



April 1, 2019

Objection Reviewing Officer
USDA Forest Service, Northern Region
26 Fort Missoula Road
Missoula, MT 59804

Sent via Email: appeals-northern.regional-office@fs.fed.us

Re: Bog Creek Road Project Objection

To the Objection Reviewing Officer,

Pursuant to 36 C.F.R. Part 218, the Center for Biological Diversity, WildEarth Guardians, Selkirk Conservation Alliance, Sierra Club, Predator Defense, Western Watersheds Project, The Lands Council, and Northeast Oregon Ecosystems (collectively, “Objectors”) file this Objection to the 2019 Final Environmental Impact Statement (“FEIS”) and the Draft Record of Decision (“DROD”) issued by the Idaho Panhandle National Forest and the U.S. Customs and Border

Protection (“Agencies”) for the Bog Creek Road Project (“project”).¹ All of the Objectors filed scoping comments on May 27, 2016 and comments on the Draft EIS on July 16, 2018. Objectors have fully participated in the agency review of the project. As such they are proper Objectors under Part 218. Pursuant to 36 C.F.R. 218.8, the Objectors hereby state that the following content of this Objection demonstrates the connections between the comments noted above for all issues raised herein, unless the issue or statement in the Draft ROD or FEIS arose or was made apparent after the opportunity for comment on the DEIS closed.

As required by 36 C.F.R. § 218.8(d), we identify the Center for Biological Diversity is the lead objector. The lead objector’s name, address, telephone number and email address are as follows:

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However, all Objectors listed above are represented herein and all agency correspondence regarding this Objection should be directed to the Objectors’ contacts as listed below.

I. The Agencies Have Failed to Assess, Consider, and Respond to Comments on the Bog Creek Road Project Draft Environmental Impact Statement

On July 16, 2018, Objectors submitted timely, substantive and specific comments on the Bog Creek Road Project DEIS per the announcement of the 45-day public comment period in the June 1, 2018 issue of the Federal Register.² Notably, on July 20, 2018 the agencies reopened the comment period through July 31, 2018 to allow for further public input. 83 FR 34601. In reviewing Appendix C in the FEIS, “[r]esponse to Comments on the Draft Environmental Impact Statement, and specifically Table C-2, “Letter Identification Number and Submitter Information,” our organizations are absent from the list and the agencies entirely failed to respond to our comments. The Idaho Panhandle National Forest website contains a project page listing each DEIS comment referenced in Appendix C, which also fails to include our DEIS comments.³ Each is a clear violation of applicable regulations that direct agencies to assess, consider and respond to comments, and attach those comments to the final statement. 40 C.F.R. § 1503.4. The Forest Service directives provide further direction for regulatory compliance, and state:

¹ The FEIS and Draft ROD are available at

<https://www.fs.usda.gov/project/?project=41296&exp=overview> (last visited Mar. 21, 2019).

² See 83 Fed. Reg. 25,472; Exhibit 1 contains a record of Objectors’ full DEIS comments with attachments; a record of our comment submission; and CPB’s acknowledgment that they were received.

³ See Idaho Panhandle National Forest, Bog Creek Road Project, Supporting, at <https://www.fs.usda.gov/project/?project=41296> (last visited Mar. 21, 2019).

When the responsible official determines that a summary of responses is appropriate, the summary should reflect accurately all substantive comments received on the draft EIS. Comments that are pertinent to the same subject may be aggregated by categories.⁴

The FEIS Appendix C serves as summary of responses and the omission of our comments demonstrates a failure to comply with the applicable regulations, and therefore equates to a clear violation of NEPA. This violation goes beyond mere technicality, as our comments raised specific concerns and recommended actions to ensure compliance with applicable laws and regulations. For example:

- We urged the Forest Service to fully analyze the proposed road activities in the context of climate change, explaining that a warming climate alters species distribution and forces wildlife migration, making landscape connectivity even more critical to species survival and ecosystem resilience. Climate change is also expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes.
- We explained that science shows that roads and trails play a role in affecting wildfire occurrence, and in taking a hard look at this proposal, the Agencies must consider how opening Bog Creek Road and Blue Joe Creek Road to year-round access is likely to increase the risk of wildfire occurrence in this area.
- We explained that because what is happening on the ground—as opposed to designations on paper—is what impacts wildlife and wildlife habitat, we believe the Agencies should be using the 2016 monitoring results as the appropriate baseline to assess the impacts of the proposed alternatives in the DEIS. Failure to use an appropriate baseline constitutes a NEPA violation.
- Our DEIS comments suggest the Agencies consider a proposed reasonable alternative to close roads designated for closure BEFORE moving forward with construction/reconstruction of Bog Creek/Blue Joe Creek, yet it is not listed amongst the alternatives proposed but eliminated from detail study (which includes alternatives proposed during the scoping and DEIS comment periods).⁵

