made outside of the planning process. However, the effects of this alternative must be analyzed the same way as the other alternatives, which may produce different conclusions from those in the original NEPA process. Since there is usually a desire to change the current plan, there may be a bias against the no-action alternative expressed in the way it is written or analyzed. This analysis should be consistent with the need for change identified based on the assessment and used in determining the scope of the revision.

Does the range of alternatives include a range of desired conditions? While there is a requirement to provide conditions within NRV within an ecosystem, this leaves some discretion to choose conditions within some range, and to differentiate by location within the ecosystem. There should be a single set of desired conditions for all alternatives only if warranted by scoping.

Does the range of alternatives include a range of acres suitable for timber production? There may be different views on whether timber production is compatible with a particular set of plan components. In such cases, it would be appropriate to consider alternative suitability determinations.

Have alternative been designed in a way that biases the analysis by including unnecessary plan components that have undesirable effects? Creating what amounts to a "straw alternative" can be done by accident (wanting to include something in an alternative, even though it doesn't logically fit, but not wanting to create more alternatives) or by design (to make the preferred alternative look better). This is a reason why it is important to understand what plan components cause which effects, so that changing specific components may be considered.

Does the EIS improperly use the "distinctive roles and contributions" of the plan area to limit the range of alternatives? The distinctive roles and contributions of the plan area within the broader landscape is include in 36 CFR §219.7(f) as "other required content in the plan. They are a result of the desired conditions and other plan components, and reflect the "expected" outcomes rather than being a motivation for them (36 CFR § 219.2(b)). Traditional uses may not arbitrarily be used to constrain a revised plan. The Preamble to the Planning Rule supports the interpretation that "distinctive roles and contributions" stem from decisions made within the planning process: "The final (rule) removes this requirement from the assessment as it (wrongly) implies a decision that should be made when *approving* the distinctive roles and contributions of the unit as part of the other plan content (§ 219.7(f))" (emphasis added, p. 21202). Decisions designed to automatically preserve existing permitted activities and facilities must include the rationale and could be challenged.

Does the analysis in the EIS match that in the biological evaluation or assessment for each at-risk species. Ideally, the former will be based on the latter, but sometimes the timing doesn't work that way. Sometimes there may also be different players in the NEPA process. Both documents should cite the same plan language (which may have changed) and make the same assumptions (and of course reach the same conclusions).

Does the record of decision cite factors for the choosing a particular alternative that are not part of that alternative? In particular, does it mention decisions that should have been plan components but weren't? This might include management approaches and strategies that are not plan components. NFMA does not require future projects to be consistent with the Record of Decision. A ROD also has no bearing on compliance with diversity requirements for forest plan components unless it is referring to actual plan components. Plan components that refer to outside sources for direction raise questions about how to analyze effects of decisions that might change, as well as possible noncompliance with NFMA.

Does the EIS properly consider the effects of identifying watersheds "that are a priority for maintenance or restoration?" These priorities are not plan components, but instead should be identified as an assumption with associated uncertainty. These priorities could become part of plan components is they are tied to objectives.

Does the EIS properly consider the effects of climate change?
(placeholder)

- reduced snow depth/extent

Dose the EIS properly address uncertainty and risk? NEPA has requirements for disclosure related to incomplete or unavailable information (40 CFR §1502.22). For at-risk species, it is important to characterize the effects in terms of how plan components increase or decrease risk. The Forest Service sometimes seems averse to using the precautionary principle (when it limits flexibility), and if the plan is not based on that principle, that must be reflected in the effects analysis.

Does the EIS improperly consider the role of monitoring? An EIS must evaluate the reasonably foreseeable impacts of a proposed action. It can't say instead that it will monitor to see what the effects are. Monitoring cannot be a substitute for effects analysis. Also, unless there is a monitoring trigger included in a mandatory standard, the monitoring program has no effects and it should not be assumed to mitigate effects.

Was all documentation necessary to understand the effects on at-risk species identified and made available during the comment period for the DEIS? The public must be able to review information needed to make a reasoned choice among alternatives. Failure to provide such information should result in an additional comment period (probably on a supplemental EIS). (Failure of the agency to consider information should also require additional documentation of how it was considered.)

<u>Ecological Integrity</u>

Are ecosystems identified and the rationale provided? The Planning Rule requires that plan components "maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area" (36 CFR 219.8(a)). The first step for assessments in the Planning Handbook is "Identifying the Ecosystems to Assess" for ecological integrity (1909.12

FSH 12.11). Compliance with the requirement for integrity of ecosystems cannot be determined without identifying the relevant ecosystems.

Are key ecosystem characteristics identified and rationale provided, and does that rationale include characteristics necessary for viability of at-risk species? Identification of key ecosystem characteristics is a requirement of Planning Handbook §12.13. Moreover, when ecosystem plan components are used to provide for species viability, the relationship between the two must be established. Ecosystem characteristics "necessary to … maintain a viable population" of SCC should be identified at the beginning of the planning process in the assessment as part of evaluating information relevant to the plan area (36 CFR §219.6(b)(1) and (5)). The importance of landscape pattern and connectivity should be addressed.

Does the plan documentation demonstrate that ecological integrity of *each* ecosystem is restored and maintained? This requires a determination of the natural range of variation (NRV) for the key ecosystem characteristics and a comparison to the projected future conditions. NRV should be determined in the assessment (1909.12 FSH §12.14a), and future conditions determined as part of effects analysis for alternatives. Where NRV would not be achieved in parts of an ecosystem, it may be necessary to "overachieve" in other parts of the ecosystem to meet the requirement for the ecosystem as a whole. Since species composition and diversity are elements of ecological integrity (36 CFR §219.19), a failure to provide ecological conditions for at-risk species would also violate the ecological integrity requirement (see below).

Does the plan use plan components to establish NRV as a desired condition for relevant ecosystem characteristics? The Planning Handbook states that, "The NRV is a tool for assessing the ecological integrity and does not necessarily constitute a management target or desired condition" (1909.12 FSH 05). However, the Planning Rule requires that plan components provide ecological integrity (36 CFR 219.8(a), 36 CFR 219.9(a)(1)), and defines "ecological integrity" to occur when "dominant ecological characteristics (for example, composition, structure, function, connectivity and species composition and diversity) occur within the natural range of variation" (36 CFR 219.19). Thus, NRV must be the desired condition for these characteristics. There is, however, no requirement that NRV be the same as historic conditions (1909.12 FSH §23.11a). A more useful definition of NRV is found in Planning Handbook §12.14(1): "conditions that sustain the integrity of the selected key ecosystem characteristics."

The Planning Handbook is confusing in its discussion of NRV in Chapters 10 and 20. Ecological integrity must be provided for ecosystems, so parts of ecosystems may be managed for other "social, economic, cultural, or ecological objectives." However, as a whole, the ecosystem within the plan area must meet the requirement for ecological integrity. The requirement for ecological integrity is the NRV for dominant ecological characteristics. That need not be the same as the historic range of variation, and can take into account "general scientific and ecological understanding of the conditions that would sustain key ecosystem characteristics and sustain at-risk species" (1909.12 FSH §23.11a(3)(9a)), see also §12.14b). Intentionally managing ecosystems outside of NRV would violate the requirement for ecological integrity in the Planning Rule.

Do plan components establish what NRV is? When plan components simply repeat the requirement for NRV it means that someone implementing the plan has total discretion to determine what is needed for ecological integrity. This violates the requirement in the Planning Rule that plan components do so, which is necessary because integrity is a landscape condition that cannot be determined on a project-by-project basis. NRV must be an actual range of ecological conditions. Other terms that seem comparable to NRV, but also leave out the actual plan content, are "properly functioning condition" (for aquatic resources) and "ecological site potential" (for non-forest vegetation). Merely using these terms to describe desired conditions would not meet the requirement that plan components maintain or restore ecological integrity.

Does the plan integrate fire management into its NRV analysis and desired vegetation conditions? There is a tendency to keep fire management decision making separate from forest planning, but fire is not an exception to NFMA's requirement for integrated forest plans. Actually, the Planning Rule requires consideration of "wildland fire and opportunities to restore fire adapted ecosystems" (36 CFR §219.8(a)(1)(v)), and desired conditions for vegetation depend in part on desired conditions for fire. Fire frequency and severity should be key conditions for ecological function of most forested ecosystems. Plans should include desired conditions for these functions consistent with their NRVs, and for vegetation conditions (e.g. fire regime condition class) that would lead to these fire characteristics. This should include the need for high severity fires where ecologically appropriate. The plan should also identify areas where protection from fire is important, and define through plan components how management will address this (including fire suppression) consistent with ecological integrity.

Does the plan properly use NRV to establish suitability for salvage logging on lands that are not suitable for timber production? The forest plan needs to include plan components to address salvage logging. In particular, it needs to clearly establish whether removal of dead or dying trees is appropriate to achieve the desired conditions for lands that are not suited for timber production. This should be done through a suitability plan component, and it should consider the contribution of dead trees to ecological integrity (including consideration of their NRV). (Numerous studies have found that salvage harvest undermines achieving ecological integrity and ecosystem resilience: Beschta et al. 2004; Karr et al. 2004; Donato et al. 2006;

Noss et al. 2006; Shatford et al. 2007; Thompson et al. 2007; Lindenmayer et al. 2004, 2006; Hutto et al. 2016).

Does the plan contain plan components for ecological sustainability? The plan documentation must also show compliance with 36 CFR §219.8. This would incorporate the analysis and conclusions regarding ecological integrity and include additional requirements for air, soil, water and riparian areas.

Do plan components for riparian areas take into account the relevant factors? Those factors are listed in 36 CFR §219.8(a)(3). To "take them into account," necessary information about these factors should be provided in the assessment. Riparian areas are not specifically addressed in the assessment requirements of §219.6(b), but these elements should be found in the assessment's discussions of "terrestrial ecosystems, aquatic ecosystems and watersheds," or "air, soil and water resources and quality."

Does the plan establish a rational relationship between the desired ecological conditions and the monitoring questions and associated indicators required for monitoring by 36 CFR §219.12(a)(5)? The Planning Rule establishes two monitoring requirements for ecological conditions. One is "the status of a select set of the ecological conditions including key characteristics of terrestrial and aquatic ecosystems" (ii). Another is a requirement to directly monitor a "select set" of ecological conditions required for at-risk species (iv). Both assume the conditions have been properly identified (as discussed above). The status of focal species must also be monitored, and should be considered necessary when there are "ecological conditions required under §219.9" that are not otherwise being monitored (iii). In any case, there should be at least two focal species selected. The relationship between the desired ecological conditions and monitoring questions and indicators should be explained in the plan, including rationale for any conditions that are not monitored.

Identifying Species of Conservation Concern

Has the regional forester documented the rationale for 1) which species were considered for SCC, 2) which species were identified as "potential" SCC, and 3) which species were identified as SCC? With regard to which species are *considered*, the Handbook (§12.52d) provides lists of categories for species that "must be considered" and "should be considered." According to FSM 1110.8, when the word "must" is used in Forest Service directives the "action is mandatory and full compliance is required." When the word "should" is used, the "action is mandatory, unless a justifiable reason exists for not taking action." This means the regional forester must document conclusions and rationale regarding species that occur in any of these categories

(Handbook §12.52b(3) and (4)), including species that should have been considered but were not.

With regard to which species are *identified*, it is important to recognize that Planning Handbook §12.52c states, “the criteria for identifying species of conservation concern are also the criteria for identifying potential species of conservation concern.” The only difference between “potential” and final SCC is where the regional forester is in the decision process; SCC are “potential” until the decision is final. Prior to removing any “potential” SCC classification, the regional forester must explain changes in how the criteria have been applied.

Planning Handbook §12.52a(1) indicates that the responsible official has the authority to identify potential SCC, and some forests have created another category of SCC – those that are “recommended” as potential SCCs to the regional forester by the forest. When the regional forester disagrees with a forest recommendation, he or she must provide a rationale that resolves the conflict, and determines the applicable best available scientific information (BASI). Note that the Planning Handbook indicates that the responsible official may “analyze additional species” beyond those provided by a regional forester (Handbook §12.52b(1)(d)), presumably those where there is a “local conservation concern” in accordance with Planning Handbook §12.52(3)(f)). However, the responsible official may not analyze fewer species without approval of the regional forester.

For species found not to meet the SCC criteria, has the regional forester (not the responsible official) made the determination? The Planning Rule is clear that SCC species are those “for which the regional forester has determined” warrant inclusion as SCC (36 CFR § 219.9(c)). The authority to identify (or not identify) SCC “may not be delegated” to the responsible official (Planning Handbook §21.22a(1)(b)). The Planning Handbook offers a menu of ways that the responsible official and regional forester may work together on identification of SCC (§12.52b(1)). To the extent that they suggest an equal or superior role for the responsible official they are inconsistent with the Planning Rule (see (a, “jointly”) and (b, “request” modifications)). Because only this part of the planning process is outside of the control of the responsible official, actions of individual forests may suggest that they are responsible for this decision. The description of the SCC identification process should clearly explain the roles of the forest and region.

Since only the regional forester can determine which species are identified as SCC, a forest supervisor cannot determine which species will not be considered by the regional forester. Therefore, the authority of the responsible official is limited to identifying the species in any of the categories listed in the directives, suggesting any other species that might meet the criteria, and recommending potential SCC. In other words, the responsible official cannot “screen out” species during the SCC identification process.

Has the regional forester properly determined whether there *is* substantial scientific concern for persistence? The meaning of “is” is important here. “Concern” is not an independent determination by the regional forester. It is a determination by the regional forester that there is concern by scientific experts about persistence, and the determination cannot be arbitrary. This is indicated by the various classifications specified in the directives, as noted above, of species that must be considered as potential SCC, and requires consideration of how those “concerns” relate to the future status of the species in the plan area. The Planning Rule does not direct the regional forester to subjectively determine his or her own level of concern. The question to be addressed is whether the available scientific information indicates that a substantial risk to long-term persistence in the plan area exists. This is a scientific determination to be discerned from BASI (to the extent that it suggests otherwise, “concern” is an inapt choice of words).

Has the regional forester documented the use of BASI for each species? According to Planning Handbook §12.52b(3) and (4), the regional forester must document the BASI used in identifying SCC. According to Planning Handbook §07.15, “citations should be one of the principal methods to show how the BASI was applied to the issues being considered.”

Information on potential SCC is likely to be gathered by each national forest, and the information they provide to the regional forester could be summarized and abbreviated and without supporting documentation or references. That would not allow the regional forester to comply with the requirement to determine that the “best available scientific information indicates substantial concern.” The actual documents provided to the regional forester prior to identifying final SCC must be referenced and available for public review.

Moreover, relying solely on forest-produced data may lead to arbitrary differences in SCC results among national forests with the same species. Since most at-risk species are not found on a single forest a regional forester should review the range-wide status of the species, and ask the forests to address persistence in the plan area in that context (as well as adding species of local concern, Planning Handbook §1252d((3)(f)). It should be rare for differences in the SCC identification to occur among forests where vulnerable species are known to occur, and thorough documentation of such situations by a regional forester is warranted.

If a species is *considered* for selection as a potential SCC it is because there is at least one source of information that suggests a possible risk to persistence. Therefore, for each species considered and rejected, there should be at least one additional source of information referenced that indicates no substantial risk, and the regional forester must document "what information is most accurate, reliable and relevant" to the SCC determination in accordance with 36 CFR §219.3. This does not preclude staff professional judgment, but that must be referenced and discussed in the same manner as other sources.

Has the Regional Forester identified SCC sufficiently early in the planning process? It is a requirement of 36 CFR §219.6(b)(5) for the assessment to provide information for "potential" SCC. This means that the regional forester should identify potential SCC prior to or during the assessment, and provide the rationale. Failure to do so suggests that the assessment may not have provided sufficient information for the development of plan components for these species, including necessary ecosystem characteristics. In addition, the June 6, 2016, letter from Deputy Chief Weldon to regional foresters states that the *final* SCC decision should be made "well before the release of the draft environmental impact statement" "to allow the Forest Service to engage with the public about their concerns regarding the SCC before release of the DEIS" (basing this on language in Planning Handbook §22.21a).

Has the NEPA process properly incorporated the selection of SCC? While the Forest Service has sometimes indicated that the NEPA process may be the basis for changing regional forester decisions about which species are SCC, the timing required by the June 2016 letter makes it clear that identification of SCC is instead strictly a scientific determination, meaning that alternative SCCs are not appropriate for NEPA analysis. Public comments must address only the regulatory criteria for SCC and they must be considered in relation to the BASI requirement. The primary role of the NEPA process is not to identify SCC but to address effects of the plan on SCC and to provide a basis for determining compliance with the NFMA viability requirement.

Have species been improperly excluded from SCC identification because occurrences are "infrequent," "occasional," "seasonal" or "peripheral," or they are rare or there is little habitat or there is no nesting or breeding habitat? None of these factors may be used to exclude SCC. According to the Planning Handbook, actual occurrence records may only be discounted if individuals are "accidental" or "transient," or are "well outside the species' existing range" (which would presumably make them accidental or transient) (§12.52(c)(1)). A "transient" species is one that is only present when migrating between seasonal ranges. Therefore, migratory species may need to be identified as SCC when their seasonal range includes a national forest. Seasonal habitat on forests for migratory species may be essential for maintaining species viability. (This may even be true of habitat for some "transient" species in some areas, and excluding such species in accordance with the Planning Handbook may violate the requirement of the Planning Rule to contribute to maintaining a viable population of the species within its range.)

In its “SCC Objection Response” on the Francis Marion National Forest, the Washington Office interpreted the language “becoming established” from Handbook §12.52(c)(1) as a basis for finding a species is not accidental or transient. This may be warranted if future occurrences are expected due to climate change, and documentation should address how climate change was considered.

Have species been improperly excluded from SCC identification because they are not “native” to the plan area? This term is added by Planning Handbook §12.52(c), and defined in §05 as “An organism that was historically or is present in a particular ecosystem as a result of natural migratory or evolutionary processes and not as a result of an accidental or deliberate introduction into that ecosystem. An organism’s presence and evolution (adaptation) in an area are determined by climate, soil, and other biotic and abiotic factors (36 CFR 219.19).” A determination that a species is not native must be supported by documented BASI that addresses these factors.

Have species been improperly excluded from SCC identification because they have not been found in the plan area recently? Any rejection of past occurrences as being too long ago must consider and discuss the biology of the species and reasons why it would no longer be present or incapable of reoccurring. Excluding all species that have not been sighted on a forest after a fixed time period would be arbitrary. The extent of subsequent surveys should also be documented, and “failure to look” should not be a basis for finding subsequent absence. (Reliability and certainty of occurrence records is relevant, and should be addressed as questions of BASI.) (Note that the obligation to contribute to recovery of listed species may apply to areas where a species that once occurred in the area does not presently occur. Because forest plans may be used to prevent listing of SCC as threatened or endangered, forests should err on the side of including species that were formerly present.)

Have species been improperly excluded from SCC identification because threats in the plan area are addressed by existing management, the existing forest plan or possible plan components? This is not one of the Planning Handbook criteria in §12.52c for excluding SCC. Identification of SCC must be based on current conditions and potential threats; how these conditions and threats are addressed by management may change through the development of plan components during the planning process. (Considering or describing a plan area’s “distinctive role and contribution” for a species is not a substitute for SCC if the species meets the criteria for SCC.) The June 16, 2016, letter from Deputy Chief Weldon to regional foresters states: “Species should not be eliminated from inclusion as SCC based upon existing plan standards or guidelines, proposed plan components under a new plan, or threats to persistence beyond the authority of the Agency or not within the capability of the plan area, such as climate change."

Have species been improperly excluded from SCC identification because threats to the species are beyond the authority of the Forest Service or not within the capability of the plan area? SCC identification is not based on the source of the threats, only that threats exist that put a species' persistence in the plan area in question. (This is reiterated in the quote from the June 16, 2016, letter above.)

Have species been improperly excluded from SCC identification because the rationale fails to consider the effect of broad-scale risk factors that are relevant to the plan area? Handbook §12.52d(2)(a) states that, "Species with NatureServe G/T1 or G/T2 status ranks are expected to be included (as SCC) unless it can be demonstrated and documented that known threats for these species, such as those threats listed for the species by NatureServe, are not currently present *or relevant* in the plan area." In addition, §12.52(f)(1) recognizes that SCC identification may be warranted by "stressors on *and off* the plan area." When any source of SCC information suggests that a species is vulnerable in an area that includes the plan area, it is incumbent on the regional forester to "determine what information is the most accurate, reliable, and relevant to" the persistence of the species in the plan area, in accordance with 36 CFR §219.3 and use that to demonstrate that the factors outside of the plan area are not relevant to populations in the plan area, and that there is not substantial concern for their persistence in the plan area. The greater the risk described by a source, the greater the need for countering it with better science to support a decision to not recognize a SCC. As an example, a species with NatureServe ranks of "vulnerable" (G3/S3) would require less than those with a "very high risk of extinction."

Have species been improperly excluded from SCC identification because they have a NatureServe rank of S3? While Planning Handbook §12.52d does not include this as a category that should be *considered*, it represents a scientific conclusion that the species is "vulnerable" in an area that includes the plan area. It would be arbitrary to exclude a species with this rank for the reason that its rank is "only" S3. Scientific information indicating vulnerability does not demonstrate a lack of concern about persistence, but in fact demonstrates that *there is a concern*. In addition, it would be arbitrary to not consider further whether that information indicates substantial concern about the species' persistence in the plan area.

Has a species been improperly excluded as SCC due to a regional forester's judgment that "insufficient" information exists about the species? Planning Handbook §12.52c states: "If there is insufficient scientific information available to conclude there is a substantial concern about a species' capability to persist in the plan area over the long-term that species cannot be identified as a species of conservation concern." This ignores the fact that, for each species that is "considered," it is because there is some information that indicates that a species may not be able to persist in the plan area. If that information is sufficient for a credible source to identify risk of persistence of the species in an area that includes the plan area, then the Forest Service must explain why it is not relevant to the plan area or why it is not sufficient information to find substantial concern for species in the plan area.

Have species been improperly excluded from SCC identification solely because of lack of information about the species in the plan area, lack of habitat in the plan area, lack of threats to habitat in the plan area, or favorable status or trend in the plan area of populations or habitat? Substantial concern for persistence in the plan area needs to be based on the broader-scale context. Planning Handbook § 12.52b(4) covers reasons for not identifying SCC and neither criterion is limited to the plan area. (Compare to §12.55 where the status is determined for the plan area.)

Planning Handbook §12.52d describes categories of species to *consider*, most of which are based on a scale larger than the plan area. Planning Handbook §12.52d(3)(f) recognizes that conditions in the plan area may create an *additional* basis for *considering* and identifying SCC. However, this language should not be interpreted by a regional forester to mean that they can *eliminate* a species that fits other categories solely because of a *lack* of local concerns in the plan area. This section is clearly intended as an additional reason for inclusion as a SCC, <u>not as a basis for excluding species considered because of broader-scale conservation concerns</u>.

The June 16, 2016, letter alludes to the need to determine that species are "secure" within the plan area (Planning Handbook §12.52c). This is a determination that needs to be made; however, the letter fails to explain what is necessary to demonstrate that a species considered as a potential SCC is actually secure. Where species are considered at risk based on some credible information, the burden should be on the Forest Service to clearly demonstrate with BASI that an excluded species is nevertheless secure in the plan area. Information about the plan area itself is not necessarily a determining factor. Reasons why the broader scale circumstances don't affect the plan area must be clearly documented in the rationale for exclusion.

Have species been improperly excluded from SCC because they were found to be "not warranted" for listing under the Endangered Species Act? The information used to make an ESA listing decision may be considered BASI regarding the degree of concern about a species persisting in the plan area (as would the petition for listing). However, the listing decision itself is based on ESA criteria over the range of the species. Moreover, a species is listed under ESA when it is or is likely to become threatened with extinction. This is clearly a higher bar than substantial concern about persistence, and should not be used as a sole determinant that a species is not an SCC.

Have species previously classified as "sensitive" by the regional forester been excluded from SCC? Species were classified as sensitive because "population viability is a concern" (FSM 2670.5). In the Preamble to the Planning Rule, the Forest Service has stated that SCC are similar to existing regional forester sensitive species (RFSS) because population viability is a concern in each case (p. 21216). For the Forest Service to change its conclusion about the risk to these species requires a justification that explains the changes in the science since the species was found to be sensitive, and how the current BASI counters the original rationale for sensitive species designation, and demonstrates that the sensitive species does not meet the criteria for including as SCC.

Have species been improperly excluded from SCC identification because of any other factors that are not included as criteria in Planning Handbook §12.52c? These legitimate factors include "knowledge of its abundance, distribution, lack of threats to persistence, trends in habitat, or responses to management" (whether within or beyond the plan area). One example of an arbitrary criterion is whether species are hunted or fished. Inappropriate factors would also include any inference by the agency that there could be "too many" SCC or they would create too much work.

Does the plan suggest that species not selected as SCC may be adequately addressed as a "species of public interest" (or something similar)? The only criteria for SCC are those in the planning rule, so this question is irrelevant to SCC determination. There is a provision in 36 CFR §219.10(a)(5) for consideration of "wildlife, fish and plants commonly enjoyed and used by the public" in various ways. This provision is explicitly "subject to the requirements of §219.9." It was in no way intended to be an exception to the requirement in §219.9 to designate SCC. Also, as noted above, the possibility of plan components protecting a species may not be used as a rationale for failing to designate it as an SCC.

<u>Species of Conservation Concern Viability Analysis</u>

Does the plan documentation provide the information for potential SCC that was used to determine their eligibility, key ecosystem characteristics or plan components? The assessment must provide existing information relevant to the plan area for potential SCC for the purpose of "informing the development of plan components" (36 CFR § 219.7(c)(2)(i)). All information used to inform the development of plan components must be in the administrative record, and should be added to the assessment to meet this requirement. This should include the relevant key ecosystem components for each potential SCC.

Does the plan documentation determine and identify the "ecological conditions necessary to … maintain a viable population of each species of conservation a concern within the plan area?" For species at risk, we need to understand what ecological conditions have been deemed necessary to meet this NFMA species diversity requirement (found in 36 CFR 219.9(b). This is in accordance with the principle from *Lands Council v. McNair* of describing the quantity and quality of habitat needed. In order to use habitat as a proxy for species viability it is necessary to establish a strong relationship between each species in question and each ecological condition based on the BASI. The nature of the relationship between these attributes and the actual condition of the species should be documented so that this fundamental relationship can be tested as a "relevant assumption" under the monitoring program (219.12(a)(2)).