These are just a few examples as to how the Agencies' failure to respond to Objectors' comments have harmed Objectors' ability to effectively participate in the project's public

⁴ See United States Forest Service, FSH 1909.15, Chapter 25.1 (Exhibit 2).

⁵ FEIS at 39-41, Table 2.3.1.

process under NEPA. The Agencies' failure to appropriately assess, consider and respond to our comments is a clear violation of NEPA.

II. The Agencies Have Failed to Reasonably Define the Purpose and Need of the Project

In our scoping comments (p. 5-6), we expressed concerns about the Agencies defining the purpose and need so narrowly so that the Agencies could not analyze a reasonable range of alternatives to meet that purpose and need. NEPA planning begins with an identification of the purpose and need for a project. NEPA's implementing regulations provide that an environmental document should "briefly specify the underlying purpose and need to which the agency is responding in proposing the alternative including the proposed action." 40 C.F.R. § 1502.13. The purpose and need will be judged under a reasonableness standard, and "[a]gencies are afforded considerable, although not unlimited, discretion to define the purpose and need of a project." Northwest Ecosystem Alliance v. Rey, 380 F. Supp. 2d 1175, 1185 (W.D. Wa. 2005) (citation omitted). However, "deference does not mean dormancy, and the rule of reason does not give agencies license to fulfill their own prophecies, whatever the parochial impulses that drive them." Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991), cert denied, 502 U.S. 994, 112 S. Ct. 616 (1991).

The Agencies conflate two completely different objectives into a single purpose and need statement to justify its preferred alternative of opening Bog Creek and Blue Joe Creek Roads. The Forest Service has a duty to comply with the Access Amendment standards of the Revised Land Management Plan, Idaho Panhandle National Forest for the Blue-Grass Bear Management Unit by 2019 regardless of what other activities it undertakes within the forest.⁶ Thus, the Forest Service cannot piggyback CBP's proposal to open roads to allow border access to this Forest Service mandate. This roundabout way to justify CBP's proposal is arbitrary and capricious, and does not meet the standard of reasonableness required by NEPA.

Moreover, "an agency may not define the objectives of its actions in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action, and the EIS would become a foreordained formality." Id. (citation omitted); see also City of New York v. United States Dep't of Transp., 715 F.2d 732, 743 (2d Cir. 1983) ("[A]n agency will not be permitted to narrow the objective of its action artificially and thereby circumvent the requirement that relevant alternatives be considered."). Furthermore, an agency must exercise independent judgment in defining the purpose and need of a project and cannot rely exclusively on the statements and opinions of the applicant. See Simmons v. United States Army Corps of Engrs., 120 F.3d 664,

⁶ USDA, Forest Service, Northern Region, Idaho Panhandle National Forests Land Management Plan (2015 Revision).

669 (7th Cir. 1997) (stating that “an agency cannot restrict its analysis to those alternative means by which a particular applicant can reach his goals”) (internal citation and quotations omitted).

Between the DEIS and the FEIS stage of NEPA analysis, the Agencies altered the purpose and need statement of the project to include additional criteria to the effect that only the Agencies’ preferred alternative meets the purpose and need of the project. Under the Need section of the FEIS, the Agencies state that “proposed land management uses—which include the transportation system—should be compatible with the needs of the grizzly bear as defined in the Recovery Plan (USFWS 1993a).” FEIS at 7. While we appreciate the Agencies taking the needs of grizzly bears further into account in the final analysis, altering the purpose and need statement at this late stage of the game has altered the entire analysis of the project proposal. With this added statement of need, the Agencies now conclude that Alternative 3 Modified—the Agencies’ preferred alternative—is the only alternative that meets the purpose and need of the project, because it is the only alternative that meets the need to remain consistent with the Grizzly Bear Recovery Plan.⁷