It is not necessary that the plan have specific desired conditions for each species. The documentation just needs to indicate what those conditions are for each species and how they will be met. They should be included as "key ecosystem characteristics" (Planning Handbook §12.13) in the assessment, and used to develop plan components. Ecosystem plan components may be used for this purpose. However, where the relationship between species and ecosystem plan components is weak, the plan must include additional species-specific plan components. For at-risk species, the lack of desired conditions that describe the ecological conditions that are necessary for viable populations of the species, and that are scientifically supported, would result in violating NFMA's diversity requirement.

Does the plan documentation include a determination of whether or not ecosystem plan components provide the necessary ecological conditions? This requirement is stated in 36 CFR 219.9(b)(1) and it is implicit in decisions to add species-specific plan components or not. On the other hand, if there are no species-specific plan components, the rationale for viability will also be the basis for this determination that ecosystem components are sufficient. In any case the Forest Service should articulate how it is protecting at-risk species with ecosystem and/or species plan components.

Has the effect on ecological conditions needed for at-risk species been determined consistent with the analysis of future vegetation management and its effects? The effects analysis may say that plan components "should" provide the appropriate characteristics, but that assumption must be validated by actual analysis. Analysis for plan revision should include a quantitative projection of changes in forest conditions over time, which should include effects of timber harvest and other vegetation management activities and natural disturbance effects. Inferences should be drawn from this analysis to determine if the relevant ecosystem characteristics for at-risk species are being provided. Ideally a wildlife effects model would be linked to vegetation effects projections. Subjective aspects of wildlife effects analysis should not be divorced from available objective analysis. The analysis should employ techniques that are considered the best available scientific approach.

Does the plan contain components that address ecological conditions other than biological characteristics? The term "ecological conditions" encompasses more than the "dominant ecological characteristics" used to evaluate integrity, which are limited to biological characteristics. The Planning Rule defines "ecological conditions" to include "habitat and other influences on species and the environment." Examples include "roads and other structural developments" and "human uses" (36 CFR §219.19).

Where the assessment identifies these as relevant to species persistence, they must be addressed by plan components. Since it is usually not possible to return human structures and uses to levels of some historic reference period, in some cases it may be necessary to manage biological characteristics differently (toward one end of or even outside of the NRV) to provide for species viability in conjunction with the presence of human-created conditions. If ecosystems and species are strongly influenced by human structures and uses outside National Forest System boundaries, additional management requirements in forest plans for the plan area may be needed to offset the effects of such other uses and structures in the larger ecosystem. This should all be accounted for in the effects analysis.

Does the analysis take into account existing conservation strategies for a species? Ideally, a forest plan would incorporate any such strategies that are based on BASI. Deviation from such strategies should be explained and the difference in effects acknowledged. In addition, inconsistent conservation measures for the same species on different national forests is an indicator of possible arbitrary decisions that must be explained using BASI.

Does the analysis properly consider short-term adverse effects in relation to long-term beneficial effects? Planning documents may state that long-term beneficial effects outweigh short-term adverse effects. It may be stated as a conclusion with little supporting analysis, but it is a key issue that must be resolved by forest planning whenever adverse effects may occur. This requires actual analysis of both the short-term and long-term effects – not just speculation.

Does the plan documentation demonstrate that the effects of plan components result in providing the necessary ecological conditions over time? This is the key determination that must be made to show compliance with NFMA diversity requirements. It must be made for the ecological integrity of each ecosystem identified in accordance with 36 CFR §219.9(a) and persistence of each species identified in accordance with 36 CFR §219.9(b), and must in some way reference and/or summarize the specific rationale and supporting analysis. The effects analysis for SCC must produce convincing evidence that the forest plan will provide the amount and distribution of necessary ecological conditions/key characteristics. Moreover, vague or discretionary plan components necessarily mean greater uncertainty, variability and risk associated with the effects, which would make it more difficult to evaluate them or use them to show compliance with NFMA diversity requirements.

It is common to see conclusory statements about viability, sometimes encompassing all species at once. It is necessary for the Forest Service to provide a logic trail for each species, from its necessary ecological conditions, to specific plan components, to conditions that would result from the plan components, to the legal sufficiency of those conditions. That should involve comparing expected outcomes from the plan to NRV for relevant key ecosystem characteristics. Departures from the NRV for key ecosystem characteristics indicate that the ecological integrity of the ecosystem may not be sustainable, and/or that individual species may not persist, and therefore diversity would not be achieved. The planning documentation should show that a positive viability finding is based on the concepts discussed in Planning Handbook §23.13(2).

Does the plan documentation conflate effects analysis for NEPA with a viability determination for NFMA? NEPA requires procedures - the analysis of effects. It does not necessarily require that this be done in terms of viability. However, NFMA requires that those effects meet a substantive threshold of viability, and that determination should be based on documented analysis, presumably found in the EIS. The Record of Decision must address compliance with the viability requirement (36 CFR §219.14(a)(2)). It is not sufficient to state that a plan meets this requirement because it analyzed effects. A ROD must explain how the effects demonstrate viability.

While this analysis may be contained in a NEPA document, it is being used to demonstrate compliance with a substantive legal requirement in NFMA, and therefore would require greater rigor and certainty than would the disclosure purpose of NEPA. The planning documents must do more than just list or restate the plan components that "support" a conclusion; they must present a reasoned rationale for viability based on reference to specific plan components.

Does the effects/viability analysis properly recognize the difference between different kinds

of plan components? The NFMA diversity requirement may not be met exclusively by aspirational and flexible plan components (especially if they are vague or subjective). While the consistency requirement of 36 CFR §219.15 discourages movement away from desired conditions and objectives, there is no requirement that they would ever occur on the landscape. On the other hand, where maintaining existing ecological conditions is important for species persistence, standards and guidelines can prevent management actions that would adversely affect those conditions. In fact, the Planning Rule advises the use of forest plan standards and guidelines to provide the certainty needed "to meet applicable legal requirements" such as species persistence (36 CFR §219.7(e)(iii) and (iv)). It could be arbitrary for a forest plan to not include mandatory plan components in such instances. Vague or subjective desired conditions create a need for stronger standards and guidelines. In addition, a plan that contains such mandatory regulatory mechanisms may be used as basis for not listing a SCC under ESA.

Does the analysis assume beneficial effects from management "flexibility?" Rationale provided for vague or subjective plan components may include the idea that "one size fits all" plan components, including strict prohibitions, limit the range of tools available to potentially benefit at-risk species. Where it is clear that use of the tool in some circumstances may adversely affect a species, any such claim should be supported by extensive analysis and rationale before beneficial effects should be assumed for this "flexibility." This would never be an appropriate rationale for designating lands suitable for "timber production," because any possible flexibility would be negated by the requirement to manage vegetation on such lands as a "regulated crop of trees" (36 CFR §219.19).

Does the analysis properly consider the relative importance and contribution of different parts of the plan area to species persistence in the plan area? The value of different parts of a national forest to a species is often not uniform. Areas of higher value should be identified in the assessment, and considered differently in the effects analysis. Ideally, they would receive more protective plan components, which would lead to better outcomes forest-wide. (This has often been done for aquatic species.)

Has the plan adequately provided for species for which a viable population cannot be maintained in the plan area? If a species is one for which "it is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of a species of conservation concern in the plan area" (36 CFR §219.9(b)(2)), the Forest Service must document the rationale, and should discuss the effects of such a finding in the context of the broader landscape. As long as members of the species are known to occur in the plan area, ecological conditions must be provided "to contribute to maintaining a viable population of the species within its range." This exception does not constitute permission to contribute less than what the authority of the Forest Service and inherent capability of the plan area allow. Also, the forest plan may have to compensate for degraded conditions on the broader landscape or include plan components to mitigate the effects of downstream and off-unit stressors on a species.

To meet the requirement to "contribute to maintaining a viable population of the species within its range," that range must be considered in developing plan components and analyzing their effects (including cumulative effects). In particular, assessments should identify species for which the national forest is a stronghold relative to elsewhere, and plan components should provide more of the ecological conditions that may be limiting. The presence or absence of such plan components must be considered in determining effects and whether this requirement is met. The degree of collaboration (§219.4) in developing plan components in the context of "the broader landscape" (§219.5) should be considered in relation to these viability findings.

Does the plan adequately provide for connectivity at forest boundaries when viability is not within the capability of the plan area? There has been a tendency for the Forest Service to equate connectivity with forest cover conditions within the forest boundaries. This is important and there should be analysis of future landscape vegetation patterns as well as the effect of fragmentation due to forest roads and their use. However, when developing plan components pursuant to 36 CFR 219.9(b)(2), coordination with other land managers must occur, which would provide the basis for plan components that address connectivity between or beyond national forest lands. The assessment must identify the relative contribution of the plan area to range-wide species persistence. If connectivity is going to be maintained at the project level, plan components need to include decisions about what areas should be managed for connectivity at a landscape scale.

Planning for connectivity is part of the NFMA diversity requirement in the Planning Rule. Therefore, plan components that provide for connectivity must be included in the plan, and they must not defer to unspecified future actions of other parties. Areas important for connectivity have been identified for many species and many geographic areas and may be considered BASI. Areas identified in a forest plan to be managed with plan components for connectivity would by definition be management areas (36 CFR §219.19) (though forests may not wish to label them as such).

Does the viability analysis inappropriately rely on discretionary implementation of the forest plan monitoring program? The monitoring program is not a plan component. Therefore, it cannot be used to meet the Planning Rule requirements for plan components in 36 CFR 219.8-9, including viability determinations. However, it can be linked to plan components in a way that requires appropriate action to occur when monitoring produces specified results (or when monitoring does not occur as assumed). For example, where species monitoring is necessary because of unproven effectiveness of "coarse filter" proxies for species populations, plans must provide greater certainty that such monitoring will occur. A plan component (standard) should include a "trigger" for action in such cases; merely including a threshold in the monitoring plan does not make it a plan component, and it should not be considered in determining viability.

Does the biological evaluation demonstrate compliance with FSM 2670 requirements for sensitive species? Unless and until the Forest Service removes the requirement for a BE, one must be prepared for forest plan decisions as provided in the June 3, 2016 2670/1930 WO memo. For RFSS where there is no longer a concern for persistence in the plan area (and therefore they have not been identified as a SCC), a BE could also serve the purpose of validating that conclusion, in addition to evaluating the effects of plan components on viability. Since this is the last time that viability for these species would be evaluated, the integrity of the scientific analysis included in these documents is important. Where species have both SCC and RFSS classifications, a single document could provide all of the necessary information, but it must meet the requirements for a BE.

Recovery of Federally Listed Species

Does the plan documentation determine and identify the "ecological conditions necessary to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species …"? The requirement should be addressed in the same manner as ecological conditions for SCC above. The primary source of information should usually be the recovery plan if one exists; however, it should be supplemented with more recent information if that is the "best available."

Has the FS considered recovery plan provisions, *and* incorporated as plan components those needed for the plan to contribute to recovery? Although recovery plan objectives are discretionary for federal agencies, the Planning Rule has made contribution to recovery a requirement of forest plan components. Forest plans cannot simply acknowledge recovery plans in some vague way, but instead they must include plan components that contribute to recovery. The Francis Marion objection decision makes it clear that "the Forest will meet their obligations under the Endangered Species Act section 7(a)(1) by implementing programs to conserve listed species, not simply consider them." Is there a document that crosswalks recovery plan requirements to plan components, and explains why any requirements were not included in the forest plan?

Where no recovery plan exists, has the FS nevertheless established desired conditions and other plan components based on BASI? The lack of recovery plan may not be used as an excuse to delay plan components needed for recovery until a recovery plan is complete. At the time, a revised forest plan is approved it must include plan components that meet the regulatory requirement to contribute to recovery. It may be subsequently amended to accommodate new recovery plan guidance, as appropriate.

Has the FS considered the forest plan biological opinion from the relevant consulting agency, and incorporated as plan components the conservation measures needed to meet 7(a)(2) requirements and avoid prohibited incidental take? It should be clear that any measures needed to prevent jeopardy or adverse modification of critical habitat would also be necessary to contribute to recovery unless the Forest Service can demonstrate otherwise. Plan components that minimize incidental take would contribute to recovery (as well as reduce the likelihood of needing to reinitiate consultation on the plan), and the Francis Marion objection instructions did require this of the Forest. This may be problematic during the objection process if consultation has not been completed at the time of an objection. For the purpose of this NFMA requirement for plan components it is necessary for the Record of Decision to clearly state that any new management requirements based on consultation are plan components, and for the plan itself to be edited to reflect this.

Have the FS and consulting agency considered the results of prior consultation on projects or the existing plan as a basis for plan components necessary for future projects? A review of prior project consultation documents should occur, including mandatory measures and discretionary conservation recommendations. Such recommendations should create a rebuttable presumption that they would contribute to recovery, and rationale must be provided for failing to include them in the plan. Also, any mandatory requirements from prior consultation on the forest plan that were not incorporated into the current plan by amendment represent a need to change the plan during revision to include them (if they are still relevant).

Does the plan inappropriately rely on future project-level consultation to determine what conditions are needed to contribute to recovery for listed species? There are two problems with this approach; it shifts planning for diversity to the project level, and it applies a jeopardy standard rather than the required (and more demanding) recovery standard. NFMA and the Planning Rule require that plan components stand on their own, independent of any ESA procedures (which would no longer be in place if the species were delisted). A forest plan should not assume a species will be protected under ESA and cannot defer to ESA requirements. If management requirements are necessary to comply with NFMA, they must be incorporated into the forest plan as plan components.

Has the FS obtained the opinion regarding the plan's contribution to recovery from the relevant consulting agency? An ESA §7(a)(1) conservation review with the appropriate consulting agency should be completed to ensure compliance with these NFMA requirements. The Francis Marion objection decision stated that the forest plan "is the agency's strategy to meet our obligations under ESA Section 7(a)(1)." If a forest plan is a "program for the conservation of (listed) species," (terms used in Section 7(a)(1)) as well as Planning Rule requirements for federal agency participation (36 CFR 219.4(a)(1)(iv)).

Has the FS properly taken into account its role in contributing to recovery relative to other jurisdictions? National forest lands may have to contribute relatively more of the ecological conditions needed by a species. "Contributing" to recovery necessarily means coordination with others responsible for recovery, and the role of the national forest needs to be defined in the assessment in order to develop plan components. (Recovery plans may or may not have articulated the relative role of a national forest.)

Has there been analysis of viability for listed species? The best (and maybe only) way for a forest plan to contribute to recovery is for plan components to provide conditions to maintain a viable population. In addition, upon recovery and delisting the plan will likely be required to treat the species as an SCC and provide such components. Moreover, the reasoning of *Seattle Audubon Society v. Evans*, 952 F.2d 297 (9^{th} Cir. 1991) would invalidate a Forest Service position that it could ignore NFMA diversity obligations for listed species (since this opinion was based on the language of NFMA, the 2012 Planning Rule should not change the outcome):

"The effect of the Forest Service's position in this litigation would be to reward the Agency for its own failures; the net result would be that the less successful the Agency is in maintaining viable populations of species required under its regulations, the less planning it must do for the diversity of wildlife sought by the NFMA."

Has the Forest documented the use of BASI in determining ecological conditions necessary to contribute to recovery? This should occur similar to what was discussed for SCC. However, there needs to be special attention paid to the use of the recovery plan, especially where forest plan components deviate from the recovery plan?

Does the forest plan provide a mechanism for responding to new or modified recovery plans or other new information bearing on whether plan components contribute to recovery? In addition to incorporating provisions of a current recovery plan, if there is one, the plan should include language that commits to implementing future changes in recovery plans. In the absence of directives similar to §21.22b in the Planning Handbook for SCC, the plan should provide a similar process for addressing new information about listed species.

Plan Component Requirements

Do plan components follow rationally from the assessment and need for change determinations? First, it is important to recognize that the focus is on changing what the forest plan says, regardless of what current practices might actually be. Then the need for change must be based on information documented in the assessment, but there have been problems with initial plan revisions not establishing this rationale. Also, since the need for change determines the purpose and need for the proposed action under NEPA, lack of a reasonable rationale for change could be a basis for challenging the scope of the NEPA process.

The development of plan components specifically relies on the assessment to identify the presence and importance of resources in the plan area (the key ecosystem characteristics) (iii) and conditions, trends and stressors (iv). However, It is not unusual to find plan components that are not supported by anything in the assessment, and that do not address needed changes that were identified. In addition, there may be needed changes identified that are not addressed by plan components. (This can be due in part to changing personnel involved at different points of the planning process.) References in the EIS should be to specific assessment content.

Did the responsible official document how "the best available scientific information was used to inform" the planning process? This is often a cursory discussion. However, the 36 CFR §219.3 has detailed requirements that must be addressed by this documentation: "the responsible official shall determine what information is the most accurate, reliable, and relevant to the issues being considered… Such documentation must: Identify what information was determined to be the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered." There is no requirement for peer review to qualify as BASI.

Are plan components internally consistent and integrated? It should be clear and stated that mandatory standards and guidelines prevail over desired conditions and objectives, and that the most restrictive standard or guideline applies (because the leads to consistency with both). Conflicting desired conditions or objectives are potentially problematic. There may be a belief that conflicts can be resolved during implementation, but to properly understand the effects of the plan it needs to be clear how they will be resolved from the language of the plan itself.

Do desired conditions meet the requirement of 36 CFR 219.7(e)(1)(i) that they "must be described in terms that are specific enough to allow progress toward their achievement to be determined?" Because of the requirement that the public have opportunities to participate in "reviewing the results of monitoring information" (36 CFR 219.4(a)), achievement of desired conditions must be determined in an objective manner and cannot simply be left to the subjective judgment of the agency. This means that it must be clear in the plan what the desired condition is and how it will be measured. The agency explicitly rejected vague, aspirational plan components considered in prior proposed planning regulations. In particular, when plan components are necessary to provide ecological conditions for at-risk species, it must be clear in the plan component itself how it will provide those conditions. (There must be something in the plan that allows a determination of project compliance.) Moreover, for at-risk species a desired condition like "increase" or "reduce," while measurable, may not be sufficient if it means that any change in the right direction will meet viability requirements for the species. (related discussion below)

Vague plan components make it difficult to determine their effects; they also place a heavy burden on project-level analysis to establish consistency. Substantively, vague plan components are less likely to provide ecological conditions required for at-risk species.

Does the plan properly use existing conditions? Existing conditions may be relevant for creating objectives to prioritize actions, but should not be relevant to determining desired conditions. Since existing conditions can be changed by management, they should also not be part of designating management areas (which can only be changed by plan amendments)

Are desired conditions adequately supported by additional plan components to make them likely to be achieved? Naked desired conditions are very weak plan components (and vagueness makes them weaker). It is important to include other plan components that help achieve the desired conditions. These may be objectives or suitability determinations for those conditions that are to be actively managed, or standards, guidelines or unsuitability determinations for those conditions that are to be protected. The support, or lack thereof, for desired conditions should be considered in how much weight they are given in the analysis.

Does the plan include sufficient standards and narrowly defined guidelines where needed to address at-risk species? The Planning Rule specifically recognizes that these plan components may be needed "to meet applicable legal requirements" like ESA and the NFMA diversity requirement (36 CFR 219.7(e)(1)(iii) and (iv)). This is especially true where existing ecological conditions must be maintained because they are limiting factors and/or not readily restored (like old growth). If the plan relies on desired conditions to provide necessary ecological conditions, has the Forest documented the rationale and addressed the inherent uncertainty? (duplicated – move to diversity section?)

Do guidelines include a purpose statement? The difference between standards and guidelines is that projects can be consistent with the latter even if they don't comply with the letter of the guideline as long as the project "is as effective in achieving the purpose of the applicable guidelines" (36 CFR §219.15(d)(3)(II)). (Without some description of a guideline's purpose, a guideline should arguably be treated like a standard.) Rationale should also be provided in the planning record for why guidelines are chosen instead of standards, especially where their purpose is related to protecting at-risk species.

Is the absence of a plan component justified based on an opinion/assumption that effects are unlikely to occur? The fact that other plan components should lead to the same result is not a good reason to omit one that directly seeks that result, especially where at-risk species are involved. Given the longevity of forest plans and the likelihood of unforeseen circumstances, the current apparent remoteness of an outcome should rarely be justifiable as a reason to not address it with a plan component. Such cases should be supported by documented and thorough rationale.

Does the plan rely extensively on "adaptive management" to provide "flexibility?" There may be statements, sometimes associated with discussions of "adaptive management," about the need to incorporate flexibility into plan components themselves. Flexibility for adaptive management is accounted for in the Planning Rule by the planning framework described in 36 CFR 219.5. It is this framework of assessment, planning, monitoring and then plan amendment or revision that "creates a responsive planning *process*" and "allows the Forest Service to adapt to changing conditions" (219.6(a). Notably, the purpose of monitoring in 36 CFR §219.12(a) is to determine if changes are needed in plan components, not to determine them in the first instance.

However, there is nothing in the Planning Rule that provides authority to establish a *flexible forest plan* by building uncertainty into the plan components themselves. Doing so would provide the Forest Service with the ability to essentially change or create plan direction in the future without public involvement.

Do plan components defer decisions about necessary ecological conditions to project-level decision-making? The Planning Rule is clear that it does not apply to projects (except with regard to determining consistency with the plan, 36 CFR 219.2(c)). In particular, this includes the requirement to use BASI. Therefore, projects may not be used to meet the requirements for forest planning.

An attempt to provide maximum discretion to future decision-makers on a project-by-project basis would be counter to the purpose of NFMA of providing integrated and strategic direction for future projects. (See Rittenhouse @ 957.) Unaccountable flexibility in plan components would prevent them from contributing to meeting viability requirements. Notably, the planning framework was intended to facilitate response to future climate change, and therefore climate change cannot be used as an excuse for inherently flexible plan components.

The most important plan component may be desired conditions because they are the basis of all other plan components (desired conditions are an element of the definitions of the other plan components in 36 CFR §219.7(e)(1)). The forest plan cannot defer that decision to project decision-making. It would be acceptable to include ranges of values that would apply to ranges of site conditions. However, the plan cannot write a blank check for project-level decisions to establish desired conditions in the first instance, at least where desired conditions for at-risk species are necessary at the plan level.) By their nature, desired conditions would apply to all future decisions so are inherently programmatic. If they are not adopted in the revised plan, it would require subsequent amendments every time they are determined.)

Do plan components provide sufficient certainty that requirements for diversity would be met? The 2012 Planning Rule requires some degree of certainty regarding its projected effects on viability because plan components necessary for viability "MUST be included in the plan." The Forest Service cannot circumvent this requirement by including a plan component that excuses itself from doing so. When a plan includes no basis for determining project consistency, it essentially defers a viability determination to the project level. As a result, the plan itself does not do what is required of it by NFMA.

This would also result in a forest having to determine viability for each project. The Rule is explicit that it does not apply to projects. The only plausible interpretation is that each project would need to conduct an analysis of forest-wide viability. That not creates maximum uncertainty, but flies in the face of the goal of NFMA for "one integrated plan," and would also create an analytical workload that the Forest Service itself could not support.

Do plan components simply restate the legal requirement for ecological integrity? Requiring desired conditions within the natural range of variation, without stating what that is, effectively delegates responsibility to project decision makers for determining NRV needed to meet requirements of the Planning Rule. There is no basis for objectively determining the validity of their decision. Such a plan component does not provide the necessary ecological conditions and defeats the purpose of having a plan. Notably, an actual desired condition would have to be determined for the first project signed after the revised plan is adopted; what additional information would be available then that cannot be used in developing the forest plan? Moreover, if the information about NRV will be available to implement the plan when it is adopted, failure to use it for the plan itself would result in ignoring the best available scientific information.

Simply establishing "NRV" as the desired condition for ecosystems or species would merely restate the legal requirement in the Planning Rule, and could apply to any national forest. This is not planning at all; putting off programmatic decisions until projects would not comply with NFMA. Similarly, plan components cannot simply repeat the requirements in 36 CFR §219.9(b) for viability and contributing to recovery.

Does a plan component include subjective terminology? Examples include adequate, sufficient, resilient, healthy, sustainable, natural, ample, typically, satisfactory, necessary, or properly. While these might suffice as goals, the failure to include objective measurable conditions means that the public has no idea what the Forest Service is planning, or what the effects will be. This effectively shifts responsibility for plan decisions to the project level, and leaves the meaning up to the whims of the individual future decision-makers. Similarly, terms like "low" or "high" mean nothing and cannot be the basis for an effects analysis or viability conclusions. This is not planning as intended by NFMA.

Does the plan leave important terms undefined? This also creates ambiguity and opportunities for decisions to be made at the project level that should be made at the plan level. Inconsistent use of terms also creates uncertainty and undesirable discretion.

Does a plan component establish a desired condition or objective to conduct future planning? While such plan components may be included, they are not a substitute for actual programmatic decisions and should carry no weight in meeting diversity requirements. In addition, substitution of future planning, or project planning, for a forest plan violates NFMA's requirement that forest plans "shall form one integrated plan" (Section 6(f)(1)).

Does the plan properly specify the spatial characteristics of necessary ecological conditions? Does it require a certain distribution (or pattern) where that is important to an at-risk species (such as old growth)? Analysis that predicts that a desired distribution is likely cannot be used as a substitute for a plan component that requires the distribution to be provided during project planning. Project planners must have landscape design criteria or else they won't understand how to achieve desired outcomes, and are essentially making plan-level decisions on a project-by-project basis.

Does the plan component make it clear where it applies (36 CFR 219.7e)? It should provide either a reference to a map or criteria for site conditions that would determine its application. In the latter case, the criteria cannot be subjective to the extent that consistency with the plan cannot be readily determined. As a last resort, the plan should include the process for determining whether the site is appropriate for the plan component. There is a tendency to write plan components so that it is entirely up to the project implementers whether to apply them (often there may be a clause starting with "where" but not providing an objective basis for finding the locations). This degree of discretion produces uncertainty that precludes the plan component from providing ecological conditions necessary to meet the viability requirement. (As part of this, it should be clear what scale a plan component applies to.)

Does the forest plan allow the location of plan components to be determined during implementation? Failure to identify the location of plan components is contrary to FSH 1909.12 22.2, renders them meaningless, and effects would be impossible to determine if they are spatially variable (such as occurring in habitat for a particular species). The whole point of a forest plan is to determine what kind of management is going to occur where. The concept of a "floating" management area (a management area being an "area that has the same set of applicable plan components," 36 CFR §219.19) is fundamentally inconsistent with NFMA. From a NEPA standpoint, because they may be determined outside of the forest planning process, potential adverse effects would have to be assumed to occur everywhere the management would be allowed, though it is also possible that it would never occur anywhere. Conceptually, it is not part of the proposed action, because it would require an amendment to add the new programmatic direction for selected areas.

Plan components cannot be applied wherever someone feels like applying them. This situation should be distinguished from one where the site-specific conditions are objectively described in the plan component so that they can be located wherever they occur during plan implementation. This could include fine scale features or precise boundary adjustments. Analysis at the plan level should approximate their numbers and locations.

Does the plan properly recognize and use management areas? One common complaint about current plans is that they have too many and/or non-contiguous management areas, and larger contiguous "geographic areas" are viewed as a solution. However, management areas are defined by the Planning Rule as areas "with the same set of applicable plan components." There is a tendency for plans to not label all such areas as "management areas," but these different sets of plan components are, along with forest-wide plan components, the cause of plan effects, and should be the basis of the analysis in the EIS. (They should also be the basis of timber suitability analysis, since that is based on compatibility with plan components.) One important management area that needs to be highlighted is the wildland urban interface, or other areas identified where protection from fire would be a priority, and thus have substantially different management from elsewhere.

Do plan components address fire management? Forest planning is where national fire strategies must be interpreted and applied to individual national forests. There has been continuing tension within the Forest Service regarding the degree to which forest plans must address fire management. While NFMA requires integration of all management, and fire and vegetation are unavoidably linked, there may be pressure to avoid making fire-related decisions in the forest plan. However, desired fire regimes and fuel conditions necessarily lead to desired vegetation, and all must be addressed by plan components. This includes any differences based on locations on the unit or resources at risk. Meaningful effects analysis and comparison of alternatives cannot occur without this. (WUI identification is not a decision that can be made independent of the forest plan if it is the basis for differences in management and effects – see lynx mapping cases.)

Do plan components require avoidance and pre-project surveys to determine where to avoid for species with uncertainty about where they may be found? Any time a plan component does not clearly identify where it applies or provide objective criteria that would determine where it applies, it must ensure that a project does so by including this procedural requirement as a standard.

Do plan components apply at the appropriate scale? The Planning Rule requires integrity of ecosystems, which affords some flexibility. However, for at-risk species it must be clear that ecological conditions will be provided at the scale at which they are relevant to the species. This may require plan components for fine-scale site conditions, as well as ecosystem conditions. The scale of historic disturbance regimes (based on the assessment) should also be considered in determining plan components.

Do plan components refer to other sources for the substance of the plan component? This may be acceptable if it refers to a specific existing document, or specific parts of that document, that the plan component incorporates. This would include "retained direction" from the current plan such as specific species conservation strategies, but it would not be appropriate to rely on a conservation strategy that is not incorporated into a forest plan. Moreover, references to future documents or changes in existing documents, including those produced by other agencies or governments, cannot be used as a basis for meeting plan requirements because their content is unknown. Future substantive changes in plan components must go through the amendment process, and cannot be presumed for plan revision. This includes definitions. A district court has held that "information" that would automatically change an existing decision triggers the need for public participation and NEPA.

Do plan components improperly defer to state wildlife management? It is a common misconception that states, represented by their wildlife agencies, have ultimate management authority over wildlife. The courts have consistently held that the federal government has supremacy regarding management of its lands, including wildlife found there, and human uses of that wildlife. State goals cannot be used as basis for avoiding use of plan components needed for at-risk wildlife species.

Do plan components improperly include references to agency directives? References to agency directives may be used to supplement and clarify plan components, but 36 CFR 219.2(b)(2) should not be interpreted as sanctioning, "program management policies, practices, and procedures that are in the Forest Service Directive Systems" as substitutes for "plan components" that are required to provide necessary ecological conditions for at-risk species. It is important to recognize that if conservation measures are needed to provide ecological conditions for species persistence in the plan area they must be included in the plan as plan components. Also, note that the Planning Rule reference to "policies" is limited to those in the FS directives, and should not be applied to anything else. Moreover, references to agency directives should not be included in plan components at all, but should instead be included as "other plan content" (1909.12 FSH 22.4).

Do plan components say that something will happen, without actually making it a plan component? Plan components may contain statements about things that may occur in the future, such as monitoring information. If the future event is not also a plan component, the basis for the plan component may not be valid. They may also refer to the way the current plan has been implemented, even though that is not a requirement of the plan. These should arguably be included in the revised plan as plan components.

Does the plan substitute "management approaches or strategies," referred to as "optional content in the plan" by 36 CFR 219.7(f)(2), for plan components by including substantive plan provisions in them? They must not be written like a plan component (1909.12 FSH 22.4). This is a particular problem if the content is needed for "plan components" to provide necessary ecological conditions for at-risk species, because they carry no legal weight and are unenforceable (projects need not be consistent with them). Justification for not including plan components should be sought in such cases.

Does the forest plan properly interface with travel management planning? Travel planning is a project-level decision that must be consistent with the forest plan. The forest planning process should not be constrained by what existing travel plans say, but should be based on roads analysis (cites). Plan components may reference how travel plans would be used, but should not tie to specific provisions of existing travel plans. Unless it is incorporating those provisions as plan components. While this is not the way it is intended to work, the Planning Rule does not prohibit it, and there may be situations where site-specific travel management decisions are necessary to provide the appropriate conditions for at-risk species.

Do plan components comply with 36 CFR 219.8(a)(3)(ii) by establishing widths for riparian management zones? Widths must be established for all lakes, perennial and intermittent streams and open water wetlands, and these terms must be defined for the plan area. The provision at (A) allowing site-specific delineation is not a substitute for the plan requirement to delineate RMZs at the plan level (note the term "replaced"). The plan should not suggest that they are only a project-level decision. The plan should recognize that these are management areas because their plan components are selected to give riparian-dependent resources "primary emphasis" (36 CFR §219.19).

Do plan components comply with 36 CFR 219.8(a)(4) by ensuring implementation of national Forest Service best management practices? The only way for plan components to ensure implementation these BMPs is to include a standard that requires them. The fact that they exist in the Directives does not ensure they will be implemented, and ignores the requirement for plan components. The fact that other BMPs (like those developed by states) might also apply is not relevant to this requirement.

Do plan components properly incorporate the Watershed Condition Framework into the forest plan? 36 CFR 219.7(f)(1)(i) requires that plans, "Identify watershed(s) that are a priority for maintenance and restoration," but this is not a plan component. 1909.12 FSH 22.31 indicates that plan components should "address conditions in priority watersheds." Any information or guidance resulting from the WCF process needs to be brought into the forest planning process, especially if there are unique desired conditions or objectives for priority watersheds. NFMA requires one integrated plan, and plan components cannot reside in unrelated documents that do not require consistency and therefore do not count towards meeting the forest plan diversity requirements.

Do plan monitoring programs properly rely on broader-scale monitoring strategies? Regional broader-scale monitoring strategies required by 36 CFR §219.12(b) will be completed "as soon as practicable." When they are, the plan monitoring program should be specific about how information from the broader-scale strategy will be integrated into forest-level monitoring. An individual forest cannot simply "pass the buck" to a regional effort; it must consider how it will use that information. If a broader-scale monitoring program has not yet been developed, a forest monitoring program cannot just assume that it will address the needs of the Forest. The relevant regional forester must make some commitment to meeting a forest's needs before a forest may rely on broader-scale monitoring.

Literature Cited

Beschta, R.L., Rhodes, J.J., Kauffman, J.B., Gresswell, R.E., Minshall, G.W., Karr, J.R., Perry, D.A., Hauer, F.R., and Frissell, C.A. 2004. Postfire management on forested public lands of the western United States. Conservation Biology. 18: 957-967.

Donato, D.C., Fontaine, J.L. Campbell, W.D. Robinson, J.B. Kauffman, and B.E. Law. 2006. Post-wildfire logging hinders regeneration and increases fire risks. Science 313: 615.

Hutto, R.L., R.E. Keane, R.L. Sherriff, C.T. Rota, L.A. Eby, and V.A. Saab. 2016. Toward a more ecologically informed view of severe forest fires. Ecosphere. 7(2): e01255.

Karr, J.R., Rhodes, J.J., Minshall, G.W., Hauer, F.R., Beschta, R.L., Frissell, C.A. and Perry, D.A. 2004. The effects of postfire salvage logging on aquatic ecosystems in the American West. BioScience. 54: 1029-1033.

Lindenmayer, D.B, D.R. Foster, J.F. Franklin, M.L. Hunter, R.F. Noss, F.A. Schmiegelow, D. Perry. 2004. Salvage harvesting policies after natural disturbance. Science. 303: 1303.

Lindenmayer, D.B., and R.F. Noss. 2006. Salvage logging, ecosystem processes, and biodiversity conservation. Conservation Biology 20(4): 949-958.

Noss, R.F., Franklin, J.F., Baker, W.L., Schoennagel, T., and Moyle, P.B. 2006. Managing fire-prone forests in the western United States. Frontiers in Ecology and Environment. 4(9): 481-487.

Shatford, J.P.A., Hibbs, D.E. and Puettmann K.J. 2007. Conifer regeneration after forest fire in the Klamath-Siskiyous: How much? How soon? Journal of Forestry. 105(3): 139-146.

Thompson, J.R., Spies, T.A., and Ganio L.M. 2007. Reburn severity in managed and unmanaged vegetation in a large wildfire. PNAS 104: 25.

<u>Appendix 3</u>

Planning for Connectivity

Defenders of Wildlife, The Center for Large Landscape Conservation, Wildlands Network, and Yellowstone to Yukon Conservation Initiative

2015

Planning for Connectivity

A guide to connecting and conserving wildlife within and beyond America's national forests



DEFENDERS OF WILDLIFE
THE CENTER FOR LARGE LANDSCAPE CONSERVATION
WILDLANDS NETWORK
RECONNECTING NATURE IN NORTH AMERICA
Yellowstone to Yukon Conservation Initiative

ACKNOWLEDGEMENTS

Planning for Connectivity is a product of The Center for Large Landscape Conservation, Defenders of Wildlife, Wildlands Network and Yellowstone to Yukon Conservation Initiative. This guide focuses on requirements established under the National Forest System land management planning rule to manage for ecological connectivity on national forest lands and facilitate connectivity on planning acrosss land ownerships. The purpose of the guide and its parent publication, *Planning for Diversity*, is to help people inside and outside of the Forest Service who are working on forest plan revisions navigate these complex diversity and connectivity requirements.

Principal authors:
Jonathan Haber
Peter Nelson

contributing authors:
Rob Ament
Greg Costello
Wendy Francis
Mark Salvo

Defenders of Wildlife
1130 17th Street, N.W.
Washington, D.C. 20036
www.defenders.org

Center for Large Landscape Conservation
303 West Mendenhall, Suite 4
Bozeman, Montana 59715
www.largelandscapes.org

Wildlands Network
1402 3rd Avenue, Suite 1019
Seattle, Washington 98101
www.wildlandsnetwork.org

Yellowstone to Yukon Conservation Initiative
Unit 200, 1240 Railway Avenue
Canmore, Alberta T1W 1P4
Canada
www.y2y.net

cover: lynx/©Jean Pierre Grosemans; Medicine Bow National Forest, Wyoming/©Howie Garber; steelhead trout, Umpqua River/Bureau of Land Management, Oregon Office

TABLE OF CONTENTS

INTRODUCTION 2

THE IMPORTANCE OF CONNECTIVITY 4

THE 2012 FOREST PLANNING RULE 6

- The Planning Process 6
- Forest Plan Components 6
- Diversity 7
- The Ecosystem-Species Approach 7
- Issues of Scale 10
- Connectivity Information 11
- Connectivity Coordination 11

BEST PRACTICES FOR CONNECTIVITY PLANNING 12

- Assessing Connectivity 12
- Connectivity Management Areas 13
  - Case Study: Wildlife Linkages in the Sky Islands 13
  - Case Study: Grizzly Bear Approach Areas 14
  - Case Study: Blue Mountains Wildlife Corridor Management Area 15
- Landscape Plan Components for Connectivity 15
- Project Plan Components for Connectivity 16
- Aquatic Ecosystem Connectivity 16
- Barriers to Connectivity 18
- Roads and Connectivity 19

CONCLUSION 21

REFERENCES 22

APPENDIX: Examples of Coordinated Connectivity Planning 24

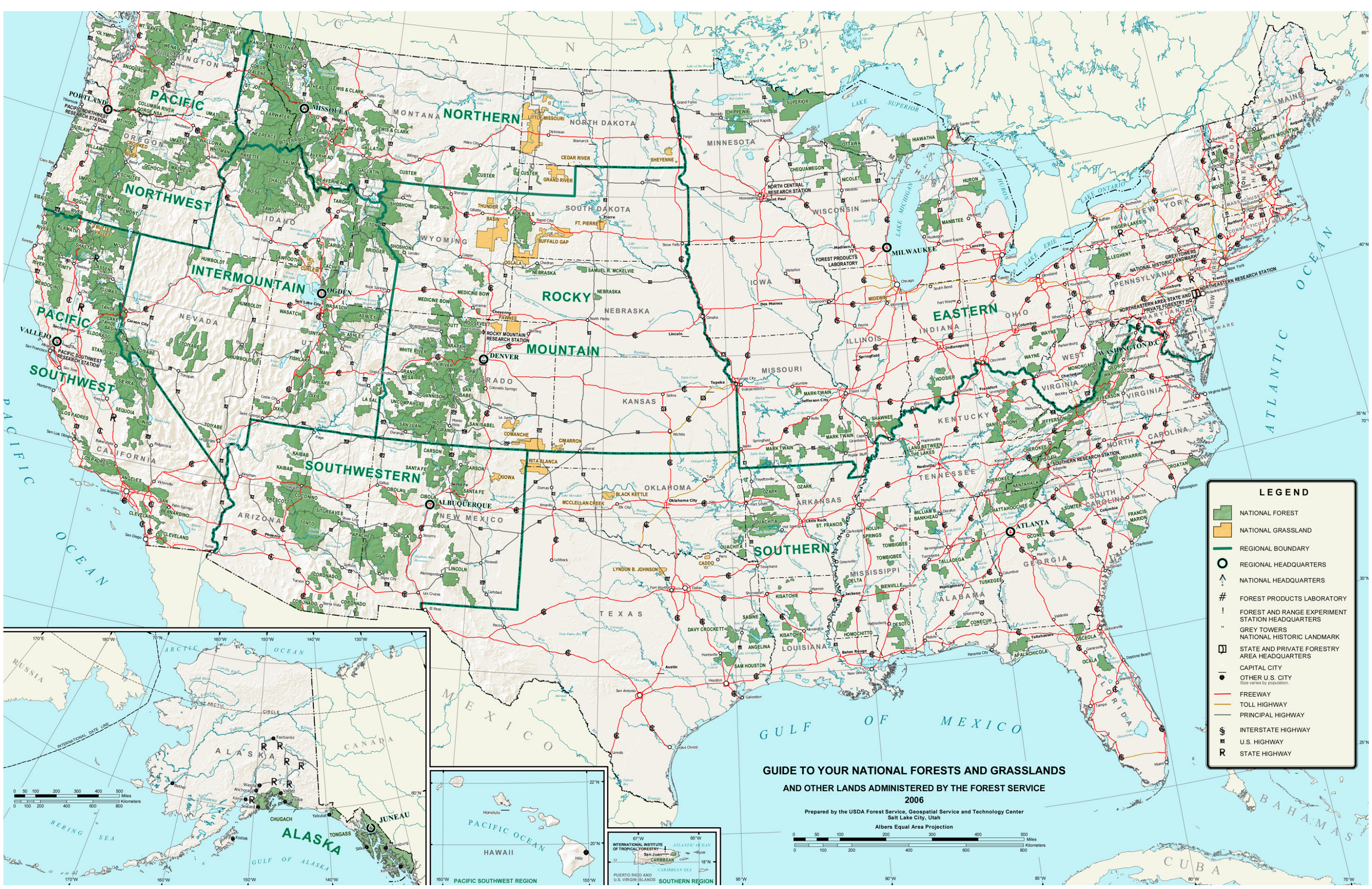
INTRODUCTION

The United States Forest Service manages more than 193 million acres—over 8 percent of all U.S. lands—an area about the size of Texas and twice the size of the National Park System. The National Forest System comprises 154 national forests and 20 national grasslands and one national prairie (collectively referred to as "national forests" in this guide). Located in 42 states, Puerto Rico and the U.S. Virgin Islands, these public lands are essential to the conservation of wildlife habitat and diversity. National forests encompass three-quarters of the major U.S. terrestrial and wetland habitat types—including alpine tundra, tropical rainforest, deciduous and evergreen forests, native grasslands, wetlands, streams, lakes and marshes. This variety of ecosystems supports more than 420 animals and plants listed under the Endangered Species Act (ESA) and an additional 3,250 other at-risk species.

To guide the management of each national forest, the Forest Service is required by law to prepare a land management plan (forest plan). Forest plans detail strategies to protect habitat and balance multiple uses to ensure the persistence of wildlife, including at-risk and federally protected species.

In April 2012, the Forest Service finalized regulations implementing the National Forest Management Act (NFMA). These regulations, commonly referred to as the "2012 Planning Rule" established a process for developing and updating forest plans and set conservation requirements that forest plans must meet to sustain and restore

The National Forest System



the diversity of ecosystems, plant and animal communities and at-risk species found on these public lands (36 C.F.R. §§ 219.1-219.19, abbreviated throughout this report by omitting "36 C.F.R. §").

The forest planning rule includes explicit requirements for managing for ecological connectivity on national forest lands and facilitating connectivity planning across land ownerships—the first such requirements in the history of U. S. public land management. The pending revisions of most forest plans provide a significant opportunity to protect and enhance the diversity of habitat and wildlife on national forest lands by developing forest plans that promote the conservation and restoration of ecological connectivity.

This guide is designed to help people, working within and outside of the Forest Service, develop effective connectivity conservation strategies in forest plans developed under the 2012 Planning Rule. It summarizes the role of connectivity within the conservation framework of the rule and offers guidance and examples of how to conduct connectivity planning in the land management planning process.

The guide is a collaboration of Defenders of Wildlife, The Center for Large Landscape Conservation, Wildlands Network and Yellowstone to Yukon Conservation Initiative and is our collective interpretation of the connectivity requirements of the 2012 Planning Rule. The guide is intended to add value to official agency policies developed to support implementation of the rule. In January 2015, the Forest Service published Final Agency Directives for Implementation of the 2012 Planning Rule (FSM 1900 Planning, FSH 1909.12). While this guide and those directives may in some cases describe different approaches to implementing the connectivity requirements of the planning rule, we believe our interpretations are consistent with the planning rule and NFMA and hope the guide is viewed as a useful companion set of recommendations from the perspective of conservation organizations experienced in national forest planning, connectivity science and policy.

The guide covers the unique connectivity aspects of the planning rule, a rule that addresses complex ecosystem and species conservation processes and has many specific requirements.

How to Use This Guide

Planning for Connectivity presents guidance and best practices for connectivity planning, including examples from case studies in forest planning. Resources associated with the case studies are listed in the references section. We suggest using this guide in tandem with *Planning for Diversity*, a companion publication that addresses the overarching conservation framework of the 2012 Planning Rule. *Planning for Diversity*, additional resources on diversity and connectivity science and planning and a collection of forest planning case studies are available online at www.defenders.org/forestplanning.

THE IMPORTANCE OF CONNECTIVITY

It is useful to think of connectivity contributing to both the structure and function of ecosystems and landscapes. Structural connectivity is the physical relationship between patches of habitat or other ecological units; functional connectivity is the degree to which landscapes actually facilitate or impede the movement of organisms and processes of ecosystems (Ament et al. 2014).

The structure or pattern of an ecosystem or landscape can be defined as the arrangement, connectivity, composition, size and relative abundance of patches that occur within an area of land at a given time. Patches are surface areas that differ from their surroundings in nature or appearance (Turner et al. 2001). They can be characterized by vegetation type, seral stage, habitat type or other features relevant to a species and also by the condition of surrounding lands, which can significantly affect the biological character of a habitat patch.

Fragmentation, the breaking up of habitat or cover type into smaller disconnected patches (Turner et al. 2001), may result from natural or anthropogenic disturbances that introduce barriers to connectivity. In natural landscapes, patches that differ from the surrounding area would likely be areas disturbed by fire, flood, blowdown or other natural processes. In managed landscapes, habitat or cover can be fragmented by human caused disturbances such as road-building or removal of vegetation. In natural and managed fragmented landscapes, patches can be thought of as the remaining undisturbed areas. The greatest conservation needs are usually associated with maintaining or restoring connectivity among patches.

©HOWIE GARBER

The arrangement of patches of vegetation defines the pattern of a landscape like this one in Medicine Bow National Forest.

Other terms related to connectivity and wildlife movements include (Ament et al 2014):

- **Corridor.** A distinct component of the landscape that provides connectivity (think of it as a linear patch).
- **Linkage area or zone**. Broader regions of connectivity important to maintain ecological processes and facilitate the movement of multiple species.
- **Permeability.** The degree to which landscapes are conducive to wildlife movement and sustain ecological processes.

The 2012 Planning Rule defines connectivity as:

Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change (219.19).

The planning rule definition reflects both structural and functional aspects of connectivity. The rule's reference to spatial scales and "landscape linkages" suggests a structure of connected patches and ecosystems. Functional connectivity is also part of the definition: water flows, sediment exchange, nutrient cycling, animal movement/dispersal, species climate adaptation and genetic interchange are all ecological processes that are sustained by connectivity.

Any comprehensive strategy for conserving biological diversity requires maintaining habitat across a variety of spatial scales and includes the maintenance of connectivity, landscape heterogeneity and structural complexity (Lindenmayer and Franklin 2002). Connectivity is especially important for enabling adaptation to changing stressors, including climate change. The challenge of climate change was a driving factor in the development of the 2012 Planning Rule (77 Fed. Reg. 21163). A review of 22 years of recommendations for managing biodiversity in the face of climate change found improving landscape connectivity is the most frequently recommended strategy for allowing biodiversity to adapt to new conditions (Heller and Zaveleta 2009).

Wildlife species are becoming increasingly isolated in patches of habitat surrounded by a human-dominated landscape. Exacerbating this fragmentation is the effect of exurban development that continues to encroach on Forest Service lands (Hansen et al. 2005; Stein et al. 2007). The distribution of many wildlife populations continues to shrink as a result. Aquatic and terrestrial landscape patterns have been substantially altered, reducing or eliminating ecological connectivity for many wildlife populations. Physical barriers with human development further reduce connectivity. Changes in habitat, such as the simplification of complex forest vegetation, can also make critical areas for movement less permeable to some species. Scientists recognize that preserving or enhancing connectivity can be a practical tool for conserving biodiversity in such circumstances (Worboys et al. 2010).

THE 2012 FOREST PLANNING RULE

The 2012 Planning Rule is a federal regulation implementing NFMA (1600 U.S.C. § 1600 et seq.). NFMA was enacted in 1976 in large part to elevate the value of ecosystems, habitat and wildlife on our national forests to the same level as timber harvest and other uses. NFMA codified an important national priority: forest plans must provide for the diversity of habitat and animals found on national forests.

NFMA established a process for integrating the needs of wildlife with other multiple uses in forest plans. Most importantly, the law set a substantive threshold Forest Service actions must comply with for sustaining the diversity of ecosystems, habitats, plants and animals on national forests. However, the law gave discretion to the Forest Service, through the development of forest planning regulations and forest plans, to define that threshold.

THE PLANNING PROCESS

According to NFMA, forest plans are to be revised on a 15-year cycle. The planning rule provides a process for developing, revising or amending plans that is adaptive and science-based, engages the public and is designed to be efficient, effective and within the agency's ability to implement (77 Fed. Reg. 21162).

The planning rule establishes a three-phase process:

1. **Assessment**. The assessment identifies and evaluates information relevant to the development of a forest plan. The assessment is used during plan revision to evaluate what needs to change in the current plan, including what is needed to meet the requirements of the planning rule.
2. **Development.** During the plan development stage, the Forest Service develops and finalizes the forest plan and plan monitoring program. A draft proposal is developed and management alternatives are evaluated through the process established by the National Environmental Policy Act (42 U.S.C. § 4321 et seq.).
3. **Implementation/monitoring.** After finalizing the forest plan, the agency begins to implement the plan, including the development and implementation of management projects. Projects must be consistent with the forest plan and implementation of the plan must be evaluated through a monitoring program. Monitoring information is then evaluated to determine if aspects of the forest plan should be changed.

In addition, the Forest Service must use the best available scientific information to inform the planning process (219.3) throughout all three phases.

The planning rule describes these phases as iterative, complementary and sometimes overlapping. The intent is to provide a planning framework that is responsive to new information and changing conditions.

FOREST PLAN COMPONENTS

Forest plans guide subsequent project and activity decisions, which must be consistent with the forest plan. Forest plans do this through the use of plan components, the basic building blocks of forest plans. Plan components (Table 1) shape implementation of the forest plan and are the means of meeting the requirements of the 2012 Planning Rule.

Two fundamental types of plan components are associated with the diversity requirements of the rule: landscape components and project components.

Landscape components relate to the vision and priorities for the plan area, a landscape larger than individual project areas. These components are outcome-oriented, describe how the Forest Service would like the plan area to look and function and include desired conditions and objectives. Projects to be initiated under the forest plan are designed to contribute to achieving one or more of these outcomes. It is important that desired conditions and objectives be specific enough to establish a purpose and need for the projects designed to help achieve them.

Project components pertain to how individual projects are designed and implemented under the forest plan. They include standards, guidelines and suitability determinations that prohibit specific uses. They can preclude or regulate particular management options, dictate the outcome specifications for project areas or establish procedures

Table 1. Plan components under the 2012 Planning Rule

Plan Component	Description (219.7(e))
Desired Conditions (Landscale-level)	A description of specific social, economic and/or ecological characteristics of the plan area (or a portion of the plan area) toward which management of the land and resources should be directed. Desired conditions must be described in terms specific enough to allow progress toward their achievement to be determined, but do not include completion dates.
Objectives (Landscape-level)	A concise, measurable and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives should be based on reasonably foreseeable budgets.
Standards (Project-level)	A mandatory constraint on project and activity decision-making established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.
Guidelines (Project-level)	A constraint on project and activity decision-making that allows for departure from its terms as long as the purpose of the guideline is met. Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.
Suitability of Lands (Project-level)	Specific lands within a plan area are identified as suitable for various multiple uses or activities based on the desired conditions applicable to those lands. The plan also identifies lands within the plan area as not suitable for uses that are not compatible with desired conditions for those lands.

that must be followed in preparing projects. It is very important to note that project plan components—especially standards—are most useful when greater certainty is important, such as in meeting diversity requirements necessary to protect at-risk species. Under the planning rule, every action proposed on Forest Service lands must comply with standards and guidelines and may not occur on lands unsuitable for that action.