But an agency may not “define a project so narrowly that it forecloses a reasonable consideration of alternatives.” Fuel Safe Washington v. Fed. Energy Regulatory Comm’n, 389 F.3d 1313, 1324 (10th Cir. 2004) (quoting Davis v. Mineta, 302 F.3d 1104, 1119 (10th Cir. 2002)); Citizens’ Comm. To Save Our Canyons v. U.S. Forest Serv., 297 F.3d 1012, 1030 (10th Cir. 2002). “Because the purpose and need defines the range of alternatives, an agency ‘cannot define its objectives in unreasonably narrow terms.’” Sierra Club v. U.S. Dep’t of Transp., 310 F.Supp.2d 1168, 1192 (D. Nev. 2004) (citing City of Carmel-By-The-Sea v. U.S. Dep’t of Transp., 123 F.3d 1142, 1155 (9th Cir. 1997)). “While it is true that defendants could reject alternatives that did not meet the purpose and need of the project, they could not define the project so narrowly that it foreclosed a reasonable consideration of alternatives.” Davis, 302 F.3d at 1119.

By altering the purpose and need of the project, the Agencies have done exactly what NEPA and NEPA case law prohibits—defining the purpose so narrowly so that only one alternative meets the purpose and need of the project. This issue also demonstrates why it is so important to appropriately define the purpose and need of the project from the outset of NEPA analysis. By failing to do so, the Agencies violated NEPA. To rectify this issue, the Agencies must prepare a supplemental EIS which analyzes the newly identified purpose and need of the project and analyzes more than one alternative that could meet the purpose and need as stated. This would allow the public to suggest alternatives that the Agencies might analyze that meets the newly identified purpose and need of the project, in addition to curing violations of NEPA by failing to analyze a reasonable range of alternatives (as described more in detail below).

⁷ FEIS at 42, Table 2.4.

In our scoping comments (p.6), we stated the Agencies must discuss the need for construction and use of Bog Creek Road in detail, including security threats along the Northern Border in the planning area, why currently existing access to the Northern Border is insufficient, and how often CBP foresees using the road. The DEIS and FEIS failed to adequately respond or demonstrate how increasing the availability of motorized access will result in improved border security. The FEIS explained, “[a]lthough firearms, bulk cash, human smuggling, and illegal immigration are some of the cross-border threats in this area, the most persistent threat is the bi-directional flow of illicit drugs across the international boundary.”⁸ Given the threat to border security stems from the ability of people to cross the border, the logical approach would be to decrease access opportunities by increasing the presence of natural barriers. The Agencies fail to demonstrate how increasing access through opening Bog Creek and Blue Joe Creek roads will address threats to border security, which may actually make it easier for people to cross the border. The Agencies suggest increased patrols and access will enable the CBP to perform specific job duties resulting in a more secure border, but the FEIS provides no discussion or supporting evidence to support this assertion. Under CBP’s reasoning, the agency would need access to every square inch of the border, discounting the effectiveness of current or increased natural barriers such as those found in forested areas and on impassable roads. President Trump recently acknowledged the effectiveness of natural barriers in deterring illegal border crossings, explaining, “[w]e have mountains that are far better than a wall. We have violent rivers that nobody goes near. ...You don’t need a wall where you have a natural barrier that’s far greater than any wall you could build, O.K.?”⁹ Similarly, an overgrown, impassable road provides an effective natural barrier that can prevent illegal crossings.

The Agencies have so narrowly defined this project’s purpose and need so as to exclude any alternative that maintains or increases the effectiveness of natural barriers to provide border security on Bog Creek Road. Opening Bog Creek Road is just as likely to result in a less secure border, regardless of the CBP’s increased ability to utilize the road. The FEIS failed to address this point or explore an alternative that fully analyzes the effectiveness of using natural barriers in the project area to secure the border.

III. CBP’s Vegetation Removal Work on Bog Creek Road Was Performed Illegally and Must Be Reclaimed

As stated in our DEIS comments (p. 2-5), CBP’s vegetation removal work on Bog Creek Road in 2016 violated NEPA and the Endangered Species Act (“ESA”) and must be reclaimed.

⁸ *Id.* at 290.

⁹ See Ron Nixon and Linda Qiu, The New York Times, “Trump’s Evolving Words on the Wall,” at <https://www.nytimes.com/2018/01/18/us/politics/trump-border-wall-immigration.html> (last visited Mar. 22, 2019).