DIVERSITY

NFMA requires that the Forest Service's planning regulations "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives" (16 U.S.C. § 1604(g)(3)(B)). This diversity requirement has been interpreted by the agency in the NFMA planning regulations and by the courts.

The Forest Service has interpreted the diversity requirement in NFMA through the development of the 2012 Planning Rule, which offers an approach to meeting the diversity requirement described in more detail in the following section on the ecosystem-species approach. A pivotal piece of the diversity interpretation is the persistence of individual species on national forest lands. Maintaining viable populations of native species is the scientifically accepted method of achieving the conceptual goal of maintaining species diversity. According to a 1999 Committee of Scientists report commissioned for the purposes of forest planning, "[d]iversity is sustained only when individual species persist; the goals of ensuring species viability and providing for diversity are inseparable" (Committee of Scientists 1999: 38).

The federal judiciary's interpretation of the diversity requirement in the rule include a ruling that the NFMA diversity mandate not only imposes a substantive standard on the Forest Service, it "confirms the Forest Service's duty to protect [all] wildlife" (*Seattle Audubon Society v. Moseley*, 1489). Courts have also recognized that the Forest Service's "statutory duty clearly requires protection of the entire biological community" (*Sierra Club v. Espy*, 364).

THE ECOSYSTEM-SPECIES APPROACH

Three overarching substantive requirements (Table 2) in the planning rule pertain to NFMA's diversity requirement:

1. Maintain or restore the ecological integrity of terrestrial and aquatic ecosystems (219.9(a)).
2. Maintain or restore the diversity of ecosystems and habitat types (219.9(a)).
3. Provide the ecological conditions necessary for at-risk species (219.9(b)).

The fundamental premise of the planning rule for meeting the NFMA diversity requirement is that plan components for ecosystem integrity and diversity will provide the ecological conditions to both maintain the diversity of plant and animal communities and support the persistence of most (but not all) native species in a

Table 2. Ecological concepts and requirements of the 2012 Planning Rule[1]

Ecological Concept	Definition and Requirement from the Planning Rule (219.9, if applicable)
Ecosystem	*Definition:* A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. An ecosystem is commonly described in terms of its composition, structure, function and **connectivity**. *Requirement:* The plan must include plan components, including standards or guidelines, to maintain or restore the diversity of ecosystems and habitat types throughout the plan area. In doing so, the plan must include plan components to maintain or restore key characteristics associated with terrestrial and aquatic ecosystem types, rare aquatic and terrestrial plant and animal communities, and the diversity of native tree species similar to that existing in the plan area.
Ecological Integrity	*Definition:* The quality or condition of an ecosystem when its dominant ecological characteristics (e.g., composition, structure, function, **connectivity**, species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence. *Requirement:* The plan must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore their structure, function, composition and **connectivity**.
At-risk Species ▪ Threatened and Endangered ▪ Candidate and Proposed ▪ Species of Conservation Concern	*Definition:* Threatened and endangered species are federally listed under the ESA; proposed and candidate species have been either formally proposed or are being formally considered for listing under the ESA. Species of conservation concern are species for which the regional forester has determined that the best available science indicates substantial concern over the species' capability to persist over the long-term in the plan area. *Requirement:* The responsible official shall determine whether or not the (ecosystem) plan components provide the ecological conditions necessary to contribute to the recovery of federally listed threatened and endangered species, conserve 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 (ecosystem) plan components 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.
Ecological Conditions	*Definition:* The biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species and the productive capacity of ecological systems. Ecological conditions include habitat and other influences on species and the environment, e.g., the abundance and distribution of aquatic and terrestrial habitats, **connectivity**, roads and other structural developments, human uses and invasive species.
Viable Population	*Definition:* 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.
Focal Species	*Definition:* A small subset of species whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area. Focal species would be commonly selected on the basis of their functional role in ecosystems.

plan area (219.9). To meet the rule's requirements for at-risk species (which include federally listed threatened and endangered species, proposed and candidate species, and species of concern (SCC)), additional "species-specific" plan components may be necessary. The rule's two-tiered conservation approach (alternatively called the "ecosystem-species" or "coarse-fine filter" planning method) relies on the use of surrogate measures, or key characteristics,

1. Ecological "conditions" are defined broadly to include human structures and uses, while "ecological integrity" stresses dominant "characteristics" that suggest natural conditions and should not include human structures and uses. The term "key ecosystem characteristics" is commonly used in discussions of ecological integrity, but should not be understood to apply to human structures and uses in that context. Human structures and uses are nevertheless relevant to species viability and persistence, and therefore to diversity.

©SANDY SISTI

Connectivity is an ecological condition that pronghorn and other species need to persist within and beyond the boundaries of national forests and grasslands.

to represent the condition of ecosystems, as well as the identification of at-risk species and evaluation of whether those species will be sustained through ecosystem-level plan components, or whether they require specific management attention in the form of species-level plan components.

At the ecosystem scale, the rule requires forest plans to have plan components to maintain or restore the integrity of terrestrial and aquatic ecosystems in the plan area (219.9(a)(1)) and the diversity of ecosystems and habitat types (219.9(a)(2)). Essentially this requires forest plans to maintain or restore the variety of ecosystems and habitat types found on the forests (e.g., conifer forests, wetlands, grasslands), as well as the condition of the ecosystems themselves. If the ecosystem-scale plan components are not sufficient to provide ecological conditions (i.e., meet the conservation needs) for at-risk species, additional plan components to do so are required (219.9(b)(1)). In some cases, the Forest Service may determine that it is beyond its authority or "not within the inherent capability of the plan area" to provide those conservation conditions and thus other requirements apply (219.9(b)(2)).

Connectivity plays a key role in the rule's conservation approach (see Table 2). As a key characteristic of ecosystems, connectivity should be addressed through ecosystem-scale plan components in order to maintain or restore "ecological integrity." Connectivity may also be an "ecological condition" needed by individual species, and so forest plans may need to address connectivity at the species level. For example, a recent amendment to forest plans in Wyoming protects migration corridors between seasonal habitats for pronghorn (Ament et al. 2014).

The rule's approach to conservation planning relies on the use of key characteristics in assessments, planning and monitoring to represent the condition of ecosystems, as well as the identification of at-risk species, some of which may require connectivity conditions to persist. It will be necessary for forest plans to identify key characteristics of ecosystem connectivity, as well as structure, function and composition (Table 3).

The concept of ecological integrity is used to represent the status of an ecosystem. An ecosystem is considered to have integrity when its key ecosystem characteristics occur within the natural range of variation (NRV) (219.19). NRV can be thought of as a reference condition reflecting "natural" conditions. Those conditions can be estimated using information from historical reference ecosystems or by other science-based methods. For example, many current forest ecosystems exhibit landscape connectivity patterns that differ from historical or reference conditions. For the purpose of sustaining ecosystems and wildlife, the 2012 Planning Rule directs the Forest Service to manage key characteristics of ecosystems, including their connectivity characteristics, in light of these reference conditions.

It is therefore important that forest plans have plan components, including desired conditions, to move landscapes toward a more natural range of connectedness.

ISSUES OF SCALE

The definition of connectivity in the planning rule intends for it to be provided at appropriate ecological scales. Strategies for managing connectivity in forest plans will vary based on the relevant species and their particular requirements for connectivity. The planning process must consider the habitat needs of target species and the nature of their movements. Forest plans should provide for habitat connectivity to address localized movements, as well as landscape-scale linkages between larger blocks of habitat.

Land managers must look at the broader landscape context when addressing connectivity in forest plans (219.8(a)(1)). They should consider what they are connecting and be alert to connecting specific watersheds or other geographic areas identified as being relatively more important for a particular species. Aquatic species provide a good example of large-scale connectivity needs because the existence of a connected network of aquatic ecosystems is known to be critically important to migratory aquatic species, especially when disturbances occur.

Steelhead trout and other migratory fishes need a connected network of aquatic ecosystems to survive. Forest plans must consider the large-scale connectivity needs of these species.

For many species, persistence within a national forest depends on connectivity that extends beyond forest boundaries. While the Forest Service has no authority to regulate land uses outside national forests, it can influence conservation on adjacent lands by how it chooses to manage its own lands. A forest plan should consider

Table 3. The use of key characteristics in forest planning

Ecosystem Character	Definition (219.19)	Examples of Key Characteristics
Connectivity	Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long-distance range shifts of species, such as in response to climate change.	Structural: size, number and spatial relationship between habitat patches, mapped landscape linkages and corridors. Functional: measure of ability of native species to move throughout the planning area and cross into adjacent areas.
Composition	The biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.	A description of major vegetation types, patches, habitat types, soil types, landforms and wildlife populations.
Structure	The organization and physical arrangement of biological elements such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern and connectivity.	Arrangement of patches within a landscape, habitat types within a forest, trees within a forest stand, wildlife within a planning area.
Function	Ecological processes that sustain composition and structure such as energy flow, nutrient cycling and retention; soil development and retention; predation and herbivory; and natural disturbances such as wind, fire and floods.	Types, frequencies, severities, patch sizes, extent and spatial pattern of disturbances such as fires, landslides, floods and insect and disease outbreaks.

connectivity when prioritizing lands for acquisition or conservation easements on adjacent ownerships. At a finer scale, a forest plan's requirements for size and arrangement of patch characteristics may be sufficient to produce an appropriately structured landscape for connectivity.

CONNECTIVITY INFORMATION

The scientific literature includes many connectivity and corridor studies and analyses. Peer-reviewed connectivity information pertaining to all regions of the country is readily available to inform national forest planning. In recent years, the Forest Service Research and Development Branch itself has produced numerous materials on various aspects of connectivity that can be used to support analyses of conditions, trends and sustainability. The available literature includes general publications about the science of connectivity and research on specific locations and/or species.[2] Examples include Cushman and others' analysis of corridors (2012) and McKelvey and others' (2011) identification of wolverine corridors.

Independent analyses of connectivity are also now available for many areas. The nationwide system of Landscape Conservation Cooperatives (LCC) has prioritized managing for connectivity across the country. For example, the South Atlantic LCC is completing a project titled "Identifying and Prioritizing Key Habitat Connectivity Areas for the South Atlantic Region." The Western Governors Association spearheaded the development of databases and mapping systems in the western states to identify important habitat and corridors region-wide.

The planning rule also cites other governmental management plans as sources of information to consider in assessing and planning for connectivity (219.6(a)(1)). It is critical that forest plans take into account land uses on adjacent lands and the importance of such lands to connectivity. The Forest Service should engage with highway departments, state wildlife agencies, tribal governments and county planning organizations that might affect connectivity on adjacent or intervening landscapes. These entities may have identified potential corridors that should be recognized in the forest planning process.

CONNECTIVITY COORDINATION

There is an additional requirement in NFMA that is particularly important to developing plan components for connectivity. It is a procedural requirement that the planning process be "coordinated with the land and resource management planning processes of State and local governments and other Federal agencies" (16 USC § 1604(a)). One of the purposes of the planning rule was to "[e]nsure planning takes place in the context of the larger landscape by taking an 'all-lands approach'" (77 Fed. Reg. 21164).[3] To accomplish this, forest plans should consider how habitat is connected across ownership boundaries.

The planning rule accounts for this type of "all lands" connectivity by:

- Requiring assessments to evaluate conditions, trends and sustainability "in the context of the broader landscape" (219.5(a)(1)).
- Recognizing that sustainability depends in part on how the plan area influences, and is influenced by, "the broader landscape" (219.8(a)(1)(ii), (iii)).
- Requiring coordination with other land managers with authority over lands relevant to populations of species of conservation concern (219.9(b)(2)(ii)).
- Requiring coordination with plans and land-use policies of other jurisdictions (219.4(b)).
- Requiring consideration of opportunities to coordinate with neighboring landowners to link open spaces and take joint management objectives into account (219.10(a)(4)).

Achieving the broader scale "all-lands" goals of the planning rule requires partnerships and compatible management across landscapes among multiple landowners and jurisdictions. In particular, there is a need for a landscape-scale strategic approach to conserving connectivity. NFMA has established that the way to communicate a long-term and reliable management commitment for National Forest System lands is through forest plan decisions for specific areas.

There is a significant commitment to connectivity conservation within Forest Service policy and from many agency partners. Examples of coordinated multi-agency planning efforts that specifically address connectivity and can guide the Forest Service as it seeks to implement the new rule are summarized in Appendix A.

2. Forest Service research publications on the topic may be found by entering the search term "connectivity" at www.treesearch.fs.fed.us/.

3. The planning rule defines landscape as "[a] defined area irrespective of ownership or other artificial boundaries, such as a spatial mosaic of terrestrial and aquatic ecosystems, landforms, and plant communities, repeated in similar form throughout such a defined area" (219.19).

BEST PRACTICES FOR CONNECTIVITY PLANNING

The following sections present guidance and best practices for connectivity planning, including examples from case studies in forest planning. Resources associated with the case studies are listed in the references at the end of the guide. Additional forest planning case studies are available online at www.defenders.org/forestplanning.

ASSESSING CONNECTIVITY

The planning rule requires that assessments be conducted prior to plan revisions to determine what needs to be changed in the existing forest plan, to serve as the basis for developing plan components and to inform a monitoring program. The Forest Service must review all relevant existing information and then determine the best available scientific information about conditions, trends and sustainability for connectivity in relationship to the forest plan within the context of the broader landscape (219.5(a)(1)). The Forest Service must document in the assessment report "how the best available scientific information was used to inform the assessment" (219.6(b)).

For connectivity, the assessment should address both ecosystem and species-level connectivity issues. At the ecosystem-scale, the assessment needs to identify the ecosystems and habitat types within the planning area, and then evaluate the diversity and integrity of those based on information related to their structure, function, composition and connectivity.

We recommend including the following in an assessment of connectivity at the ecosystem level:

- The selection of key characteristics for connectivity (see Table 3, page 10).
- A discussion of the NRV or "reference conditions" for the characteristics (e.g., historical pattern and connectivity).
- An evaluation of system drivers (e.g., climate change) and stressors (e.g., barriers to connectivity) on the characteristics.
- A discussion of the future status of the characteristic under current management and the current plan.

The end result should be a connectivity assessment that can be used to determine:

- How the current plan needs to change to maintain or restore connectivity.
- What plan components may be necessary to achieve the ecosystem-based connectivity requirements in the rule.

Connectivity must also be assessed as a potential condition necessary to sustain individual species. In the assessment, the Forest Service will present information on the ecological needs of species so that plan components can be developed to meet the rule's requirements for species. Particular attention should be paid to the connectivity needs of all at-risk species. To demonstrate that plan components will be effective in maintaining a "viable population" in the plan area, the assessment must provide a means of determining a "sufficient distribution" (see Table 2, page 8). The assessment should describe the relationship between connectivity and the distribution of species necessary for persistence, especially with regard to stressors like climate change. It is important that the assessment evaluate how species move, what barriers to those movements may exist and how the Forest Service can reduce the impact of those barriers within the context of recovery, conservation and viability.

The Flathead National Forest plan revision (assessment, 2014), which is being conducted under the 2012 Planning Rule, offers an example of assessing connectivity needs. The Flathead assessment includes a significant discussion of connectivity for terrestrial habitat, views connectivity from both an ecosystem and species perspective and considers both shorter term vegetation barriers on the forest and longer term human barriers between national forest lands. The example below shows how the Flathead National Forest presented a key ecosystem characteristic, description and data source for connectivity (adapted from Flathead 2014: 103, Table 26):

Key Ecosystem Characteristic: Horizontal Patterns and Landscape Connectivity

Description: The horizontal pattern of forest size/structure classes across the landscape and the spatial linkages between them, which is influenced both by human activities, such as harvesting and development, and natural processes, such as wildland fire.

Data Source for Current Condition: Montana Natural Heritage Program databases; Flathead National Forest VMap; Flathead National Forest NRV analysis.

The assessment provides a description of current and reference (NRV) conditions and expected trends for this key characteristic, as well as an evaluation of the impact of stressors (e.g., from timber harvest and developments) on habitat. The following is a key finding from the assessment:

> *Significant departures from historical conditions in patch sizes and density was noted in the NRV analysis for nearly all forest structural classes forest-wide. This trend mirrored that occurring at the larger Northern Rocky Mountain ecoregion, where drastically increased forest fragmentation was noted. The analysis found a decrease in patch size and corresponding increase in patch density, resulting in a trend of increasing forest fragmentation. The changes were most dramatic for the early successional forest patches and found to be outside the range of historical variability, which is of particular concern to ecological integrity* (Flathead 2014: 137, internal citations omitted).

JOHN JACOBSON/WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

The Flathead National Forest connectivity assessment for the fisher specifies that this at-risk species requires mature forests arranged in connected, complex shapes with few isolated patches.

The Flathead assessment also presented connectivity information for an at-risk species, the fisher. This information can be used to determine the effectiveness of the current plan in providing for habitat connectivity for the species or to develop new plan components:

> *At the scale of 50–100 km2 (12,355–24,710 acre) landscapes, fishers in northern Idaho and west-central Montana selected for home ranges with greater than 50 percent mature forest arranged in connected, complex shapes with few isolated patches, and open areas comprising <5 percent of the landscape. Jones and Garton (1994) stated that preferred habitat patches should be linked by travel corridors of closed canopy forest and that riparian areas make excellent corridors provided they are large enough to enable fishers to avoid predation* (Flathead 2014: 197).

CONNECTIVITY MANAGEMENT AREAS

For connectivity, it is especially important to determine where plan components will apply. While it may be relatively easy to state desired forest-wide conditions related to connectivity, this approach by itself fails to focus efforts on areas with known connectivity values (e.g., roadless areas) and may not effectively promote integration with other uses that can lead to recognition of conflicts.

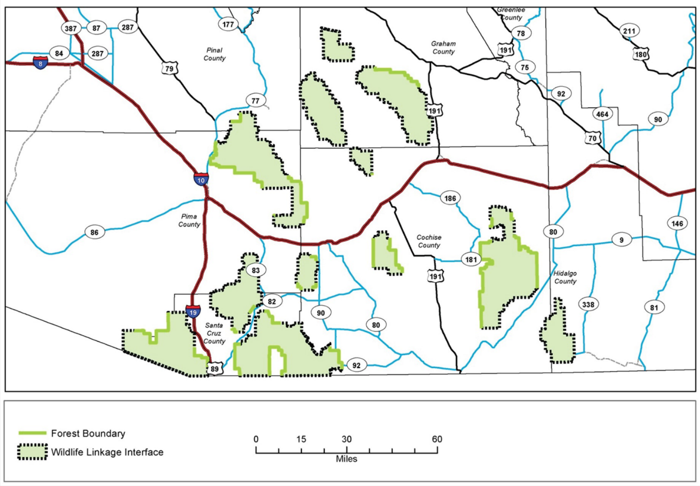
The planning rule states that the plan must indicate to which part of the plan area each plan component applies (219.7(e)). It defines "management areas" as parts of the plan area that have "the same set of applicable plan components" (219.19). Desired conditions and other plan components should be specified for particular linkage areas or corridors where they can be identified and the assessment finds them to be important to the persistence of target species in the plan area. Where connectivity is constrained, it may be necessary to identify specific areas to be managed as patches and their connecting corridors. Identifying specific management area(s) for connectivity provides clear forest plan direction on the importance of these areas and clarity for future projects.

The following case studies are examples of spatially recognizing connectivity in forest planning. An additional example is provided in the section on "Barriers to Connectivity" on page 18.

CASE STUDY: Wildlife Linkages in the Sky Islands

The mountainous "sky islands" of the Coronado National Forest in Arizona are made up of forested ranges separated by valleys of desert and grassland plains. They are among the most diverse ecosystems in the world because of their topographic complexity and location at the convergence

Figure 1. Wildlife linkages on the Coronado National Forest



Source: Coronado 2013: 64, Figure 3

U.S. FISH AND WILDLIFE SERVICE

A remote camera captured this image of an ocelot in the Huachuca Mountains of Arizona, an area where the proliferation of highways has affected connectivity among ocelot populations. To address the problem, the Coronado National Forest plan designated linkage areas on the boundary of the forest to coordinate connectivity management with other jurisdictions.

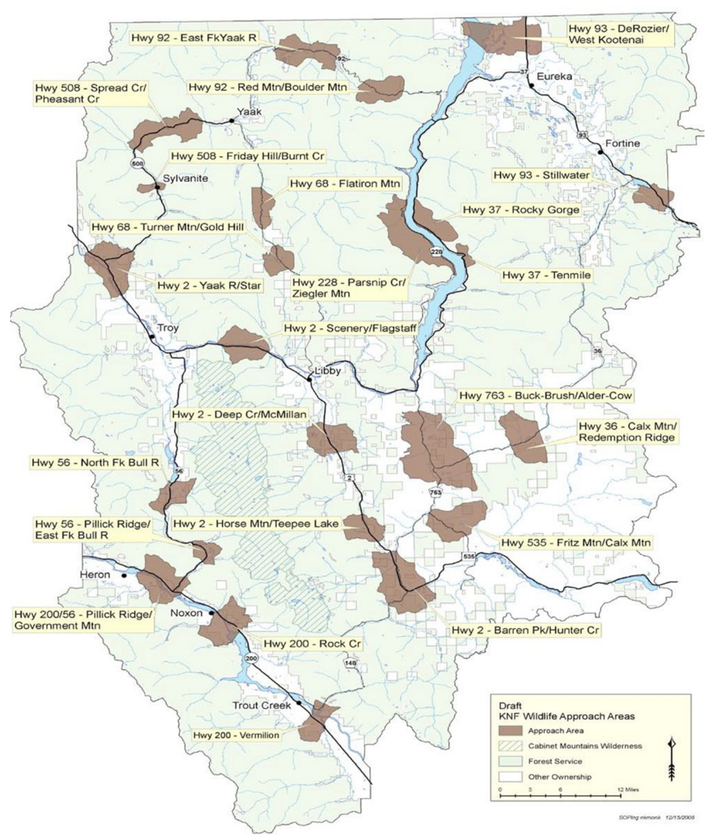
of several major desert and forest biological provinces. The valleys act as barriers to the movement of certain woodland and forest species. Species such as mountain lions and black bears depend on movement corridors between mountain islands to maintain genetic diversity and population size. Ocelots and jaguars at the northern end of their range here depend on connectivity to source populations in Mexico. The proliferation of highways and resulting increase in the number of road deaths among dispersing ocelots has affected connectivity among ocelot populations and colonization of new habitats. Movement corridors for jaguars in the American Southwest and northern Mexico are not well known but probably include a variety of upland habitats that connect some of the isolated, rugged mountains, foothills and ridges in this region.

The revised plan for the Coronado (draft, 2013) designates "wildlife linkages interface" areas, based on a statewide interagency effort that produced *Arizona's Wildlife Linkages Assessment* (Arizona Wildlife Linkages Workgroup 2006). The forest plan recognized that land management outside of the national forest boundaries affects biological resources on the national forest. Using data from the interagency group, the plan designates linkage areas on the boundary of the national forest (see Figure 1). These designated areas have management direction to maintain and reduce connectivity barriers and to coordinate connectivity management with other jurisdictions.

CASE STUDY: Grizzly Bear Approach Areas

The Kootenai National Forest in Idaho and Montana provided an excellent example of how to plan strategically for connectivity that has been confined to identifiable corridors and linkage areas. In 2008, the Kootenai identified and mapped locations of 24 approach areas important for grizzly bear connectivity using the best available scientific information from existing government and nongovernmental organizations, criteria for barriers (land ownership, topography, forest cover, land development) and wildlife use (Figure 2). Approach areas were defined as places where corridors or linkage zones cross what are termed "fracture zones" (e.g., valley bottoms

Figure 2. Grizzly bear approach areas on the Kootenai National Forest[4]



Source: Brundin and Johnson 2008: 3, Figure 1

4. The approach areas were not carried forward into the final, revised forest plan.

NATIONAL PARK SERVICE

The Kootenai National Forest plan identified "approach areas"—places where roads and other barriers to connectivity may hinder grizzly bear movement.

with highways and railways) where animal movements may be hindered and mortality risk elevated. The Kootenai also identified conservation measures that could be included in the forest plan as plan components for the approach areas and identified private lands where land exchanges, conservation easements or direct acquisition may be appropriate to improve management for one or more wildlife species (IGBC Public Lands Wildlife Linkage Taskforce 2004).

CASE STUDY: Blue Mountains Wildlife Corridor Management Area

The draft Blue Mountains National Forests plan (proposed plan, 2014), which covers the Malheur, Umatilla and Wallowa-Whitman national forests (the three forests span the states of Oregon, Washington and Idaho), establishes a management area identified as a "wildlife corridor" to connect wilderness areas and provide for landscape connectivity and defined as follows:

> *Wildlife corridors are areas designed to maintain habitat linkages between wilderness areas. Although disagreement exists regarding the utility of corridors, this management area emphasizes management for landscape connectivity, which is "the degree to which the landscape facilitates or impedes movement among resource patches," [sic] (Taylor et al. 1993) or "the functional relationship among habitat patches, owing to the spatial contagion of habitat and the movement responses of organisms to landscape structure," [sic] (With et al. 1997). A wide variety of vegetation structure and composition is present, with some showing evidence of past human disturbance and others showing affects primarily from natural disturbances, such as wildfires. Both summer and winter motor vehicle travel is restricted to designated routes. Recreation users can expect to find evidence of human activity in the form of vegetation management, mining, and road building. However, many of the roads that are closed to motor vehicle travel occur in these areas* (Blue Mountains 2014: 90).

The plan also provides a "strategy" for each management area. While the draft forest plan has drawn some criticism over unrelated issues, establishing a management area for corridors based on landscape function and structure allows for the design of habitat linkages in a variety of forms other than just simple linear connection between habitat patches.

LANDSCAPE PLAN COMPONENTS FOR CONNECTIVITY

Forest plan connectivity assessments should indicate if plan components are necessary to maintain or restore connectivity, either as an important contribution to ecological integrity or to provide conditions necessary for an at-risk species. An early consideration in forest plan connectivity planning should be the desired structure and pattern of the planning area landscape and the development of landscape plan components—desired conditions and objectives, where the desired condition describes how the connected landscape should look, and the objectives describe the timeframe and steps for achieving the desired condition.

Forest plans should include desired conditions and objectives for the sizes and distribution of habitat patches and other key characteristics of connectivity. It is also important to show the general areas where connectivity will be emphasized on a map and that the identification and management of these areas take into account the role and contribution of national forest lands to connectivity across other land ownerships.

©JEAN PIERRE GROSEMANS

The Canada lynx, a species listed as threatened under the Endangered Species Act, requires connected habitat across wide areas. Forest plan standards are in place to ensure that the connectivity and other habitat needs of lynx are met on national forests.

Table 4. Examples of landscape connectivity plan components in forest plans

Landscape Plan Components	Case Study and Comments
▪ Forest boundaries are permeable to animals of all sizes and offer consistent, safe access for ingress and egress of wildlife. In particular, segments of the national forest boundary identified in [the wildlife linkages interface] remain critical interfaces that link wildlife habitat on both sides of the boundary. Fences, roads, recreational sites and other man-made features do not impede animal movement or contribute to habitat fragmentation.	The Coronado National Forest consists of isolated mountain ranges, leading the draft plan to explicitly recognize the importance of connectivity and the value of coordinated planning with adjacent jurisdictions. This is especially important to ocelots and jaguars, which occur here at the northern end of their range and depend on connectivity to source populations in Mexico (Coronado 2013). This is direction for a specific management area.
▪ Retain natural areas as a core for a regional network while limiting the built environment to the minimum land area needed to support growing public needs. ▪ Reduce habitat loss and fragmentation by conserving and managing habitat linkages within and, where possible, between the national forests and other public and privately conserved lands. ▪ Preserve wildlife and threatened, endangered, proposed, candidate and sensitive species habitat and connecting links between the San Diego River Watershed and San Dieguito/Black Mountain.	The forest plan for the Cleveland National Forest was revised in conjunction with three other California national forests. The forests face a common management challenge of collaborating in nontraditional formats with local communities and governments to maintain and restore habitat linkages between the national forests and other open space reserves. This is forest-wide direction, but also refers to specific locations.
Landscape patterns are spatially and temporally diverse and have a positive influence on overall ecological function and scenic integrity. Landscape patterns provide connectivity, allowing animals to move across landscapes. Landscape patterns are resilient and sustainable, considering the range of possible climate change scenarios. The plans include a forest-wide desired condition that mentions "the ability of species and individuals to interact, disperse, and find security within habitats in the planning area" (Blue Mountains 2014: 30).	The Blue Mountains National Forests provide an important wildlife corridor connecting habitats and wildlife migration routes between the Rocky Mountains and central Oregon (Blue Mountains 2014). This is forest-wide direction about landscape patterns, in addition to the specific management area direction described above.
Federal ownership is consolidated when opportunities arise to improve habitat connectivity and facilitate wildlife movement.	This is forest-wide direction in the proposed action for the Nez Perce-Clearwater plan revision for use in subsequent land adjustment planning. Identifying priority locations in the plan would be more helpful (Nez Perce-Clearwater 2014).

Table 4 presents examples of landscape connectivity plan components in forest planning. (The language of the plan components is either verbatim or summarized. See the "References" section for source materials.) It should be noted that these examples (drawn from older forest plans) would need to be worded more explicitly under the 2012 Planning Rule, which requires desired conditions to be "specific enough to allow progress toward their achievement to be determined" (219.7(e)(1)(i)).

PROJECT PLAN COMPONENTS FOR CONNECTIVITY

Project components pertain to how projects are designed and implemented under the forest plan. Standards and guidelines, and suitability determinations for connectivity should be designed to promote achievement of the desired conditions and objectives for connectivity. Connectivity standards should be developed when greater certainty is important, such as in meeting diversity requirements necessary to protect at-risk species.

Table 5 provides examples of standards and guidelines for connectivity in forest planning. (The language of the plan components may be verbatim or summarized. See the "References" section for source materials.)

AQUATIC ECOSYSTEM CONNECTIVITY

Forest Service lands are most often found in the higher elevations of watersheds where streams provide clear, high-quality water. Management of aquatic ecosystems often centers on providing habitat that will support important fisheries.

Plan components for ecosystem integrity (including connectivity) must take into account the interdependence of terrestrial and aquatic ecosystems (219.8(a)(1)). There

Table 5. Examples of connectivity standards and guidelines in forest plans

Project Connectivity Plan Component	Case Study and Comments
▪ Retain connections of at least 400 feet in width to at least two other [late-successional/old growth] stands. ▪ Connections should occur where medium diameter or larger trees are common, and canopy closures are within the top one-third of site potential. ▪ The length of connecting corridors should be as short as possible. ▪ Understory should be left in patches or scattered to assist in supporting stand density and cover.	The Eastside Screens are rules for logging adopted as amendments to forest plans east of the Cascade crest in Washington and Oregon in 1996. They are intended to protect remaining late-successional and old-growth forests and to retain "connectivity corridors" between them (USFS 1995).
▪ When highway or forest highway construction or reconstruction is proposed in linkage areas, identify potential highway crossings. ▪ [National forest] lands in lynx linkage areas shall be retained in public ownership. ▪ New permanent roads should not be built on ridge-tops or saddles, or in lynx linkage areas.	The Canada lynx was listed as a threatened species in March 2000, largely due to a lack of adequate regulatory mechanisms in existing land management plans for federal lands. Lynx are known to disperse over wide areas, therefore it was important to add conservation measures to forest plans for lynx connectivity, which the Forest Service did in 2007 (USFS 2007) .

is an additional requirement in the planning rule to maintain or restore the ecological integrity of riparian areas, "including plan components to maintain or restore structure, function, composition, and connectivity …" (219.8(a)). This must be done by establishing "riparian management zones" and applying plan components to them that address riparian management issues. In particular, plan components for riparian management areas must specifically address ecological connectivity, blockages of watercourses, and aquatic and terrestrial habitats (219.8(a)(3)).

Many connectivity issues become intertwined in riparian areas, and plans can address them in conjunction with either terrestrial or aquatic connectivity or both. At a broad scale, management of riparian zones contributes to overall ecological integrity by providing connectivity between watersheds for both terrestrial and aquatic species. Riparian zones also provide connectivity that contributes to the terrestrial and aquatic integrity of individual watersheds. At a fine scale, the integrity of riparian areas themselves depends on the quality of aquatic and terrestrial habitat and often requires connectivity within and from riparian areas to other systems, including the hydrologic connectivity of a water body to floodplains or groundwater (floodplain connectivity can be a limiting factor for fish).

Sophisticated conservation strategies for salmonid species have been included in forest plans in the inland Pacific Northwest for two decades. The "PACFISH" and "INFISH" conservation strategies (1995) developed by the Forest Service and the Bureau of Land Management address connectivity in two primary ways. At the broader scale, they designate watersheds where management will emphasize water quality and fish habitat. This includes existing stronghold populations of fish and, importantly, additional watersheds that can be connected to those strongholds and restored. This will create a network of connected high-quality habitat that allows recolonization after a disturbance event such as a wildfire, flood or drought has rendered an area temporarily unsuitable.

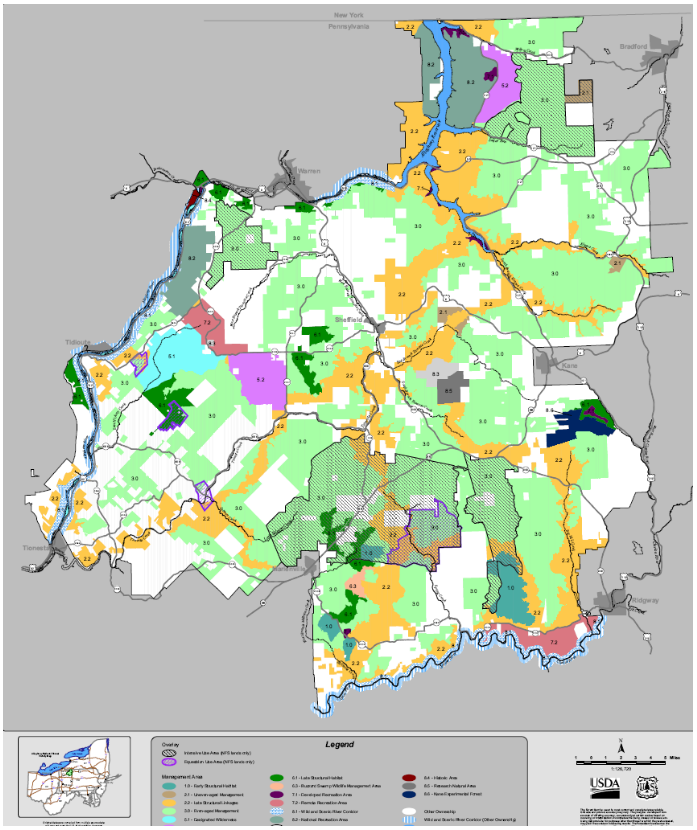
The Eastern Brook Trout Joint Venture, a partnership of state and federal agencies, nongovernmental organizations, and academic institutions, used a similar approach with the eastern brook trout in its native habitat (Maine to Georgia).According to its publication, *Conserving the Eastern Brook Trout: Action Strategies*, restoration should focus on habitat supporting populations that are doing relatively well, and then extend to adjacent habitats. An important part of this strategy is to "[i]dentify barriers to fish passage and re-establish habitat connectivity where possible" (Eastern Brook Trout Joint Venture 2008: 26).

The combination of designating watersheds and identifying connectivity barriers should lead to objectives that prioritize locations for restoration, such as the following connectivity objectives:

- Increase aquatic habitat connectivity through replacement of 90 culverts.
- Restore stronghold watersheds connectivity for aquatic species in four to six subwatersheds or on 80 to 120 stream miles.
- Establish self-sustaining brook trout populations in 10 percent of known extirpated key watersheds by 2025.

Existing forest plans also define riparian management areas, where standards and guidelines to protect aquatic resources apply to various management activities. While

Figure 3. Old forest connectivity management



Source: Allegheny National Forest Management Area Map (2007)

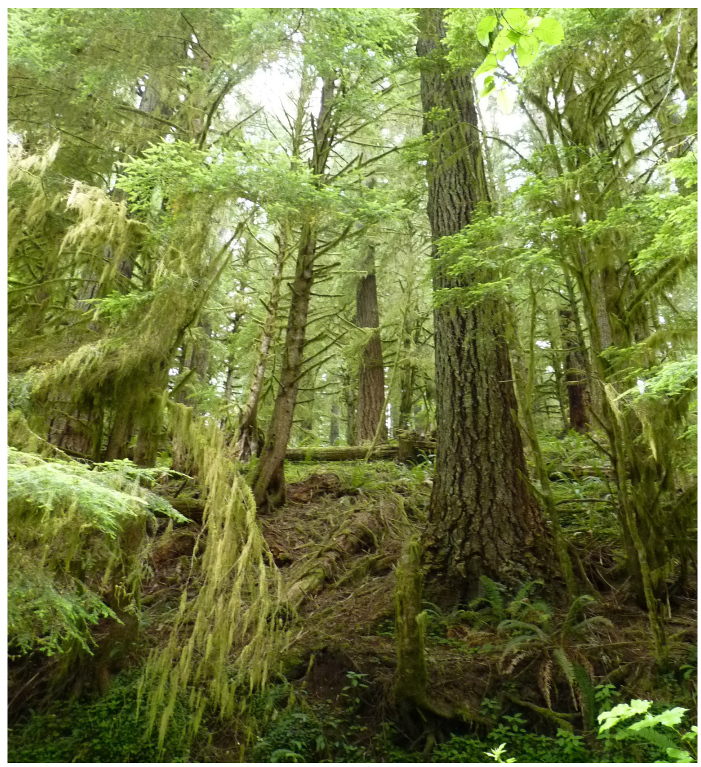
these plan components are primarily for the purpose of protecting resident fish, they also facilitate migration. The following type of standard would specifically address this connectivity issue: Construction or reconstruction of roads shall provide for passage of fish at all stream crossings.

BARRIERS TO CONNECTIVITY

National forest lands encompass a variety of permanent developments such as roads, railways, energy and mineral development infrastructure, recreation infrastructure and fencing. Evaluation and management of connectivity require determining the nature and effect of barriers on permeability and providing direction to reduce the effects of existing barriers and to avoid the creation of new ones. The more confined and unique the corridors or linkage zones are, the more attention should be paid to how barriers are managed. Forest plans must address barriers to connectivity that are relevant to ecological diversity and the persistence of species in a plan area.[5]

One key aspect of barriers that must be considered in relation to national forest management is their cause and degree of permanence. If barriers to wildlife movement and connectivity are due to natural disturbance (e.g., a forest opening caused by a fire or landslide), they can be viewed as transitory barriers that can be expected to "move" from place to place as new openings are created and then closed by natural succession. However, if the movement barrier for a particular species of wildlife is a lack of habitat that is difficult to restore, such as old-growth forest, the connectivity problem may be longer term and the need to protect existing patches using project plan components may be greater.

The Allegheny National Forest in Pennsylvania provides an example of old forest connectivity management, where habitat diversity was one of the key issues identified at the beginning of the plan revision process. The forest plan paid specific attention to "providing late structural and old growth forests and habitat connectivity across the landscape" (ROD, 2007: B-3). The revised plan established a management area for "late structural linkages" based on



©ELIZABETH ALDORA

Forest plans should recognize the value of rare habitats, such as old-growth forest like this in the Siuslaw National Forest, in providing for connectivity.

5. While the effectiveness of habitat corridors providing connectivity is no longer disputed (Gilbert-Norton et al. 2010), potential negative consequences may result from movement of invasive, exotic, and otherwise harmful species or diseases, especially in aquatic habitats. This has been noted especially for inland trout species, where enhancing connectivity could do more harm than good by promoting competition or hybridization with non-native species, or introducing diseases. These kinds of risks should be identified and mitigated to the extent possible when designing landscape connections. Moreover, efforts to connect landscapes that have not historically been connected should be avoided.

existing core blocks of wilderness areas, research natural areas, national recreation areas and other protected areas. It was also designed to specifically include areas of known goshawk nest sites and rattlesnake dens, thus affording additional protection for these species (see Figure 3).

ROADS AND CONNECTIVITY

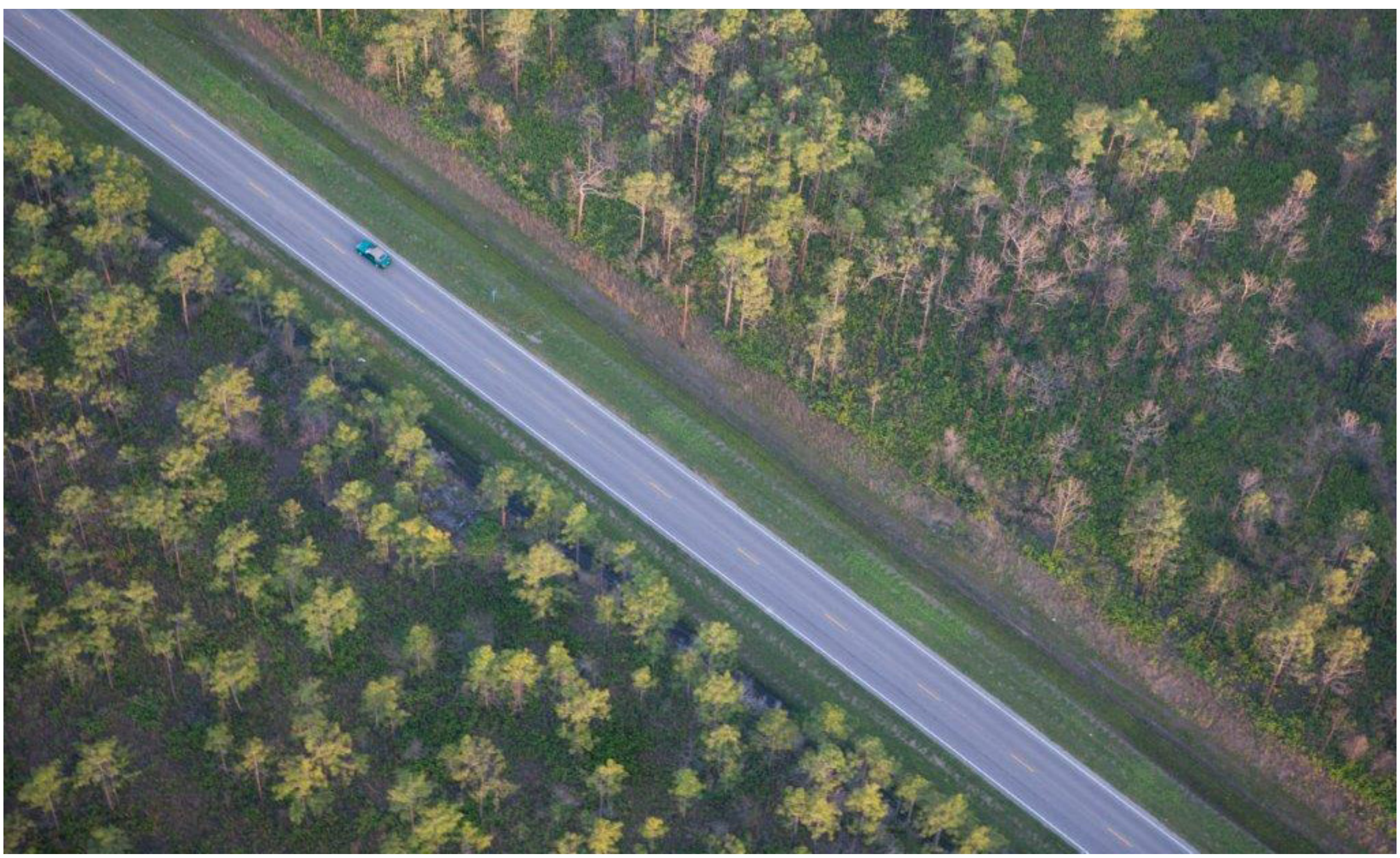
Roads and their associated human uses are one of the most common, persistent and obstructive barriers to terrestrial and aquatic wildlife connectivity. The National Forest System has approximately 375,000 miles of roads.[6] Decisions to build, decommission, open or close roads can affect connectivity in significant ways. Recognition of the role of unroaded (i.e., roadless) areas for the purposes of connectivity planning is equally important. Forest plans provide the overall guidance for how many roads there will be on a forest and how they are to be used.

Use of roads by the public is also governed by the Forest Service "Travel Management Rule," regulations published in 2005 to establish a nationally consistent approach to local determinations of where excluding motorized use is necessary to protect other resources or, conversely, where such use is desirable and ecologically acceptable. The regulations require each national forest to identify and designate roads, trails, and areas that are open to motor vehicle use. Motorized use is prohibited anywhere that is not so designated. These decisions are part of travel management plans, and these plans must be consistent with forest plans.

Clearly, decisions to have a road or to allow motorized use should take into account the effect of that particular road on connectivity. To fully understand the effects, it is necessary to know what role an area or corridor is expected to play in providing connectivity and what else is likely to happen there that will affect its connectivity value. The forest plan is the place to provide answers to those questions.

Where motorized use is inconsistent with the desired condition for an area, including desired connectivity conditions, a forest plan can identify the area as one that is not suitable for motorized use. This precludes the establishment of motorized routes in the area. It should also lead to eliminating any existing motorized use through road or area closures.

Site-specific desired conditions for connectivity are helpful in deciding where to manage for motorized use. The Gallatin National Forest Travel Plan Final



©KRISTA SCHLYER/DEFENDERS OF WILDLIFE

Roads and their associated human uses are one of the most common, persistent and obstructive barriers to connectivity on national forest lands. The National Forest System has about 375,000 miles of roads.

6. See www.fs.fed.us/eng/transp/.

Environmental Impact Statement (2006) includes a site-specific goal for identified "wildlife corridors," which provides a good example of a desired condition that should be included in a forest plan:

> *Provide for wildlife movement and genetic interaction (particularly grizzly bear and lynx) between mountain ranges at Bozeman Pass (linking the Gallatin Range to the Bridger/Bangtails); across highway 191 from Big Sky to its junction with highway 287 (linking the Gallatin and Madison Mountain Ranges); the Lionhead area (linking the Henry's Lake Mountains to the Gravelly Mountains and areas west); Yankee Jim Canyon (linking the Absoroka Mountains to the Gallatin Range); and at Cooke Pass (linking the Absoroka/Beartooth Range to areas south)* (Gallatin 2006: 3-88 – 3-89).

A connectivity characteristic commonly used in forest plans to protect wildlife and fish habitat is road density. Road density limits are especially useful for protecting big game hunting opportunities. The presence and use of roads have also been found to create risks to movement of large carnivores such as grizzly bears, a federally listed threatened species. To comply with the ESA, forest plans in grizzly bear range include restrictions on road density.

The Flathead National Forest provides some of the most important grizzly bear habitat in the National Forest System. As a result of ESA consultation on the forest plan, the Forest Service adopted Amendment #19 in 1995 that applied objectives and standards for each of 70 grizzly bear management subunits across the Flathead (where national forest ownership is greater than 75 percent) (Flathead 1995). For example, an objective was developed stating that within five years total road density of greater than two miles per square mile would occur on less than 24 percent of the grizzly bear management unit and in 10 years that would be further reduced to less than 19 percent. Similarly, standards were used to ensure there would be no net increases in road densities above a certain threshold and to maintain the security of core grizzly bear habitat areas. These types of connectivity and security plan components have been successful in reducing the number of roads forest-wide by approximately 700 miles and increasing secure core area from 63 percent to 70 percent (Flathead 2012: unpaginated, Tables 16b-9 and 16b-10).

For terrestrial species, it is often the use of the road that is more of a barrier to connectivity than the physical presence of the road. Many current plans address the need to limit motorized access during big game hunting season or to protect sensitive big game habitat such as winter range.

CONCLUSION

The connectivity planning direction found in the 2012 Planning Rule provides a significant opportunity to develop and implement landscape- and project-scale connectivity strategies on Forest Service lands and to coordinate connectivity planning across land ownerships. To be successful, forest planning stakeholders—including Forest Service planners, conservation advocates, scientists and other agencies and governments—must collaborate to devise innovative approaches.

Connectivity planning also requires forward thinking to execute the vision of a connected landscape. There is no one way to develop and implement connectivity strategies within forest plans. We hope this guide stimulates innovative ideas and is a starting point for developing effective approaches to connectivity planning within forest plans.

Share Your Experiences

Please share your forest planning experiences with us and let us know if this guide was useful. Your input will help us build our list of case studies and improve the effectiveness of this planning tool. Send your feedback to Pete Nelson (pnelson@defenders.org).

REFERENCES

FEDERAL CASELAW

Seattle Audubon Society v. Moseley, 798 F. Supp. 1484 (W.D. Wash. 1992)

Sierra Club v. Espy, 822 F.Supp. 356 (E.D. Tex. 1993) (rev'd on other grounds, 38 F.3d 792) (5th Cir. 1994)

FEDERAL STATUTES

Forest and Rangeland Renewable Resources Planning Act of 1978, 16 U.S.C. §§ 1641-1648.

Forest Service Organic Administration Act of 1897, 16 U.S.C. §§ 473-478, 479-482, 551.

Multiple-Use Sustained-Yield Act of1960, 16 U.S.C. §§ 528-531.

National Forest Management Act of 1976, 16 U.S.C. §§ 1600-1614.

FOREST SERVICE DIRECTION

National Forest System Land Management Planning, 36 C.F.R. §§ 219.1-219.19.

National Forest System Land Management Planning Rule, 77 Fed. Reg. 21162.

Forest Service Manual, FSM 1900 Planning (Amend. No. 1900-2015-1); available at www.fs.fed.us/im/directives/fsm/1900/wo_1920.doc.

Forest Service Land Management Planning Handbook, FSH 1909.12 (Amend. No. 1909.12-2015-1); available at www.fs.usda.gov/detail/planningrule/home/?cid=stelprd3828310.

Travel Management; Designated Routes and Areas for Motor Vehicle Use, 70 Fed. Reg. 68264.

SCIENTIFIC LITERATURE

Ament, R., R. Callahan, M. McClure, M. Reuling, G. Tabor. 2014. Wildlife Connectivity: Fundamentals for Conservation Action. Center for Large Landscape Conservation. Bozeman, MT.

Cushman, S. A. and E. L. Landguth. 2012. Ecological associations, dispersal ability, and landscape connectivity in the northern Rocky Mountains. Res. Pap. RMRS-RP-90. U.S. Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Lindenmayer, D. B. and J. Franklin. 2002. CONSERVING FOREST BIODIVERSITY. Island Press. Covelo, CA.

Gilbert-Norton, L., R. Wilson, J. R. Stevens, K. H. Beard. 2010. A meta-analytic review of corridor effectiveness. Conservation Biology 24(3): 660-668.

Hansen, A. J., R. L. Knight, J. M. Marzluff, S. Powell, K. Brown, P. H. Gude, K. Jones. 2005. Effects of exurban development on biodiversity: patterns, mechanisms, and research needs. Ecological Applications 15(6): 1893–1905.

Heller, N. E. and E. S. Zavaleta. 2009. Biodiversity management in the face of climate change: a review of 22 years of recommendations. Biological Conservation 142(1): 14-32.

McKelvey, K. S., J. P. Copeland, M. K. Schwartz, J. S. Littell, K. Aubrey, J. R. Squires, S. A. PARKS, M. M. Elsner, G. S. Mauger. 2011. Climate change predicted to shift wolverine distributions, connectivity, and dispersal corridors. Ecological Applications 21(8): 2882–2897.

Turner, M. G., R.H. Gardner, R. V. O'Neill. 2001. LANDSCAPE ECOLOGY IN THEORY AND PRACTICE: PATTERN AND PROCESS. Springer-Verlag. New York, NY.

Stein, S. M., R. J. Alig, E. M. White, S. J. Comas, M. Carr, M. Eley, K. Elverum, M. O'Donnell, D. M. TheobaldK. Cordell, J. Haber, T. W. Beauvais. 2007. National forests on the edge: development pressures on America's national forests and grasslands. Gen. Tech. Rep. PNWGTR-728. U.S. Forest Service, Pacific Northwest Research Station. Portland, OR.

Worboys, G. L., W. L. Francis, M. L. Lockwood. 2010. CONNECTIVITY CONSERVATION MANAGEMENT: A GLOBAL GUIDE. Earthscan Publications. London, UK.

OTHER REFERENCES

Arizona Wildlife Linkages Workgroup. 2006. Arizona's Wildlife Linkages Assessment; available at http://azdot.gov/docs/planning/arizona_wildlife_linkages_assessment.pdf. (Dec. 2006).

IGBC Public Lands Wildlife Linkage Taskforce. 2004. Identifying and Managing Wildlife Linkage Approach Areas on Public Lands: A Report to the Interagency Grizzly Bear Committee. (Jun. 17, 2004). Available at http://www.igbconline.org/images/pdf/PublicLandsReporttoIGBC.pdf.

South Atlantic Landscape Conservation Cooperative, "Terrestrial Habitat Connectivity," www.southatlanticlcc.org/page/projects-1?projectid=1415003

CASE STUDIES (in alphabetical order by source)

Brundin, L. and W. Johnson. 2008. Kootenai National Forest Wildlife Approach Areas (draft). U.S. Forest Service, Kootenai National Forest. (Dec. 16, 2008). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5336891.pdf.