A. The Agencies Violated NEPA by Conducting Work on Bog Creek Road Before Completing a NEPA Analysis

The Agencies held two scoping periods to evaluate the proposal to repair and maintain Bog Creek Road: one in 2013 and one in 2016.¹⁰ In response to scoping, the Agencies received several comment letters, including from environmental groups opposing the project. Without completing the required analysis under NEPA, CBP went forward and conducted vegetation-clearing activities on the eastern portion of the Bog Creek Road corridor in 2016.¹¹ According to the FEIS, “[v]egetation removal was performed on an approximately 6-foot-wide x 1-mile-long corridor on the east end of the roadway.”¹² The Agencies admit that no NEPA analysis was performed before the vegetation removal on Bog Creek Road, instead suggesting that no NEPA analysis was necessary because it was “done for safety purposes to facilitate a non-motorized response to an exigent circumstance.”¹³ This explanation appears intentionally vague and provides no information on the safety issues rectified or the “exigent circumstance”. Most importantly, the agencies do not address CBP’s failure to comply with NEPA.

While NEPA regulations acknowledge that there may be instances where “emergency circumstances” make it difficult to timely comply with NEPA, those regulations do not subvert NEPA’s directive that all agencies comply with NEPA “to the fullest extent possible.” 40 C.F.R. § 1506.11. Thus, when an emergency circumstance makes it necessary to take action without first providing an environmental analysis, “the Federal agency taking the action should consult with the [Environmental Quality] Council about alternative arrangements,” which will be “limit[ed] . . . to actions necessary to control the immediate impacts of the emergency.” *Id.* In no way does CBP describe an emergency that made it impossible for the agency to comply with NEPA, nor does CBP describe making alternative arrangements with the Environmental Quality Council. Rather, it appears CBP went forward with vegetation removal on Bog Creek Road with complete disregard to NEPA’s mandates.

NEPA’s twin objectives are (1) to ensure that agencies take a “hard look” at every significant aspect of the environmental impact of a proposed action, and (2) to guarantee that relevant information is available to the public to promote well-informed public participation. “NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.” 40 C.F.R. § 1500.1(b) (emphasis added). An agency cannot take any action or make any commitment of resources before making its final decision if that action would have an adverse environmental impact or prejudice or limit the choice of reasonable alternatives. *Id.* §§ 1502.2(f), 1506.1(a). Thus,

¹⁰ FEIS, Executive Summary at xvii .

¹¹ *Id.* at 2.

¹² *Id.*

¹³ *Id.*, App C at 42 (Resp. to Comment 64-131).

NEPA requires that an agency take a “hard look” at the impacts of its actions before the point of commitment so that it does not deprive itself of the ability “to foster excellent action.” See id. § 1500.1(c). Thus, agencies must commence the NEPA process “at the earliest possible time to insure that planning and decisions reflect environmental values.” Id. § 1501.2. In this way, NEPA ensures that the agency will not act on incomplete information only to regret its decision after it is too late to correct.

CBP’s work on the Bog Creek Road is a clear violation of NEPA. Before completing this work, CBP failed to conduct any NEPA. CBP did not prepare an environmental impact statement, an environmental assessment, a finding of no significant impact, or a categorical exclusion for the road work. CBP failed to take the requisite “hard look” at the environmental impacts of its decision, including by properly involving the public and by studying the direct, indirect, and cumulative impacts of its actions, and alternatives that might be less environmentally destructive.

We request that the Agencies complete a supplemental environmental impact statement for the work already completed on Bog Creek Road. Agencies must prepare a supplement to the FEIS when the agency makes substantial changes in the proposed action that are relevant to environmental concerns or when there are significant new circumstances or information relevant to environmental concerns bearing on the proposed action or its impacts. Id. § 1502.9(c)(1). CBP must prepare a supplemental environmental impact statement on the work completed on Bog Creek Road, which reflects a change in the proposed action and significant new information.

B. The Agencies Violated the ESA by Conducting Work on Bog Creek Road Before Consulting with FWS

CBP’s work on the Bog Creek Road is also a violation of the ESA, because CBP failed to consult with the Fish and Wildlife Service on the impacts of its actions on grizzly bears, woodland caribou, Canada lynx, and bull trout – all of which are federally listed species. Section 7 of the ESA requires each federal agency, in consultation with FWS, to insure that any proposed action is not likely to jeopardize the continued existence of a threatened or endangered species, or result in the destruction or adverse modification of its critical habitat. 16 U.S.C. § 1536(a)(2). To facilitate compliance with Section 7, the agency must first inquire with FWS to determine whether any listed or proposed species may be present in the area of the proposed action. Id. § 1536(c)(1). When a listed or proposed species may be present in the action area, the agency must prepare a “biological assessment” to determine whether the species or their critical habitat may be affected by the action. Id. If the agency determines that the proposed action may affect any listed species or critical habitat, it must engage in formal consultation with FWS. 50 C.F.R. § 402.14.