Conservation Strategy/Habitat Work Group, Eastern Brook Trout Joint Venture. 2008. Conserving the Eastern Brook Trout: Action Strategies. (August 2008). Available at http://www.fws.gov/northeast/fisheries/pdf/EBTJV_Conservation_Strategy_July08.pdf.

U.S. Forest Service. 1995. Decision Notice and Finding of No Significant Impact for the Inland Native Fish Strategy; Interim Strategies for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH). U.S. Forest Service, Northern Region, Intermountain Region, Pacific Northwest Region. Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033158.pdf.

U.S. Forest Service. 2007. Northern Rockies Lynx Management Direction Record of Decision, National Forests in Montana, and parts of Idaho, Wyoming, and Utah. (March 2007). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5277399.pdf.

U.S. Forest Service; Bureau of Land Management. 1995. Decision Notice/Decision Record, Finding of No Significant Impact, Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). U.S. Forest Service; Bureau of Land Management. Washington, DC. (February 1995). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033465.pdf.

U.S. Forest Service, Allegheny National Forest. 2007. Allegheny National Forest Record of Decision for Final Environmental Impact Statement and the Land and Resource Management Plan. U.S. Forest Service, Eastern Region Office. Milwaukee, WI. (March 2007). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5044088.pdf.

U.S. Forest Service, Flathead National Forest. 1995. Forest Plan Amendment #19, Allowable Sale Quantity and Objectives and Standards For Grizzly Bear Habitat Management Decision Notice. U.S. Forest Service, Northern Region, Flathead National Forest. (Mar. 1995). Available at http://merid.org/~/media/Files/Projects/FNF/General%20Resources/Amendment19Grizzly%20Bear%20Habitat%20Mgt.pdf.

U.S. Forest Service, Flathead National Forest. 2012. Forest Plan Monitoring and Evaluation Report, Fiscal Years 2008-2010: Item #16b: Grizzly Bear Habitat. (April 2012). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5365012.pdf.

U.S. Forest Service, Flathead National Forest. 2014. Assessment of the Flathead National Forest, Part 1. U.S. Forest Service, Flathead National Forest. Kalispell, MT. (April 2014). Available at https://fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3796880.pdf.

U.S. Forest Service, Gallatin National Forest. 2006. Gallatin National Forest Travel Plan Final Environmental Impact Statement. U.S. Forest Service, Gallatin National Forest. Bozeman, MT.

U.S. Forest Service, Pacific Northwest Region. 1994. Decision Notice for the Continuation of Interim Management Direction Establishing Riparian, Ecosystem and Wildlife Standards for Timber Sales; available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5211880.pdf.

U.S. Forest Service, Pacific Northwest Region. 2014. Blue Mountains National Forests Proposed Revised Land Management Plan. U.S. Forest Service, Malheur, Umatilla, and Wallowa-Whitman National Forests. Portland, OR. (February 2014). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3792953.pdf.

U.S. Forest Service, Pacific Southwest Region. 2005. Final Environmental Impact Statement, Land Management Plans: Angeles National Forest, Cleveland National Forest, Los Padres National Forest, San Bernardino National Forest. 2 vols. R5-MB-074-A; R5-MB-074-B. U.S. Forest Service, Pacific Southwest Region. (September 2005). Volume 1 available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5320704.pdf; volume 2 available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5320706.pdf.

U.S. Forest Service, Pacific Southwest Region. 2006. Record of Decision, Final Environmental Impact Statement, Cleveland National Forest Land Management Plan. R5-MB-112. U.S. Forest Service, Pacific Southwest Region. (April 2006). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5320708.pdf.

U.S. Forest Service, Northern Region. 2014. Proposed Action for Forest Plan Revision Nez Perce-Clearwater National Forests. U.S. Forest Service, Northern Region. (July 2014). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3807168.pdf.

U.S. Forest Service, Southwestern Region. 2013. Coronado National Forest Draft Land and Resource Management Plan. MB-R3-05-7. U.S. Forest Service, Southwestern Region Office. Albuquerque, NM. (October 2013). Available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5439740.pdf.

APPENDIX:

EXAMPLES OF COORDINATED CONNECTIVITY PLANNING

Multi-Organization Initiatives, including the Forest Service

America's Great Outdoors Initiative
www.doi.gov/americasgreatoutdoors/index.cfm

One of the goals of the President's America's Great Outdoors Initiative is "the conservation of land, water, wildlife, historic, and cultural resources, creating corridors and connectivity across these outdoor spaces, and for enhancing neighborhood parks." The "Large Landscapes Initiative" seeks to "improve collaboration across federal agencies and with state and local partners, especially given the inherent cross-jurisdictional nature of restoring large landscapes." It currently includes a study of specific wildlife linkage locations across major highways in the "Crown of the Continent" ecosystem in Montana.

Department of the Interior, Landscape Conservation Cooperatives
www.fws.gov/landscape-conservation/lcc.html

LCCs provide a forum for federal agencies (including the Forest Service), states, Tribes, non-governmental organizations, universities and others to work together to coordinate management response to climate change at the landscape level. "New wildlife corridors" was one of the specific needs identified nationally. The Great Northern LCC partners, for example, agreed to conservation goals that prominently feature connectivity as an important element of ecosystem integrity, and they also identified "target species" that depend on connectivity. Land management plans would be the vehicle for the Forest Service to incorporate broader landscape conservation goals.

Western Governors' Association Wildlife Corridors and Crucial Habitat Initiative
www.westgov.org/wildlife-corridors-and-crucial-habitat

The Western Governors' Association's initial policy stated that federal land management agencies should identify key wildlife migration corridors in their land management plans. The Forest Service is participating in implementing this connectivity guidance. In November 2012, the Forest Service encouraged forest supervisors conducting forest planning to consider information compiled by states for this initiative as part of implementing the 2012 Planning Rule.

Grizzly Bear Recovery Planning
www.igbconline.org/index.php/population-recovery/grizzly-bear-linkage-zones

The Recovery Plan for Grizzly Bear identifies the need to evaluate potential linkage areas within and between recovery areas. The Interagency Grizzly Bear Committee (IGBC, which includes the Forest Service) determined that "… linkage zone identification and the maintenance of existing linkage opportunities for wildlife between large blocks of public lands in the range of the grizzly bear are fundamental to healthy wildlife." Maps of linkage areas have been developed by the U.S. Fish and Wildlife Service and sanctioned by the IGBC.

Forest Service Initiatives

Properly addressing connectivity in land management plans will also promote coordination and integration within the Forest Service and advance other agency prerogatives.

The Forest Service Strategic Framework for Responding to Climate Change includes "development of wildlife corridors to facilitate migration" as a strategy to address climate change effects (www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf). One of the "immediate initiatives" in the roadmap is connecting habitats to improve adaptive capacity by:

- Collaborating with partners to develop strategies that identify priority locations for maintaining and restoring habitat connectivity. Seeking partnerships with private landowners to provide migration corridors across private lands.
- Removing or modifying physical impediments to species movement most likely to be affected by climate change.
- Managing forest and grassland ecosystems to reduce habitat fragmentation.
- Continuing to develop and restore important habitat corridors for fish and wildlife.

The Forest Service Open Space Conservation Strategy states that "[o]ur vision for the 21st century is an interconnected network of open space across the landscape that supports healthy ecosystems and a high quality of life for Americans" (www.fs.fed.us/openspace/national_strategy.html).

<u>Appendix 3</u>

Scientific Basis for Protecting Wildlife Corridors
The Wilderness Society

Scientific Basis for Protecting Wildlife Corridors
The Wilderness Society

Properly designed networks of wildlife corridors represent one of the best strategies to mitigate the negative impacts of habitat fragmentation and help wildlife species adapt to climate change. Strategies that seek to maintain or restore connectivity between protected or otherwise intact natural areas are now considered critical to biodiversity conservation (Hilty et al. 2006, Miller & Hobbs 2002, Taylor et al. 2006). Conservation scientists have now long agreed that "the preponderance of evidence is that corridors almost certainly facilitate travel by many species" (Beier and Noss 1998). Many analytical frameworks for prioritizing specific habitat corridors to preserve landscape connectivity have been formulated (e.g., Bunn et al. 2007, Compton et al. 2007, Carroll et al. 2011, McRae et al. 2008, Walker & Craighead 1997), and this area of conservation science continues to see intense growth. Although the particulars of wildlife response to climate change are largely unknown (Root 2003, Travis 2003, Jarema et al. 2009), establishment of landscape connectivity via corridors is the most frequently cited strategy for combating the impacts of climate change on biodiversity (Heller & Zavaleta 2009).

Ecosystem Function and Thresholds of Landscape Connectivity

Planning for corridors and connectivity requires an examination of the physical structure of the landscape as well as the functional response of wildlife and other landscape elements to that structure:

> (1) The structural (or physical) component: the spatial arrangement of different types of habitat or other elements in the landscape, and (2) The functional (or behavioral) component: the behavioral response of individuals, species, or ecological processes to the physical structure of the landscape (Crooks and Sanjayan 2006).

Habitat fragmentation leads to a reduction in landscape connectivity by reducing the occurrence or the effectiveness of natural ecosystem processes and preventing wildlife species from moving across the landscape (Crooks and Sanjayan 2006). Biologists are in agreement that habitat fragmentation is one of the greatest threats to the persistence of individual wildlife species and overall biodiversity (Wilcove 1998). Habitat fragmentation consists of two different processes that simultaneously and negatively affect wildlife species: (1) a reduction in the overall habitat available to wildlife species – habitat loss; and (2) the creation of isolated patches of habitat separated from what was once the contiguous landscape (Crooks and Sanjayan 2006).

Habitat loss and fragmentation can occur as a result of a variety of human activities on the landscape. On public lands, industrial energy development, logging, mining, off-road vehicle (ORV) trails (both designated and illegally created), and roads are the land use changes that drive fragmentation. These are associated with a complex of stressors that cause further fragmentation such as the introduction of invasive species; disease transmission and other issues related to the presence of pets; noise, light, and water pollution; change in wildfire regimes; power transmission lines; and others. When the total effect of the "human footprint" from all fragmentation is modeled across land ownerships in the West, it cumulatively covers approximately 48% of the landscape (Leu et al. 2008). This study defined the human footprint as any human development or activity on private or public land (everything from ORV trails to residential and industrial development); and includes direct habitat loss as well as habitat fragmentation and overall degradation. Fahrig (2002) suggested that each species tends to have an "extinction threshold" of minimum habitat necessary, meaning that when available habitat drops below the threshold, the risk of extinction increases. Habitat fragmentation may play an important role in adjusting this threshold level because as fragmentation increases, the amount of habitat necessary for the species to persist also increases. If habitat is connected, even when drastically reduced, there is a much higher probability of population persistence than if the available habitat is reduced and fragmented (Travis 2003). A reduction in landscape connectivity does not just affect wildlife directly; it can also affect species indirectly through ecological processes that provide beneficial services to wildlife as well as humans (also known as "ecosystem services") (Kremen 2005, Ricketts et al. 2006). Examples of ecosystem services include water purification, oxygen production, erosion control, and insect pollination of important food crops. There is also a growing consensus in the scientific community that not only is biodiversity dependent on landscape connectivity, but also overall ecosystem health, as measured by biomass production, nutrient cycling, water and nutrient retention, community stability and other measures independent of biodiversity (Lyons et al. 2005).

Impacts of Habitat Fragmentation on Wildlife Migration, Movement and Resource Acquisition

When wildlife habitat patches become isolated and individual animals within a species are unable to move across the landscape, wildlife populations are affected by a multitude of harmful processes. According to Hilty et al (2006), there are six main adverse effects that may occur as a result of habitat fragmentation: (1) increased isolation leading to detrimental genetic and demographic effects; (2) changes in species richness or composition; (3) modification of energy flow, nutrient cycling, and hydrological regimes; (4) declines in populations of individual species or their geographic extent across the landscape; (5) edge effect problems that can lead to the introduction of exotic invasive species as well as increases in predation and competition among different wildlife species; and (6) increased human disturbance and associated direct and indirect mortality.

Wildlife population persistence, evolution, and speciation are all driven by genetic factors. As the areas between crucial wildlife habitat patches are converted to human use, fragmenting the landscape, individual wildlife populations become more isolated (Frankham 2006). When wildlife is not able to disperse from natal habitats or migrate throughout the landscape then the entire population may face genetic isolation. Genetic isolation increases the prevalence of negative genetic factors that can lead to a higher extinction risk. These genetic factors include "inbreeding depression, decreased ability to adapt to environmental factors, mutation accumulation, and outbreeding depression." Id. In contrast, if individual animals within populations are still able to migrate, even with decreased overall habitat, the genetic effects of isolation can be mitigated. Frankham (2006) estimates that “with sufficient migration, a fragmented population will have the same genetic consequences as a single large population of the same total size.” This reflects Travis’s (2003) observation that when habitat is connected, even when reduced overall, there is a higher probability of population persistence.

Changes in vegetation composition, energy flow, nutrient cycling, and microclimates may negatively impact wildlife if they are unable to find vital resources necessary for survival. Food, water, minerals, and other resources that individual animals require are not evenly dispersed throughout the landscape (Hobbs et al. 2008). For example, the most nutritious forage may be in a completely different location from a watering hole. Due to this isolation and inconsistent allocation, wildlife species need the ability to move unhindered throughout the landscape to find resources. Habitat fragmentation restricts wildlife from “matching their distribution to the resources they require to survive and reproduce” and these impacts can drastically affect wildlife; rendering “landscapes effectively unsuitable [for wildlife]” (Hobbs et al. 2008).

Human disturbance that causes and contributes to fragmentation is often associated with roads. Edge effects and human exploitation can influence individual animals and entire populations. According to Clevenger and Wierzchowski (2006), “roads cause changes to wildlife habitat that are more extreme and permanent than other anthropogenic sources of fragmentation.” Edge-sensitive species will have declined nesting, production, and survival rates in highly fragmented locations. Additionally, edge-sensitive species may be exposed to interactions with edge generalist species, that can outcompete them for resources, and predators that can now prey on those species more effectively (Fletcher 2005).

Fragmentation also allows for biologically diverse areas to be opened up to human activity (Ewers and Didham 2006). An increase in human activity can often have negative impacts on wildlife species. For example, motor vehicles can cause mortality through collision, ORV operators may illegally enter core habitat –further fragmenting the landscape, and legal and illegal hunters may access wildlife species more easily (Ewers and Didham 2006).

Landscape Connectivity and Mitigating Wildlife Impacts of Climate Change

It is unequivocal that warming of the earth due to human-induced climate change is rapidly occurring (IPCC 2007). The Intergovernmental Panel on Climate Change and the U.S. Global Change Research Program agree that global climate change will have drastic effects on biodiversity worldwide (IPCC 2007, Karl et al. 2009). Over the last twenty years, conservation biologists have firmly established that climate change may pose a significant threat to the future persistence of some wildlife species; wildlife species already have and will continue to respond to climate change in various ways as well (Hughes et al. 2000, Burns et al. 2003, Travis 2003, Pyke 2004). Climate change will also likely exacerbate stressors that wildlife already face, most notably habitat loss and fragmentation.

Researchers have noticed that some species have started to respond to climate change in significant ways (Root et al. 2002, Pyke 2004). Hughes (2000) and Root et al. (2003) predict that climate change will impact wildlife species in four specific ways: (1) Physiological – the metabolic and developmental rates of some species may be affected; (2) Distributional – species are already changing their distributions and will likely continue to do so even more; (3) Phenological – as the timing of environmental cues change, life cycle events triggered by those cues will also change; and (4) Adaptative – some species with short life cycles and rapid population growth may undergo microevolution in situ. Some wildlife species are already responding to climate change in many of the above ways, as are the plant species essential to support wildlife populations. Researchers have also recorded habitat distribution changes in several species (Hughes 2000; Barnosky et al. 2003, Burns et al. 2003). Range shifts occur dissimilarly throughout different latitudes, and some species may change only the density level within the metes and bounds of their traditional ranges. According to Jarema et al. (2009), beaver (*Castor canadensis*) habitat ranges in Quebec have not shifted in response to the climate, but the density of beavers within the range has shifted north. Romme and Turner (1991) have also speculated that in the Greater Yellowstone Ecosystem, many species that are alpine zone obligates will likely go extinct because their ranges will shift upward to a point where no more shifting can occur.

Observational studies of phenological changes occurring within multiple species demonstrate some of the best scientific evidence that climate change is already impacting wildlife species (Hughes 2000, Root et al. 2003). Various bird species are migrating from their winter habitats and arriving at their summer habitats earlier in the spring. For example, Inouye et al. (2000) illustrated that the average day of first sighting for the American Robin (*Turdus migratorius*) in Gothic, Colorado changed from April 14 to March 11 between 1974 and 1999. At the same time that bird species are arriving earlier, the winter snow pack is staying longer at higher elevations adding extra stress to birds who arrive early and are unable to find food (Inouye et al. 2000). Amphibian reproduction, insect peak flights, and flower budding are also taking place earlier (Hughes 2000). If the timing of insect peak flights and flower budding occurs at times when birds are not arriving, a rapid decoupling in the phenological relationship between species may result – compounding stress on species that depend on flowers and insects.

Research indicates that many species are capable of rapid evolution, or microevolution, in response to anthropogenic environmental changes such as climate change. Briggs (2009) presents a thorough examination of microevolution in a range of plant species. Case studies from around the world support that Darwinian evolution in many plant species is rapid and ongoing, and call into question the ability to conserve intact ecosystems or restore degraded ecosystems in this context through existing management frameworks. Microevolution in animal species has been also documented for invertebrates (Umina et al. 2005, Balanya 2006). Evidence for vertebrate animals is sparse to date, but the first case of microevolution in a vertebrate species has recently been documented (Karrell et al, 2011). The tawny owl in Finland has been shown to have shifted its feather coloration over the last decade from white towards brown in response to milder winters and resulting lack of snow cover. It is important to note that this genetic plasticity cannot be expected from all species, particularly organisms with long generation times and limited reproductive potential. For these species, arguably those that are considered the most highly evolved on the planet, adaptation to climate change must be facilitated by management, and this management must be innovative, adaptive, tailored to specific goals, and based on the very best available science.

As Root et al. (2003) state, "if such climatic and ecological changes are now being detected when the globe has warmed by an estimated average of only 0.6°C, many more far-reaching effects on species and ecosystems will probably occur in response to changes in temperature to levels predicted by IPCC, which run as high as 6°C by 2100." The West is changing rapidly, and land managers must become the leaders in working towards solutions that help wildlife species in the face of climate change, or the Intermountain West may lose the species for which it is known. Although scientists cannot know wildlife will respond to climate change, research supports that habitat ranges of some species will have to shift to avoid extinction, and this highlights the need to manage for a landscape that wildlife can easily traverse in order to adapt to a changing climate (Root et al. 2003, Botkin et al. 2007, Jarema et al. 2009). The measures land managers take to plan for climate change must include strategies that allow wildlife species to adapt to climate change. One particularly useful way for the USFS to help wildlife species adapt is by protecting wildlife corridors because "[l]andscape connectivity will play an increasingly important role in the persistence of many plant and animal populations in the face of global change and resultant shifts and restructuring of species distributions" (Taylor et al. 2006). In fact, in a review of 22 years of scientific literature in which strategies were recommended for managing biodiversity in the face of impacts from climate change, the top recommended strategy was to maintain habitat connectivity (Heller & Zavaleta 2009). As the second largest land manager in the U.S., the USFS must be particularly invested in producing and implementing useful climate change solutions.

Literature Cited

Balanya, J., Oller, J. M., Huey, R. B., Gilchrist, G. W. & Serra, L. Global genetic change tracks global climate warming in Drosophila subobscura. Science 313, 1773–1775 (2006).

Barnosky, A.D., et al. 2003. Mammalian response to global warming on varied temporal scales. Journal of Mammalogy. 84(2): 354-368. 31 | Page

Beier, P. and Noss, R.F. 1998. Do habitat corridors provide connectivity? Conservation Biology. 12(6): 1241-1252.

Beier, P. et al. 2008. Forks in the road: choices in procedures for designing wildland linkages. Conservation Biology 22(4): 836-851.

Botkin, D.B. et al. 2007. Forecasting the effects of global warming on biodiversity. BioScience. 57(3): 227-235.

Briggs, D. 2009. Plant Microevolution and Conservation in Human-influenced Ecosystems. Cambridge: Cambridge University Press. 618 pp.

Burns, C.E. et al. 2003. Global climate change and mammalian species diversity in U.S. national parks. PNAS 100(20): 11474-11477.

Clevenger, A.P. and Wierzchowski, J. 2006. Maintaining and restoring connectivity in landscapes fragmented by roads. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. 502-535.

Crooks, K.R. and Sanjayan, M. 2006. Connectivity conservation: maintaining connections for nature. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. p. 1-19.

Ewers, R.M. and Didham, R.K. 2006. Confounding factors in the detection of species responses to habitat fragmentation. Biological Review 81: 117-142.

Fahrig, L. 2002. Effect of habitat fragmentation on the extinction threshold: a synthesis. Ecological Applications. 12(2): 346-353.

Fletcher, Jr., R.J. 2005. Multiple edge effects and their implications in fragmented landscapes. Journal of Animal Ecology 74: 342-352.

Frankham, R. 2006. Genetics and landscape connectivity. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. p. 72-96.

Karl, T.R., Melillo, J.M., Peterson, T.C. (eds.). 2009.. Global Climate Change Impacts in the United States. Cambridge University Press, Cambridge.

Karell, P. et al. 2011. Climate change drives microevolution in a wild bird. Nat. Commun. 2:208. Available at http://www.nature.com/ncomms/journal/v2/n2/full/ncomms1213.html%3FWT.ec_id%3DMARKETING%26WT.mc_id%3DNC1107CE1YR0?message-global=remove&WT.ec_id=MARKETING&WT.mc_id=NC1107CE1YR0.

Haddad, N.M. and Tewksbury, J.J. 2006. Impacts of corridors on populations and communities. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. p. 390-415.

Hargrove, W.W. et al. 2004. A practical map-analysis tool for detecting potential dispersal corridors. Landscape Ecology. 20: 361-373.

Hilty J.A., Lidicker W.Z., and Merenlender A.M. (2006) Corridor Ecology: The Science and Practice of Linking Landscapes for Biodiversity Conservation. Washington DC: Island Press.

Hobbs, N.T. et al. 2008. Fragmentation of rangelands: Implications for humans, animals, and landscapes. Global Environmental Change 18: 776-785.

Hughes, L. 2000. Biological consequences of global warming: is the signal already apparent?. Trends in Ecology and Evolution 15(2): 56-61.

Inouye, D.W. et al. 2000. Climate change is affecting altitudinal migrants and hibernating species. PNAS 97(4): 1630-1633.

IPCC. 2007. Climate change 2007: synthesis report. contribution of working groups I, II, III to the fourth assessment report of the intergovernmental panel on climate change. [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland.

Jarema, S.I., et al. 2009. Variation in abundance across a species' range predicts climate change responses in the range interior will exceed those at the edge: a case study with North American beaver. Global Change Biology 15: 508-522.

Kremen, C. 2005. Managing ecosystem services: what do we need to know about their ecology. Ecology Letters 8: 468-479.

Leu, M. et al. 2008. The Human Footprint in the West: A Large-Scale Analysis of Anthropogenic Impacts. Ecological Applications 18:1119–1139.

Lyons, K. G. et al. 2005. Rare species and ecosystem functioning. Conservation Biology 19(4): 1019-1024.

Pascual-Hortal, L. and Saura, S. 2006. Comparison and development of new graph-based landscape connectivity indices: towards the prioritization of habitat patches and corridors for conservation. Landscape Ecology 21: 959-967.

Pyke, C. 2004. Habitat loss confounds climate change impacts. Frontiers in Ecology and the Environment 2(4): 178-182.

Ricketts, T.H. et al. 2006. Connectivity and ecosystem services: crop pollination in agricultural landscapes. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. p. 256-289.

Romme, W.H. and Turner, M.G. 1991. Implications of global climate change for biogeographic patterns in the Greater Yellowstone Ecosystem. Conservation Biology 5(3): 373-386.

Root, T.L. et al. 2003. Fingerprints of global warming on wild animals and plants. Nature 421:57-60.

Taylor, P.D., et al. 2006. Landscape connectivity: a return to the basics. In: Crooks, K.R. and Sanjayan, M., editors. Connectivity Conservation. Cambridge: Cambridge University Press. p. 29-43.

Travis, J.M.J. 2003. Climate change and habitat destruction: a deadly anthropogenic cocktail. Proceedings of the Royal Society of Biological Sciences. 270: 467-473.

Umina, P. A., Weeks, A. R., Kearney, M. R., McKechnie, S. W. & Hoffmann, A. A rapid shift in a classical clinal pattern in Drosophila reflecting climate change. Science 308, 691–693 (2005).

Wilcove, D.S. et al. 1998. Quantifying threats to imperiled species in the United States. Bioscience 48(8): 607-615.

<u>Appendix 4</u>

Planning for Climate Change on U.S. National Forests

Defenders of Wildlife
(Working Draft)

> *"Climate change is a huge challenge; meeting it will take bold and ambitious action." – Forest Service Chief Tom Tidwell, July 2016.*

2016 was the hottest year ever recorded on earth, marking three consecutive record setting years. [1] For Defenders of Wildlife, the extinction of imperiled species and the associated loss of biodiversity accelerated by climate change is alarming. There is an urgent need to confront this growing threat.

This report explains how the U.S. Forest Service, working with the American public, can take bold and ambitious actions to address climate change impacts on America's national forests, which harbor a significant quantity of the nation's at-risk fish and wildlife populations. As the primary steward of America's national forests, the Forest Service must lead the response to the climate crisis facing America's national forests by making climate-based conservation a centerpiece of the agency's agenda. The report discusses how the agency's *2012 Planning Rule* can be used as an affirmative vehicle for systematic climate conservation planning and action.

This is the third in a series of reports issued by Defenders of Wildlife associated with the conservation of national forest lands, waters and wildlife under the Forest Service's 2012 Planning Rule. Readers may find the two previous reports – *Planning for Diversity* and *Planning for Connectivity* – valuable background reading in understanding the 2012 Planning Rule. [2]

Introduction

Because of specialized habitat needs, limited distributions and restricted dispersal abilities, imperiled fish and wildlife populations experience heightened vulnerability to climate change impacts (Thomas et al., 2004). America's national forests are strongholds for at-risk fish and wildlife, supporting more than 400 animals and plants listed under the Endangered Species Act (ESA) and over 3,000 other at-risk species, many of which will have difficulty adapting or moving in response to likely future climates. To put this in perspective, nearly one in three species listed under the ESA depends on national forests to some degree for their survival, including roughly one in three listed birds, and nearly

> *Nearly one in three species listed under the Endangered Species Act depends on national forests to some degree for persistence.*

[1] http://www.noaa.gov/stories/2016-marks-three-consecutive-years-of-record-warmth-for-globe

[2] Available at: www.defenders.org/publication/planning-diversity and www.defenders.org/publication/planning-connectivity

40 percent of listed mammals, including iconic species such as gray wolves, Canada lynx, jaguars, Florida panthers and brown bears.