During consultation, FWS must review all relevant information, evaluate the current status of the species or critical habitat, and evaluate the effects and cumulative effects of the proposed action on the listed species and their critical habitat. 16 U.S.C. § 1536(b)(3)(A); 50 C.F.R. § 402.14(g)(1)–(3). For the purposes of the ESA, “[e]ffects of the action” refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline.” 50 C.F.R. § 402.02. Cumulative effects “are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.” *Id.* Throughout its analysis, the consulting agency must utilize the “best scientific and commercial data available.” 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(d).

The Agencies note that they initiated consultation with FWS under Section 7(a)(2) of the ESA on April 3, 2013.¹⁴ However, that consultation clearly did not encompass this premature work, because as the Agencies assert, “[t]he prior brush trimming is outside the scope of this National Environmental Policy Act (NEPA) analysis.”¹⁵ Nor does the Biological Assessment, signed March 4, 2019, contemplate and analyze impacts from vegetation removal on Bog Creek Road in 2016.¹⁶ By failing to consult before completing work on the Bog Creek Road, the Agencies have violated the ESA’s consultation requirements.

Section 9 requires that agencies insure that the proposed action does not result in the “take” of any listed species. 16 U.S.C. § 1538(a)(1)(B). “Taking” under the ESA “means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” *Id.* § 1532(19). The “take” prohibited by Section 9 need not be the result of purposeful action. *Nat’l Wildlife Fed. v. Burlington Northern Railroad*, 23 F.3d 1508, 1509 (9th Cir. 1994) (trains accidentally hitting and thereby taking grizzly bears constitutes an ESA violation). It is highly likely that CBP’s road work harmed and harassed listed species, including grizzly bears, woodland caribou, Canada lynx, and bull trout.

For these reasons, CBP’s road work violates both Section 7 and Section 9 of the ESA.

C. The Agencies Must Reclaim Work Done on Bog Creek Road

In order to avoid litigation on CBP’s illegal road work, we urge the Agencies to reclaim the work done on Bog Creek Road and return the road to its pre-project condition. This may include the placing of boulders, seeding, and/or shrub planting to prevent motorized equipment from using

¹⁴ *Id.* at 339.

¹⁵ *Id.*, App. C at 42 (Resp. to Comment 64-131).

¹⁶ SWCA Environmental Consultants and Idaho Panhandle National Forests, Bog Creek Road Project Biological Assessment (March 2019) (hereinafter, “Biological Assessment”).

the old existing route. The Agencies must provide a written agreement to Objectors of their intent to reclaim the road. Furthermore, the Agencies must agree in writing to do no more repair work, including but not limited to vegetation clearing, on the Bog Creek Road or the Blue Joe Creek Road until NEPA analysis and ESA consultation is complete. This includes a supplemental NEPA analysis, required to rectify various issues discussed throughout this objection, including the Agencies' failure to respond to Objectors' comments on the DEIS. If no action is taken, Objectors may initiate a lawsuit to seek judicial remedies.

IV. The Agencies Have Failed to Ensure Compliance with the National Forest Management Act

The Agencies must comply with National Forest Management Act ("NFMA") and its implementing regulations. NFMA requires the Forest Service to ensure that site-specific management projects are consistent with the applicable forest plan. 16 U.S.C. § 1604(i). Thus, the Forest Service must ensure that all aspects of the proposed action comply with the Idaho Panhandle National Forests Land Management Plan.¹⁷

A. The Agencies Failed to Use an Appropriate Baseline to Demonstrate Compliance with Access Amendment Standards

The Forest Service must ensure the project complies with all forest wide standards and guidelines, including the Grizzly Bear Access Amendment, which adopted the following standards for the Blue-Grass BMU:

- Open motorized route density (OMRD) of greater than 1 mile per square mile on no more than 33 percent of the BMU;
- Total motorized route density (TMRD) of greater than 2 miles per square mile on no more than 26 percent of the BMU; and Grizzly bear core area habitat comprising at least 55 percent of the BMU.¹⁸

Our DEIS comments (p. 5-6) urged the Forest Service to utilize the 2016 monitoring data in the FEIS to serve as a baseline for the No Action Alternative, which would have provided a more accurate comparison with each action alternative. We explained:

According to Table 1.2.1 in the DEIS, in 2016 the OMRD in the Blue-Grass MMU was 30 percent, the TMRD was 29 percent, and the grizzly bear core area habitat was 48 percent.¹⁹ However, the Agencies rely on lower numbers represented in Table 2.2.1,

¹⁷ USDA, Forest Service, Northern Region, Idaho Panhandle National Forests Land Management Plan (2015 Revision).