As one of the nation's primary drinking water providers, climate change impacts to national forest watersheds will profound implications for human communities.

There are also 200,000 miles of streams in America's national forests, and national forests support many at-risk aquatic species, including over 50 percent of the nation's listed amphibians, one of the most vulnerable taxonomic groups to climate change impacts. In addition, roughly two-thirds of the fish species listed under the ESA occur on national forests, or are potentially affected by national forest management, along with nearly one-third of listed crustaceans (e.g. shrimp and crayfish), and a stunning 80 percent of listed mollusks (e.g. snails, slugs, and mussels). Many freshwater mussels concentrated in national forest streams in America's south are being pushed to the brink by warming waters, drought, development and pollution.

National forests are the headwaters of America's watersheds. In the American west, mountain snowpack accounts for roughly 75 percent of streamflows. Altered streamflows and rising water temperatures pose an acute threat to these waters, including to iconic and commercially valuable cold-water dependent species such as native trout and salmonids. Considerable research attention is being focused on the conservation of cold-water ecosystems and cold-adapted native salmonids (Nelson et al., 2016).

As one of the nation's primary drinking water providers, climate change impacts to national forest watersheds also have profound implications for human communities. About 20 percent of the nation's waters originate in national forests and some 180 million people rely on these sources for their drinking water, including the urban residents of Los Angeles, Portland, Denver, Atlanta and many other large cities. National forest based water has been valued at over $7 billion.

One quarter of Alaska's 5.4 million acre Chugach National Forest, the northernmost of all the national forests, is covered by retreating snow and ice.

Climate change impacts will be particularly severe in certain regions. For example, Alaska is warming at twice the rate than the rest of the United States (Haufler et al., 2010). In 2015, driven by warm temperatures and uncharacteristically dry and flammable vegetation, wildfires burned over 5 million acres in Alaska, the second largest number of acres burned since 1940. Alaska is also annually losing 75 billion metric tons of ice from glaciers (Larsen et al., 2015). One quarter of Alaska's 5.4 million acre Chugach National Forest, the northernmost of all the national forests, is covered by now retreating snow and ice. The Forest's coastal glacial fjords, bays and glacier fed streams support abundant fish and wildlife, including the imperiled Kittlitz's murrelet, a seabird which utilizes glacial habitat for nesting and foraging, as well as all five species of pacific salmon, which in addition to playing a keystone role in ecosystem productivity, contribute more than 230 million dollars per year to the commercial fishing economy. According to the forest's proposed revised forest plan: "Recent and increasing climate change effects represent perhaps the most pervasive environmental alterations affecting the Chugach National Forest" (USDA, 2015a). The forest is particularly concerned with the spread of the highly invasive *Elodea spp.* (waterweed), which has been discovered in the Copper River Delta – one of the largest and most productive wetlands of the world – and is known to degrade water quality, reduce dissolved oxygen, and impact native fisheries.

The Third National Climate Assessment, the definitive report compiled by more than 300 experts summarizing the impacts of climate change on the lands and waters of the United States, concluded that "(c)limate change is increasing the vulnerability of many forests to ecosystem changes and tree mortality through fire, insect infestations, drought, and disease outbreaks" (Joyce et al., 2014). Forests have always been shaped by wildfire, insects and disease, but their natural resiliency was maintained in the absence of human-driven impacts that lead to habitat loss, degradation and fragmentation. The immediate repercussions of a changing climate, such as persistent drought and longer dry seasons, will be significant changes in the magnitude of wildfire, insect and disease disturbances. These uncharacteristic disturbances, in combination management-based stressors such as invasive species, inappropriate grazing, road building, and fire suppression, pose a serious threat to the resiliency and persistence of national forest ecosystems and resident biodiversity (Vose et al., 2012).

Increases in the frequency and severity of wildfire due to climate-driven drought and longer fire seasons – coupled with ongoing management stressors like invasive species and fire suppression – could result in unprecedented and devastating changes to forests.

Increases in the frequency and severity of wildfire due to climate-driven drought and longer fire seasons could result in unprecedented and devastating changes to forests and the fish and wildlife they harbor (McKenzie et al., 2004; Gaines et al., 2012). A recent study estimated that climate change accounted for more than half of the documented increases in forest aridity found in Western U.S. forests over the past four decades, and is the primary driver expanding the seasonal duration, extent and severity of wildfires (Abatzoglou and Williams, 2016).

The Forest Service is expending an enormous amount of resources fighting and suppressing wildfires, a problem that becomes more acute as more people move into the areas adjacent to national forests, and more acres burn due to climate impacts. For example, 2015 was a record for wildland fire in the United States: it marked the first time that over 10 million acres burned, and federal fire suppression costs exceeded $2 billion for the first time ever.[3] Firefighting now consumes over 50 percent of the Forest Service's budget and, barring a fix to the budgeting process and changes in suppression policies, is expected to account for two of every three dollars of the agency's budget by 2025 (USDA, 2015b).

Systematic conservation planning on national forests will be critical to support the conservation of fish and wildlife habitat in the face of climate change. Due to their location, elevation, size and management focus, national forests provide distinctive and critical conservation and climate protection values.

For many climate and management-stressed populations of fish and wildlife, national forests may offer climate refugia; areas likely to experience less change than the surrounding landscape.

National forests will play a critical role in providing climate refugia for a significant number of climate and management-stressed fish and wildlife populations. Climate change effects will not be uniform in space and time. Climate refugia can be defined as habitat areas likely to experience less change than the surrounding landscape, and many national forests will need to provide these valuable climatic conditions.

For example, in 2013 the U.S. Fish and Wildlife Service (USFWS) identified climate change as the primary threat to the wolverine in the continental United States (USDI, 2013). Wolverines rely on deep spring snow to rear their young, so they are especially vulnerable to the loss of their alpine habitat due to climate change. Scientists predict that wolverines in the coterminous United States may lose two-thirds of their suitable, snow-covered habitat by the end of the century. Much of the remaining suitable habitat will be found in high-elevation national forests, such as those in Montana's northern Rockies. These forests will need to recognize the key role they play in the species' conservation, manage alpine refugia habitat to alleviate other threats (for example from motorized recreation), and proactively plan to provide for connections between increasingly isolated snowy alpine habitats.

Similarly, national forests will play a major role in maintaining and restoring climate-resilient conditions for species such as bull trout, which were listed as threatened under the ESA in 1999 and rely upon cold, pristine streams and lakes throughout their range. Rising temperatures and lower stream flows, along with management stress brought on by grazing and inappropriate timber harvest, degrade the cold-water habitat conditions that bull trout require for spawning and rearing. But the loss of cold-water habitat will not be uniform throughout the range of bull trout; some areas are more likely than others to retain cold-water conditions over time, due to factors such as high elevation, low

[3] https://www.nifc.gov/fireInfo/fireInfo_statistics.html

exposure to solar radiation, or high rate of groundwater inflow, thus providing climate refugia for the fish (USDI, 2015). The promulgation of a new forest planning regulation provides the Forest Service with a mandate to consider climate change in the conservation of climate-stressed species such as bull trout.

THE 2012 PLANNING RULE

Conserving fish and wildlife populations on national forests in the face of climate change will require science-driven, systematic and well-coordinated landscape-scale conservation planning efforts to assess and respond to climate-driven threats to habitat (Margules and Pressey, 2000).

Management in the face of climate change is commonly referred to as climate change adaptation, defined by the Intergovernmental Panel on Climate Change (IPCC) as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (McCarthy et al., 2001). Climate adaptation planning involves the development of forward-looking goals and strategies "specifically designed to prepare for and adjust to current and future climatic changes, and the associated impacts on natural systems and human communities" (Stein et al., 2014). The Forest Service can help ameliorate climate-driven and compounding anthropogenic impacts through strategic conservation planning and targeted action to increase the likelihood that ecosystems and species will persist over time.

Thanks to a regulation adopted in 2012, the Forest Service is well positioned to do this. In 2012 the Forest Service adopted a new regulation to guide the development of land management plans – commonly called forest plans.

Forest plans dictate where and how to conserve and recover at-risk species, or where to harvest timber or graze livestock. Importantly, forest plans balance the conservation of habitat with management activities so that fish and wildlife populations will be sustained.

The 2012 Planning Rule is a regulation that implements the National Forest Management Act (NFMA, 1600 U.S.C. § 1600 et seq.), the primary law governing management and conservation of our national forests, watersheds and occupant fish and wildlife. Every national forest has a forest plan to guide conservation actions and management projects. For example, forest plans dictate where and how to conserve and recover at-risk species, or where to harvest timber or graze livestock. Importantly, forest plans balance the conservation of habitat with management activities so that fish and wildlife populations will be sustained.

The planning rule's adaptive framework mirrors those proposed in other adaptation planning guidances (Cross et al., 2012; Stein et al. 2014), and reflects primary principles for adaptation planning, including the establishment of clear conservation goals, adaptive management, the use of vulnerability assessment, best available science and science-management partnerships (Joyce et al., 2009; Littell et al., 2012; Peterson et al., 2011).

The 2012 Planning Rule explicitly pushes the Forest Service to address climate change impacts on fish and wildlife populations during the forest planning process. For instance, one of the primary policy goals of the planning rule is to "emphasize restoration of natural resources to make our (national forest) lands more resilient to climate change" (Preamble, 21164). The rule itself states that one of its purposes is to allow "the Forest Service to adapt to changing conditions, including climate change…" (§219.5(a)). Forest plans developed under the 2012 Planning Rule will also reflect the conservation goals and objectives of the Forest Service' strategic plan, one of which is to "(f)oster resilient, adaptive ecosystems to mitigate climate change" (USDA, 2015c). The Planning Rule's directives – the procedural policies that prescribe the development of forest plans – have numerous instructions over how to incorporate climate change into the planning process.

Assessing Climate Change Impacts to Ecosystems and At-risk Species

The planning rule requires an assessment to appraise "the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change" (§219.6(b)(3)).

The planning rule adopts an adaptive planning framework that includes: 1) an assessment of climate impacts to ecosystems, watersheds, fish and wildlife; 2) the development of the forest plan, including strategies and actions to sustain those resources in the face of climate threats, and; 3) a monitoring and evaluation program to determine whether the forest plan's climate conservation strategies are effective.

The forest planning process begins with an assessment of social, economic and ecological conditions and trends within the forest planning area. The purpose of this assessment is to determine how the revised forest plan can meet the requirements of the planning rule and sustain these values and resources.

The ecological assessment applies the best available scientific information to evaluate climate change impacts to the ecosystems, watersheds, and at-risk species within the forest planning area. The planning rule specifically requires the assessment to appraise "the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change" (§219.6(b)(3)). To support adaptive management, the assessment should also identify information gaps, uncertainties, and assumptions associated with ecosystem and species adaptation to climate change.

The purpose of the assessment is to determine how the revised forest plan can meet its conservation objectives in the face of climate impacts. It will therefore evaluate climate impacts on 1) the sustainable condition - or in the jargon of the rule, the ecological integrity – of the forest's ecosystems and watersheds, and 2) the biological and physical environments (in the rule, the ecological conditions) that support the ability of at-risk fish and wildlife populations to persist on the forest (Table 1).

Table 1: Conservation objectives of the 2012 Planning Rule for ecosystems and species

Ecological Integrity	Requirement: Maintain or restore the *ecological integrity* of terrestrial and aquatic ecosystems and watersheds in the plan area, including their structure, function, composition, and connectivity. Definition: The quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence.
At-risk Species *Threatened and Endangered* *Candidate and Proposed* *Species of Conservation Concern (SCC)*	Requirement: Determine whether or not the (ecosystem) plan components provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve 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 (ecosystem) plan components 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. Definition of ecological conditions: The biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species, and the productive capacity of ecological systems. Ecological conditions include habitat and other influences on species and the environment. Examples of ecological conditions include the abundance and distribution of aquatic and terrestrial habitats, connectivity, roads and other structural developments, human uses, and invasive species.

Managing for "coarse-filter" ecosystem conditions is expected to support the majority of biodiversity found in national forests; however, the planning rule appropriately acknowledges that some fish and wildlife populations are not likely to be conserved through an ecosystem approach alone (Noon, 2003). The rule therefore establishes a second set of conservation targets at the species-level of biological organization for conservation and adaptation planning. At-risk species include species listed, proposed for listing, or candidates for listing under the ESA, and others designated by the Forest Service as being species of conservation concern (SCC).[4] Climate threats may be a factor in determining that a species is of conservation concern on the forest.

[4] A species of conservation concern is a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the

The assessment will identify the ecosystems and the at-risk species within the forest planning area. For each of the forest's ecosystems, a limited set of measurable ecosystem characteristics will be evaluated to determine the integrity of the ecosystem (Table 2). In addition to reflecting the conservation needs of individual species associated with the ecosystem, the chosen characteristics should be selected because they are helpful for understanding the effects of climate change; for example, the characteristic may be vulnerable to climate impacts (e.g., wildfire frequency and severity, or water temperature).

Table 2: Key Ecosystem Characteristics

Ecosystem Characteristic	*Definition*	*Examples*
Composition	The biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.	Major vegetation types, patches, habitat types, soil types, landforms, and wildlife populations
Structure	The organization and physical arrangement of biological elements such as, snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity.	Arrangement of patches within a landscape, habitat types within a forest, trees within a forest stand, wildlife within a planning area
Function	Ecological processes that sustain composition and structure, such as energy flow, nutrient cycling and retention, soil development and retention, predation and herbivory, and natural disturbances such as wind, fire, and floods.	Types, frequencies, severities, patch sizes, extent and spatial pattern of disturbances such as fires, landslides, floods, and insect and disease outbreaks
Connectivity	Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change.	Size, number and spatial relationship between habitat patches; mapped landscape linkages and corridors Measure of ability of native species to move throughout the planning area and cross into adjacent areas

The assessment will also identify the ecological conditions that are necessary to support each of the at-risk species and will evaluate likely climate impacts on those conditions. There will likely be overlap between key characteristics of ecosystem integrity and ecological conditions necessary to support at-risk species. For example, stream flows and flow regimes, stream temperature, the fragmentation of stream segments, and the composition of native vegetation within a streamside zone, are key

best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area.

ecosystem characteristics that are also ecological conditions that support the persistence at-risk cold-water native fish. It is very important that the assessment explicitly articulate (for example through the use of a conceptual or species-habitat models) the proxy relationship between the ecological condition and the conservation of the species.

The assessment will evaluate likely climate impacts – operating in concert with other stressors (such as sedimentation from roads, barriers to connectivity, or water withdrawals) – on ecosystem characteristics and ecological conditions for at-risk species. To do this, the assessment compares the status and trend of the characteristics and conditions against a climate-informed reference model using information on the natural range of variation (NRV). The reference condition can be thought of as the "natural" condition that would be expected in the absence of human influence, considering likely climate effects; it is often estimated using historical ecological information, but needs to take into account expected changes in climate.

The assessment will evaluate likely climate impacts – operating in concert with other stressors (such as sedimentation from roads, barriers to connectivity, or water withdrawals) – on ecosystem characteristics and ecological conditions.

A projected departure from the climate-informed reference condition for a key characteristic or ecological condition indicates that the ecosystem or wildlife population may not be sustained. The threat to sustainability could be caused by management stressors, by climate impacts operating in concert with management stressors, or by climate impacts alone. The purpose of the assessment is to alert the forest planning process to the vulnerability of the characteristic or condition, and to identify the specific threat so that it can be addressed, if feasible, within the forest plan.

Climate change adaptation requires an understanding of how climate change may impact a given biological system so that appropriate management strategies can be identified. Vulnerability to climate change refers to the degree to which an ecological community or individual species is likely to experience harm as a result of changes in climate (Schneider et al. 2007). Vulnerability is a function of exposure to climate change – the magnitude, intensity and duration of the climate changes experienced, the sensitivity of the species or community to these changes, and the capacity of the species or system to adapt (IPCC 2007, Williams et al. 2008). A vulnerability assessment can help to identify which species or systems are likely to be most strongly affected by projected changes in climate and provides a framework for understanding why particular species or systems are likely to be vulnerable (Glick et al. 2011). Such an assessment informs conservation planning by identifying climate-related threats and resulting stresses, which then become part of the decision-making process undertaken to identify and prioritize conservation strategies.[5]

For example, an assessment may find that seasonal stream flows – a condition necessary to sustain at-risk fish – are departed from historical/reference levels due to climate-driven changes in precipitation patterns, and exacerbated by ongoing water withdrawals. While the forest plan may not be able to address the underlying climate change stress, it may be able to affect the withdrawals. Or, an assessment may find that uncharacteristic wildfire severity (i.e., outside of the expected natural range) may be driven by climate-driven drought acting in concert with fire suppression actions, which could be modified within the forest plan by allowing fires to burn under certain circumstances. (See Appendix A for a discussion of how conceptual models can be employed to illustrate such complex relationships and support decisionmaking.)

Developing a robust science-based method to estimate future reference conditions is a key, yet challenging, process in forest and climate planning. The Okanogan-Wenatchee National Forest developed a method to estimate a future range of variation for key indicators of forest ecosystems in order to address climate-driven vulnerabilities to ecological integrity and conditions for at-risk species.

The method assumed drier and warmer conditions under a future climate change scenario. To establish the reference conditions, existing empirical data from an ecosystem that was warmer and drier than the ecosystem undergoing planning was used. The condition of the planning ecosystem was then measured against that reference "warmer and drier" ecosystem for certain indicators to determine departure from a future NRV (Gartner et al., 2008; USDA., 2012). Measurable desired future conditions for integrity could then be established for planning and adaptive management.

The Okanogan-Wenatchee National Forest developed a method to estimate a future range of variation for key indicators of forest ecosystems in order to address climate-driven vulnerabilities to ecological integrity and conditions for at-risk species.

The assessment results in status determinations on the likely future condition of ecosystems, watersheds and conditions for at-risk species, assuming climate effects and continued implementation of the current forest plan (i.e., the plan that is being revised). Some ecosystem characteristics and conditions for at-risk species will be functioning and require continued maintenance and protection

[5] Excerpted from the Defenders of Wildlife report: *Integrating Climate Change Vulnerability Assessments into Adaptation Planning*.

within the new forest plan; others will be departed from reference conditions and may require restorative conservation actions.

The Forest Service is making a concerted effort to make vulnerability assessments available for use in forest planning and other management processes. For example, the Northern Rockies Adaptation Partnership (NRAP) is a science-management collaboration involving the 13 national forests of the Northern Region, the Forest Service's Pacific Northwest and Rocky Mountain Research Stations, the National Park Service (Glacier, Yellowstone and Grand Teton) and other academic and non-governmental institutions. NRAP conducts vulnerability assessments to develop adaptation strategies for use in national forest planning. A draft 2017 report assessed climate vulnerability of water resources (including snowpack and glaciers), cold-water salmonids, forest and rangeland vegetation, ecological disturbance and wildlife across the region (Halofsky et al., 2017).

Forest Plan Climate Conservation Strategies

The findings presented in the assessment are used to develop the forest plan, which will outline the strategies and actions necessary to maintain or restore ecosystems and fish and wildlife habitats in the face of climate change. Because ecosystems and fish and wildlife populations are generally not adapted to the rapid environmental change brought upon by climate change, it will be necessary to manage for their adaptation to those changing conditions.

In cases where the assessment has indicated that an ecosystem characteristic or condition for an at-risk species is likely to persist in the face of likely climate effects, the forest plan should adopt a resistance-oriented strategy. Resistance-oriented (or maintenance) strategies are intended to build resistance to climate-related stresses, and often capitalize on opportunities to protect areas projected to have less exposure to climate change impacts.

It is likely that forests will have to designate and protect areas outside of existing reserves to offer landscape-scale refugia networks for fish, wildlife and plants displaced from existing protected areas due to climate impacts.

Forest plans should identify, designate and protect predicted climate refugia; these areas likely meet the rule's test of fulfilling a unique and special purpose on the forest. It is likely that forests will have to designate and protect areas outside of existing reserves to offer landscape-scale refugia networks for fish, wildlife and plants displaced from existing protected areas due to climate impacts; a new study estimates that only a fraction of existing protected areas will offer stable climatic habitat conditions in the future (Batllori et al., 2017). Importantly, in addition to designating landscape-scale climate-reserve networks, the forest plan will need to establish non-reserve – or matrix-based strategies – to constrain management actions that may degrade conditions outside of protected reserves (Lindenmayer and Franklin, 2002).

For example, within the range of bull trout, forest plans should identify and prioritize the conservation of bull trout cold-water habitats that are most likely to resist the effects of climate change. Specifically, cold-water habitats fed by springs are expected to be more resistant to climate change impacts than other warmer and lower-elevation habitats, due to the uniformity of groundwater temperature. In addition, forest plans may need to provide the necessary constraints on projects and activities that could degrade cold-water conditions for bull trout, for example by limiting the impacts of the "Four Horsemen of the Apocalypse" for native trout: livestock grazing, logging (and related road networks), mining and harmful water management (Behnke and Tomelerri, 2002).

In cases where the assessment has indicated that a characteristic or condition for an at-risk species is degraded or is likely to be degraded in the future due to climate and/or other threats, the forest plan should adopt a resilience-oriented strategy.

In cases where the assessment has indicated that a characteristic or condition for an at-risk species is departed from future reference conditions, or is likely to be departed in the future, the forest plan should adopt a resilience-oriented strategy. Resilience-oriented (or restorative) strategies recognize the need to adapt to change, and are intended to minimize the severity of climate change impacts, reduce vulnerability, and improve the ability of ecosystems and species to "bounce back" from a climate-related stress. Many of these strategies will include restorative or resiliency-enhancing management that improve the functionality of an ecosystem by moving it towards the climate informed reference condition. Resiliency actions may focus on altering ecosystem structure and composition in order to prepare the system for climate-driven changes in disturbance regimes.

For many at-risk fish and wildlife populations, abating management threats and maintaining existing suitable habitat conditions may not be enough to ensure persistence; it will also be necessary to restore key conditions for which the species is adapted or more likely to adapt to. For example, returning to the previous example, bull trout require streams with complex habitat structure, including deep pools, overhanging banks, riparian vegetation, and large woody debris (USFWS, 2015). For many national forest streams, each of these key characteristics may be departed from the reference conditions that are necessary to recover bull trout populations.

Finally, there may be cases, given the rapid or significant nature of the climate effects, where maintenance or restoration strategies are unlikely to sustain a specific fish or wildlife population. In these cases, transformation-oriented strategies may be necessary to manage systems so that they respond in new ways. For instance, a forest plan may need to facilitate a shift in the range of a climate-threatened fish, wildlife or plant population.

In 2009 the Tongass National Forest planted yellow-cedar, on a trial basis, near Yukutat, Alaska, an area where the species did not previously grow, and which is at the northern limit of the species range. Survival of more than 90 percent of the planted trees indicates that facilitated range shift may be a viable adaptation strategy for the species.

For example, climate-driven snow loss and the transition from snow to rain-dominated precipitation conditions impact soil temperature by diminishing the insulation function provided by snow. Yellow-cedar, found in southeast and coastal Alaska, is threatened by spring freezing, which increasingly occurs in the absence of snowy thermal cover. A recent article estimated that half of the yellow-cedar's native range in coastal Alaska is threatened by this climate driven mortality (Buma et al., 2016). Because yellow-cedar is long-lived and has low productiveness, the species is limited in its ability to adapt to climate change and may require intentional transformation-oriented adaptation strategies. For instance, in 2009 the Tongass National Forest planted yellow-cedar, on a trial basis, near Yukutat, Alaska, an area where the species did not previously grow, and which is at the northern limit of the species range. Survival of more than 90 percent of the planted trees indicates that facilitated range shift (sometimes referred to as "assisted migration") may be a viable adaptation strategy for the species (Hennon et al., 2016).

Plan Components

Forest plans will guide climate conservation strategies through the development of plan components, which shape and direct the management actions that will be implemented under the plan. Plan components include desired conditions objectives, standards, guidelines, and suitability of lands (Table 3). Plan components must have clear geographic applicability, which means they can be applied to certain areas of the forest identified as being important to maintaining or restoring necessary climate conservation conditions for fish and wildlife populations.

Table 3. Plan components associated with adaptation strategies under the 2012 Planning Rule

Plan Component	*Description*
Desired Conditions	A description of specific social, economic and/or ecological characteristics of the plan area (or a portion of the plan area) toward which management of the land and resources should be directed. Desired conditions must be described in terms specific enough to allow progress toward their achievement to be determined, but do not include completion dates.
Objectives	A concise, measurable and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives should be based on reasonably foreseeable budgets.
Standards	A mandatory constraint on project and activity decision-making established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.
Guidelines	A constraint on project and activity decision-making that allows for departure from its terms as long as the purpose of the guideline is met. Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.

Desired conditions

Generally, forest plans must include clear and measurable descriptive statements about the desired future conditions for the key ecosystem characteristics and ecological conditions identified as being necessary for the persistence of the at-risk species. The characteristics and conditions employed in the assessment should be carried forward into the plan as plan components. To continue a prior example, for forest plans within the range of bull trout, there should be measurable desired condition statements for each of the key conditions necessary for recovery. Desired conditions should clearly describe desired habitat complexity, including the desired depth of pools, the desired riparian vegetation composition and structure, and the amount and location of large woody debris.

For characteristics and conditions that are less vulnerable to climate effects, there will be a desire to maintain the condition; for example, for some forest ecosystems existing high-frequency and low-severity fire regimes may be predicted under likely future climate conditions, and the forest plan would encourage that continuation; however, it may be necessary to remove management stressors that prohibit maintaining the current condition.

In other cases, the assessment may indicate that in the future a characteristic or condition will be departed from climate-informed reference conditions. The desired condition in this case should reflect the expected range of future conditions, while acknowledging uncertainty, and subject to monitoring. Desired conditions that don't acknowledge likely climate changes, such as a shift to more frequent and severe fire regimes in some forest ecosystems, will not be effective; they will in essence ignore reality. Yet because many elements of the ecosystem will not be adapted to those changing conditions, a combination of resistance, resiliency-building, and transformative strategies will need to be adopted to sustain resources into the future. Restoring the structure and composition of ecosystems so that they can withstand changes in dominant ecological processes is a logical approach to prepare for dramatic changes in disturbance; however, at some point those new disturbance regimes will need to be embraced, at least in some places. The plan should specify priority areas for maintenance and restoration.

Desired conditions can be applied across the forest, throughout an entire ecosystem type, or can be targeted to specific areas. The application of plan components within specific areas (e.g. management areas, geographic areas, or other areas designated to maintain unique and special characteristics) should be used to concentrate climate change response and climate conservation strategies within specific areas of the forest.

To be most effective in guiding climate conservation actions at the project-level, and to enable effective monitoring, it is critical that desired conditions be articulated for specific characteristics and conditions, and described in terms specific enough to allow progress toward their achievement to be objectively determined.

To be most effective in guiding climate conservation actions at the project-level, and to enable effective monitoring, it is critical that desired conditions be articulated for specific characteristics and conditions, and described in terms specific enough to allow progress toward their achievement to be objectively determined. We have found that many desired condition statements in current forest plan revisions are subjective and lack necessary specificity.

Desired conditions should articulate the actual measurable desirable reference conditions. This desired condition from the Flathead National Forest is good in that it ties the desired condition for watersheds to actual reference watersheds within the planning area (which should facilitate monitoring and adaptive management), but it could be improved with a fuller description of the desired reference condition for each of the key characteristics and habitat features:

> Instream habitat conditions for managed watersheds move in concert with or towards those in *reference watersheds*. Aquatic habitats are diverse, with channel characteristics and water quality reflective of the climate, geology, and natural vegetation of the area. Stream habitat features across the forest, such as *large woody material, percent pools, residual pool depth, median particle size, and percent fines are within reference ranges* as defined by agency monitoring (USDA, 2016a, emphasis added).

In contrast, the Draft Revised Land Management Plan for the Sequoia National Forest included the following desired condition for fire regimes in the Upper Montane ecosystem, which is more measurable:

> At the landscape scale, fire is a key ecological process, restoring and maintaining patchy fuel loads and increasing heterogeneity and understory plant vigor. Fires occur irregularly, generally every 15 to 100 years, with frequency averaging about 40 years. Fires in this vegetation type burn with low, moderate or mixed severity, with minimal patches of very high severity (greater than 90 percent basal area mortality), rarely greater than 300 acres in size. The proportion of areas burned at high severity within a fire is generally less than 10 to 15 percent. Due to existing high levels of fuels and weather variability, greater proportions of areas of high severity burn (up to 50 percent) may be unavoidable during large landscape prescribed fires or wildfires managed to meet resource objectives. Some patches of high severity burn reach 1,000 acres in size (USDA, 2016b).

Desired conditions should reflect the forest's distinctive roles and contributions to conserving habitat in the face of climate change; for example, many forests will have desired conditions to maintain the resilient conditions of areas that are expected to provide future climate refugia conditions not found on the surrounding landscape. For example, the Flathead National Forest developed the following desired condition for connectivity between important areas, including habitat refugia:

> Spatial connectivity exists within or between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, *and intact habitat refugia.* These network connections provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic, riparian-associated, and many upland species of plants and animals (USDA, 2015a, emphasis added).

Objectives

> *Objectives should be used to prioritize the most important climate conservation actions in the forest planning area.*

Specific, climate-informed desired conditions establish the underlying purpose for climate conservation actions, but are not sufficient in and of themselves to ensure that conservation actions will occur. Other direction within forest plans is necessary to guide implementation.

The purpose of plan objectives is to ensure that progress is actually made toward the desired conditions. Objectives should be used to prioritize the most important climate conservation actions in the forest planning area, for example, those cases where the assessment documented clear vulnerability to climate change impacts and noted activities that could restore the characteristic or condition or alleviate threats that compound the magnitude of the climate impact.

The following is a typical objective supporting implementation of a desired condition to increase forest heterogeneity and restore species composition:

> Increase forest heterogeneity, reduce forest density and surface fuels, and restore species composition (i.e. increase black oak and pine) on 9,000 to 15,000 acres of the montane, upper montane, and portions of the foothill landscape, using mechanical treatment, often in combination with prescribed fire, within 10 to 15 years following plan approval (USDA, 2016b).

And here is a restoration objective from the Flathead National Forest to maintain or restore key characteristics of streams (note that there should be affiliated desired conditions for large woody debris, road networks, riparian vegetation composition and structure, and channel conditions):

> Enhance or restore 50 to 100 miles of stream habitat to maintain or restore structure, composition, and function of habitat for fisheries and other aquatic species. Activities include, but are not limited to, berm removal, large woody debris placement, road decommissioning or stormproofing, riparian planting, and channel reconstruction (USDA, 2016a).

The Planning Rule also requires that the forest plans identify priority watersheds for restoration. The identification of such watersheds is tiered to the Forest Service's *Watershed Condition Framework* (USDA, 2011), the objective of which is to improve watershed conditions including their ability to moderate the effects of climate change. Forest plans should therefore identify priority adaptation and conservation actions for these watersheds.

The Flathead National Forest's draft revised forest plan prioritized identified a subset of watersheds, called the *Conservation Watershed Network*, to prioritize conservation of bull trout and pure westslope cutthroat trout. These watersheds received a set of unique plan components to guide management. For example, there is an objective which states that "Conservation Watershed Network are the highest priority for restoration actions for native fish. Stormproof 15 to 30% of the roads in Conservation Watershed Network prioritized for restoration as funding allows to benefit aquatic species, e.g. bull trout" (USDA, 2016a).

Standards and Guidelines

Standards and guidelines constrain projects and activities that may pose a threat to key characteristics or conditions for at-risk species, and will frequently be used to maintain desired conditions by avoiding harmful effects. Because standards and guidelines are geared towards management actions, they will be used to address particular interacting management stressors that magnify climate effects. For instance, forest plans can use standards and guidelines to prohibit certain types of timber harvest in riparian areas in order to ensure that a key characteristic or condition is sustained.

Standards and guidelines constrain projects and activities that may pose a threat to key characteristics or conditions for at-risk species, and will frequently be used to maintain desired conditions by avoiding harmful effects.

For example, water howellia (*Howellia aquatilis*) is a plant species listed under the ESA that occurs on the Flathead National Forest; it is threatened by management activities (timber harvest, livestock use, invasion of non-native plants, and conversion of wetland habitat) and climate change, which is affecting wetland inundation processes. The Draft Revised Forest Plan for the Flathead National Forest included the following standard to avoid stresses to the plant's wetland habitat:

> Retain a buffer of a minimum width of 300 feet from the margins of ponds (occupied and unoccupied) that provide *Howellia aquatilis* habitat, for the purpose of maintaining or creating a favorable physical environment in and around the ponds, protecting against adverse hydrological changes, and maintaining the structural and floristic diversity of the vegetation (USDA, 2016a).

Connectivity

Connectivity is a dimension of ecological integrity, as well as a condition necessary to support many at-risk species. Because well-distributed populations are more resilient than isolated ones, managing for connectivity is especially important for enabling adaptation to changing stressors, including climate change. In fact, a review of 22 years of recommendations for managing biodiversity in the face of climate change found improving landscape connectivity is the most frequently recommended strategy for allowing biodiversity to adapt to new conditions (Heller and Zaveleta, 2009). Connectivity should therefore play a prominent role in forest planning for climate conservation.

Assessments should determine a reference condition for landscape pattern that will support the ability of fish and wildlife populations to adapt to changing climate conditions. Barriers to connectivity should be identified and prioritized for removal within forest plans. Generally, forest plans should aspire to create a more resilient transportation network, given the significant negative effects roads and other routes have on ecosystem functionality, watershed conditions, and species persistence. Areas important for connectivity should be identified within forest plans.

> *Reconnecting fragmented habitat for fish and other aquatic species should be a high priority adaptation strategy on all national forests, given that there are more miles of road within the National Forest System than stream, resulting in at least 40,000 places where roads cross streams.*

Reconnecting fragmented habitat for fish and other aquatic species should be a high priority adaptation strategy on all national forests, given that there are more miles of road within the National Forest System (375,000) than stream (200,000), resulting in at least 40,000 places where roads cross streams.

For example, the Santa Fe National Forest has proposed the following desired condition that emphasizes the role of connectivity in facilitating species migration and genetic exchange:

> Aquatic habitats are connected and free from alterations (e.g., temperature regime changes, lack of adequate streamflow, barriers to aquatic organism passage) to allow for species migration, connectivity of fragmented populations and genetic exchange (USDA, 2017).

This desired condition could be supported by an objective to prioritize areas for restoration of connectivity and possibly standards or guidelines to constrain management actions that may impede achievement of the desired connected condition.

To improve aquatic ecosystem integrity and provide necessary habitat conditions for at-risk fish and other aquatic species, the Forest Service is embarking on a major effort to improve aquatic organism passage by removing or upgrading the thousands of culverts that fragment aquatic habitat on national forest lands. All forest plans will likely have plan components similar to this objective within the Flathead's Draft Revised Forest Plan: "Reconnect 10 to 20 miles of habitat in streams disconnected by roads or culverts where aquatic and riparian-associated species' migratory needs are limiting distribution of the species" (USDA, 2016a).

Implementation, Monitoring and Evaluation

After the plan has been finalized, projects and activities will be implemented in order to achieve the plan's desired conditions and objectives; all projects and activities must be consistent with the plan components.

The forest should begin implementing the priority climate conservation activities to fulfill the desired conditions; many of these will be resiliency-oriented strategies to restore key ecosystem characteristics and conditions for at-risk species that have been degraded by management actions and are not likely to be resilient to future climates.

The forest should begin implementing the priority climate conservation activities to fulfill the desired conditions; many of these will be resiliency-oriented strategies to restore or enhance key ecosystem characteristics and conditions for at-risk species that have been degraded by management actions and are not likely to be resilient to future climates. Priority implementation actions should be undertaken in key areas identified within the forest plan.

The forest will also implement other plan direction, including activities to fulfill other multiple-use objectives, such as timber harvest, grazing, mineral development and recreation management. Some of these activities may contribute stress to climate-threatened resources (and should have been identified and evaluated in the assessment), in which case the management constraints of the forest plan (standards and guidelines) will be employed to avoid or mitigate the stress to ecosystem characteristics and conditions supporting at-risk species. Project-level analysis will be conducted to disclose environmental effects and ensure the activity is consistent with the forest plan.

In addition, a monitoring program will evaluate the plan's effectiveness, including the efficacy of the climate conservation strategies. The monitoring program establishes monitoring questions and indicators to evaluate the effect of the plan on watershed conditions, key ecosystem characteristics, and ecological conditions for at-risk species.

Forest monitoring programs will also directly monitor changes in the condition of focal species, which will be selected to provide insight into the integrity of the ecosystem to which they belong. Forest plans should select focal species sensitive to climate impacts to evaluate whether strategies to maintain, restore or enhance ecosystem integrity are effective. For example, the Chugach National Forest designated Dolly Varden char, rainbow, and cutthroat trout as a focal species group, and will monitor changes in their distribution to evaluate climate change impacts on aquatic ecosystem integrity and adaptive capacity (USDA, 2015a). Similarly, the Flathead National Forest identified western white pine as a focal species; the five-needle pine is vulnerable to the interacting stressors of climate change, fire suppression, white pine blister rust, and mountain pine beetles (Loehman et al., 2011). Species that are known to play an important role in enhancing and maintaining ecological integrity, such as beavers, should be considered as focal species.

Focal species can be selected from the pool of at-risk species; if there is uncertainty over the relationship between an at-risk species and the conditions needed to support its persistence, the forest should consider direct monitoring of the species within the plan area, if monitoring methods are available and feasible.

At-risk species vulnerable to climate effects can be directly monitored, even if not designated as focal species. For example, the Flathead National Forest will monitor the condition of whitebark pine, a candidate for listing under the ESA.

While the rule encourages the monitoring of the ecological conditions that support at-risk species, it should be noted that at-risk species vulnerable to climate effects can be directly monitored (i.e. distribution, occupancy, or demographic rates), even if not designated as focal species. For example, the Flathead National Forest will directly monitor the condition of cold-climate adapted whitebark pine, a candidate for listing under the ESA. The forest will also evaluate the effectiveness of actions to restore whitebark pine populations, including prescribed burning and the planting of white pine blister rust-resistant seedlings; the non-native fungus, interacting with fire suppression and rising temperatures, threaten the persistence of whitebark throughout much of its range.

Forest-level monitoring programs will operate in conjunction with broader-scale monitoring strategies developed by the at the regional level; many climate change impacts will likely be most effectively monitored and evaluated at scales larger than individual national forests, and it is important that forest-level and broader-scale climate monitoring be well-coordinated.

There will be at least two primary areas of uncertainty associated with the climate conservation strategies that should be addressed and reduced through the monitoring program. First, it is likely that some of the underlying assumptions behind the climate conservation strategy, such as predicted precipitation levels or changes in disturbance regimes, do not come to pass. The monitoring program must track actual climate-driven changes within the plan area so that the plan can be adjusted if necessary. Science-based partnerships and coordination with climate researchers will be fundamental in acquiring new information. New information and advances in best available science, outside of the forest monitoring program, can also illicit changes in the forest plan. For instance, science may reveal concerning vulnerabilities to fish or wildlife populations previously thought to be secure within the planning area.

It is likely that some of the climate conservation actions assumed to improve ecosystem or wildlife population resiliency may in fact not have the desired effect, and will need to be adjusted in the forest plan.

Second, it is likely that some of the climate conservation actions assumed to improve ecosystem or wildlife population resiliency may in fact not have the desired effect, and will need to be adjusted in the forest plan. For instance, in some settings, the assumption that reductions in stand densities will create more resilient conditions to climate-driven wildfire disturbances may be contradicted by effectiveness monitoring. Or, monitoring may reveal that resiliency-building actions have unforeseen negative effects on other resources that were not considered during the development of the plan.

Given the uncertainty associated with climate change effects, as well as the high degree of uncertainty over the efficacy of climate conservation actions, a robust and well-funded adaptive monitoring program is an absolute necessity; it must not be an afterthought or abandoned, as has been the unfortunate case over the years in natural resource management (Lindenmayer and Likens, 2010). In addition, it is important to not equate uncertainty with flexibility; forest plans need to establish a range of measurable future conditions based on the best available science, as hypotheses for testing, as opposed to open-ended plans, which lack both accountability and the necessary direction for effective conservation.

Conclusion

Climate change poses an enormous risk to our forests and the fish, wildlife and biodiversity they harbor; it also threatens our communities and way of life, which are so intertwined with our national forests.

Some biologists called the Yellowstone fish kill a "perfect storm" of stressful events, but in fact what happened on the Yellowstone in the summer of 2016 is likely the "new normal."

In the summer of 2016 thousands of fish, including native mountain whitefish and iconic Yellowstone cutthroat trout, died in the waters of Montana's famed Yellowstone River, which originates in the Absaroka Range of the Bridger-Teton National Forest. The fish were killed by acute Proliferative Kidney Disease (PKC) brought on by a parasite. With summer water flows at dangerously low levels due to premature snowpack loss and stream temperatures exceeding suitable levels by as much as 20 degrees °F., the cold-water adapted fish succumbed to the extreme stress brought on by the highly contagious parasite. After closing over 180 miles of river to fishing and boating to reduce stress on the fishery, the Governor of Montana declared the situation to be an emergency; one with major implications for the fishing and outdoor recreation-based economy of the region. Some biologists called the Yellowstone fish kill a "perfect storm" of stressful events, but in fact what happened on the Yellowstone in the summer of 2016 is likely the "new normal."

That same summer Forest Service Chief Tom Tidwell gave a speech on the subject of forest restoration in the era of climate change, in which he painted the dire picture facing America's national forests:

> (O)ur forests are facing some of the greatest challenges in history. In California alone, we have 66 million dead trees due to extreme drought and epidemic insect outbreaks. Years of fire suppression and fuel buildups, along with the hot, dry conditions that come with climate change, are causing immense wildfires. These fires release enormous amounts of carbon dioxide, sterilize soils, and severely hamper carbon sequestration.

Yet the Chief concluded his speech on a positive note, reminding people that meeting the climate change challenge will take bold and ambitious action, but that the Forest Service had the tools to do so:

> In 2012, we adopted a landmark forest planning rule – the first such rule in a generation – to guide management of the 77 million hectares of national forests and grasslands. As units revise their land management plans, they evaluate climate stressors and monitor impacts on forest health.

The Forest Service, along with all of the stakeholders involved in forest planning, have the opportunity to take the necessary bold and ambitious actions that will support the persistence of forests, fish and wildlife. We hope this report contributes to that effort.

Literature Cited

ABATZOGLOU, J.T., AND A.P. WILLIAMS. 2016. Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences. 113 (42): 11770-11775.

BATLLORI, E., PARISIEN, M., PARKS, S.A., MORITZ, M.A., AND C. MILLER. 2017. Potential relocation of climatic environments suggests high rates of climate displacement within the North American protection network. Global Change Biology. doi: 10.1111/gcb.13663.

BEHNKE, R.J., AND J.R. TOMELLERI. 2002. *Trout and salmon of North America*. New York: Free Press.

BUMA, B., HENNON, P.E., HARRINGTON, C.A., POPKIN, J.R., KRAPEK, J., LAMB, M.S., OAKES, L.E., SAUNDERS, S., AND S. ZEGLEN. 2016. Emerging climate-driven disturbance processes: widespread mortality associated with snow-to-rain transitions across 10° of latitude and half the range of a climate-threatened conifer. Global Change Biology. doi: 10.1111/gcb. 13555.

CROSS, M.S., ZAVALETA, E.S., BACHELET, D, BROOKS, M.L., ENQUIST, C.A.F., FLEISHMAN, E., GRAUMLICH, L.J., GROVES, C.R., HANNAH, L. HANSEN, L., HAYWARD, G., KOOPMAN, M., LAWLER, J.J., MALCOLM, J., NORDGREN, J., PETERSEN, B., ROWLAND, E.L., SCOTT, D., SHAFER, S.L., SHAW, M.R., AND G.M. TABOR. 2012. The Adaptation for Conservation Targets (ACT) Framework: A Tool for Incorporating Climate Change into Natural Resource Management. Environmental Management. 50: 341-351.

DUBOIS, N., A. CALDAS, J. BOSHOVEN, AND A. DELACH. 2011. Integrating Climate Change Vulnerability Assessments into Adaptation Planning: A Case Study Using the NatureServe Climate Change Vulnerability Index to Inform Conservation Planning for Species in Florida [Final Report]. Defenders of Wildlife, Washington D.C.

GAINES, W. L.; PETERSON, D. W.; THOMAS, C. A., AND R. J. HARROD. 2012. Adaptations to climate change: Colville and Okanogan-Wenatchee National Forests. Gen. Tech. Rep. PNW-GTR-862. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 34 pages.

GARTNER, S., REYNOLDS, K.M., HESSBURG, P.F., HUMMEL, S., AND M. TWERY. 2008. Decision support for evaluating landscape departure and prioritizing management activities in a changing environment. Forest Ecology and Management. 256: 1666-1676.

GLICK, P., B. A. STEIN, AND N. A. EDELSON (EDS.). 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, D.C.

HABER, J., NELSON, P., AMENT, R., COSTELLO, G., FRANCIS, W., AND M. SALVO. 2015. Planning for Connectivity [Final Report]. Defenders of Wildlife, Center for Large Landscape Conservation, Wildlands Network, Yellowstone to Yukon Initiative. Washington, D.C.

HABER, J., NELSON, P., MCCAIN, L., AND M. SALVO. 2015. Planning for Diversity [Final Report]. Defenders of Wildlife, Washington, D.C.

HALOFSKY, J.E., PETERSON, D.L., DANTE-WOOD, S.K., HOANG, L., HO, J.J., JOYCE, L.A. (EDS). 2017. Climate change vulnerability and adaptation in the Northern Rocky Mountains. Gen. Tech. Rep. RMRS-GTR-xxx. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. xxx pages. (in press).

HAUFLER, J.B., MEHL. C.A., AND S. YEATS. 2010. Climate change: anticipated effects on ecosystem services and potential actions by the Alaska Region, U.S. Forest Service. Ecosystem Management Research Institute, Seeley Lake, Montana, USA.

HELLER, N. E. AND E.S. ZAVALETA. 2009. Biodiversity management in the face of climate change: a review of 22 years of recommendations. Biological Conservation. 142(1): 14-32.

HENNON, P.E., MCKENZIE, C.M., D'AMORE, D.V., WITTWER, D.T., MULVEY, R.L., LAMB, M.S., BILES, F.E., AND R.C. CRONN. 2016. A climate adaptation strategy for conservation and management of yellow-cedar in Alaska. Gen. Tech. Rep. PNW-GTR-917. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 382 pages.

JOYCE, L.A., BLATE, G.M., MCNULTY, S.G., MILLAR, C.I., MOSTER, S., NEILSON, R.P., AND D.L. PETERSON. 2009. Managing for Multiple Resources under Climate Change. Environmental Management. 44(6): 1022-1032.

JOYCE, L.A., RUNNING, S.W., BRESHEARS, D.D., DALE, V.H., MALMSHEIMER, R.W., SAMPSON, R.N., SOHNGEN, B., AND C.W. WOODALL. 2014. Ch. 7: Forests. *Climate Change Impacts in the United States: The Third National Climate Assessment*, Melillo, J.M., Richmond, Terese (T.C.), and G.W. Yohe (Eds). U.S. Global Change Research Program. 175-194. doi:10.7930/J0Z60KZC.

LARSEN, C. F., BURGESS, E., ARENDT, A.A., O'NEEL, S., JOHNSON. A. J., AND C. KIENHOLZ. 2015. Surface melt dominates Alaska glacier mass balance. Geophysical Research Letters. 42 (14): 5902-5908.

LINDENMAYER, D.B., AND J.F. FRANKLIN. 2002. *Conserving Forest Biodiversity: a comprehensive multiscaled approach*. Washington D.C. Island Press.

LINDENMAYER D.B., AND G.E. LIKENS. The science and application of ecological monitoring. Biological Conservation. 143 (2010): 1317-1328.

LITTELL J.S., PETERSON, D.L., MILLAR, C.I., AND K.A. O'HALLORAN. 2012. U.S. National Forests adapt to climate change through Science-Management partnerships. Climatic Change. 110(1): 269-296.

LOEHMAN, R.A., CLARK, J.A., AND R.E. KEANE. 2011. Modeling effects of climate change and fire management on western white pine (Pinus monticola) in the northern Rocky Mountains, USA. Forests. 2: 832-860.

MARGULES, C.R., AND R.L. PRESSEY. 2000. Systematic conservation planning. Nature. 405: 243-253.

MCCARTHY, J.J., CANZIANI, O.F., AND N.A. LEARY (EDS). 2001. Climate Change 2001: Third assessment report of the Intergovernmental Panel on Climate Change. Working Group II: Impacts, adaptation and vulnerability. Cambridge University Press. 976 pages.

MCKENZIE, D., GEDALOF, Z.E., PETERSON, D.L., AND P. MOTE. 2004. Climatic change, wildfire, and conservation. Conservation Biology. 18: 890–902.

NELSON, R., CROSS, M., HANSEN, L., AND G. TABOR. 2016. A three-step decision support framework for climate adaptation: Selecting climate-informed conservation goals and strategies for native salmonids in the northern U.S. Rockies. Wildlife Conservation Society, Crown Conservation Initiative, EcoAdapt, Center for Large Landscape Conservation. Bozeman, MT, USA.

NOON, B. R. 2003. An optimal mix of coarse- and fine-filter elements to conserve biological diversity (oral abstract) in "Innovations in Species Conservation: Integrative Approaches to Address Rarity and Risk" Symposium; April 28-30, 2003; Portland, Oregon.

PETERSON, D.L., MILLAR, C.I., JOYCE, L.A., FURNISS, M.J., HALOFSKY, J.E., NEILSON, R.P., AND T.L. MORELLI. 2011. Responding to climate change in national forests: a guidebook for developing adaptation options. Gen. Tech. Rep. PNW-GTR-855. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 109 pages.

SCHNEIDER, S. H., S. SEMENOV, A. PATWARDHAN, I. BURTON, C. H. D. MAGADZA, M. OPPENHEIMER, A. B. PITTOCK, A. RAHMAN, J. B. SMITH, A. SUAREZ, AND F. YAMIN. 2007. Assessing key vulnerabilities and the risk from climate change. Pages 779-810 *in* Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson (Eds.). Cambridge University Press, Cambridge, UK.

STEIN, B.A., GLICK, P., EDELSON, N., AND A. STAUDT (EDS.). 2014. Climate-Smart Conservation: Putting Adaptation Principles into Practice. National Wildlife Federation, Washington, D.C.

THOMAS, C.D., CAMERON, A., GREEN, R.E., BAKKENES, M., BEAUMONT, L.J., COLLINGHAM, Y.C. ERASMUS, B.F.N., DE SIQUEIRA, M.F., GRAINGER, A., HANNAH, L., HUGHES, L., HUNTLEY, B.F., VAN JAARSVELD, A.S., MIDGLEY, G.F., MILES, L., ORTEGA-HUERTA, M.A., PETERSON, A.T., PHILLIPS, O.L., AND S.E. WILLIAMS. 2004. Extinction risk from climate change. Nature. 427: 45–148.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2011. Watershed condition framework. 34 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2012. The Okanogan-Wenatchee National Forest Restoration Strategy: adaptive ecosystem management to restore landscape resiliency. 118 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2015a. Chugach National Forest Proposed Revised Management Plan. 65 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2015b. The Rising Cost of Wildfire Operations: Effects on the Forest Service's Non-Fire Work. 17 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2015c. USDA Forest Service Strategic Plan: FY 2015 – 2020. 53 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2016a. Draft Revised Forest Plan. Flathead National Forest. 186 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2016b. Draft Revised Land Management Plan for the Sequoia National Forest. 171 pages.

US DEPARTMENT OF AGRICULTURE FOREST SERVICE. 2017. Initial Forest Plan Components. Santa Fe National Forest. 78 pages.

US DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE. 2013. Endangered and Threatened Wildlfie and Plants; Threatened Status for the Distinct Population Segment of the North American Wolverine Occurring in the Contiguous United States. Proposed Rule. Federal Register Vol. 78, No. 23: 7864-7890.

US DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

VOSE, J.M., PETERSON, D.L., AND T. PATEL-WEYNAND (EDS). 2012. Effects of climatic variability and change on forest ecosystems: a comprehensive science synthesis for the U.S. forest sector. Gen. Tech. Rep. PNW-GTR-870. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 265 pages.

WILLIAMS, S. E., L. P. SHOO, J. L. ISAAC, A. A. HOFFMANN, AND G. LANGHAM. 2008. Towards an integrated framework for assessing the vulnerability of species to climate change. PLoS Biology 6:2621-2626.