¹⁸ FEIS at 3.

¹⁹ DEIS at 5, Table 1.2.1.

which shows OMRD at 14.87 percent, TMRD at 28.95 percent, and grizzly bear core habitat at 48.25 percent.²⁰ While the difference in the tables is not entirely clear, the DEIS asserts that Table 2.2.1 “reflects route designations . . . , not monitoring results from prior years.”²¹ Moreover, the DEIS explains that OMRD is not static, but rather is modeled based on the open motorized route density for a specific year and changes from year to year.²² Over the past ten years, OMRD in the Blue-Grass BMU has ranged from a low of 22.76 percent to a high of 34.65 percent, with the high obviously being above that permitted under the Access Amendment standard.²³ This is largely because “[s]ometimes motorized administrative use exceeds the trip limit restrictions for individual road segments.”²⁴

In any event, the Agencies cannot ignore the monitoring results from 2016, which is a true reflection of what is happening on the ground. Furthermore, the Agencies fail to explain the drastic difference between the 2016 monitoring results and the current designations. The large difference between the 2016 monitoring results and route designations, however, implies that either the public is unaware of or is ignoring closure designations, or that closure designations are insufficiently marked and not being enforced. Under either scenario, the Agencies must adequately explain the difference between the 2016 monitoring results and the current designations and explain why it is appropriate to ignore the 2016 monitoring results while relying instead on the current designations.

Rather than appropriately respond to our comments, the FEIS includes nearly identical language and carries forward the same flawed methodology in its baseline for the No Action Alternative and thus its comparison with each action alternative. “Table 1.2.1 provides the current status (end of 2017) of the Blue-Grass BMU Access Amendment standards for route density and core area habitat from the annual monitoring report (Forest Service 2018).”²⁵ Looking at the table, OMRD dropped to 28 percent from the 30 percent found in 2016, but the TMRD and core grizzly bear habitat remained nearly the same at 29 percent and 48 percent respectively.²⁶ In comparing alternatives, Table 2.2.1 relies on low and unrealistic designated use values rather than incorporate past monitoring results.²⁷ Table 3.1.3 illustrates our point. It displays OMRD designated and actual motorized road use for the past ten years by each alternative, which shows actual use ranges from 22.8 percent to 34.7 percent with a ten-year average of 29.7 percent; the

²⁰ Id. at 16, Table 2.2.1.

²¹ Id.

²² Id. at 73.

²³ Id. at 74.

²⁴ Id.

²⁵ FEIS at 3.

²⁶ Id. at 5, Table 1.2.1.

²⁷ Id. at 16, Table 2.2.1.

designated OMRD is 14.9 percent.²⁸ In other words, in the past ten years, actual road use never met the minimum designated use. Even at the lowest year (22.8 percent), the actual use was 7.9 percent above the designated use.²⁹ During the highest year, the actual use was 19.8 percent above the designated use.³⁰ Overall the ten-year average was 14.8 percent above the designated use.

Looking at the 2016 and 2017 monitoring results, we calculated actual use to be higher by 15.1 percent and 13.1 percent respectively compared to the OMRD of 14.9 percent under the No Action alternative.³¹ Yet, the Forest Service arbitrarily asserts that raising the OMRD designated use in the preferred alternative to 23.3 percent will not result in use levels exceeding the maximum Access Amendment OMRD standard of 33 percent.³² We strongly disagree, as it is more likely the true OMRD value will be above the designated use and closely follow past levels of actual use. In other words, it is reasonable to expect actual motorized use will follow similar trends in the past where actual OMRD was far above the designated OMRD.³³

Further, it is likely that raising the designated OMRD, as the Agencies propose under the preferred alternative, will result in higher actual OMRD than even what has been documented in previous monitoring reports. Current average actual use is 29.7 percent (or 14.8 percent higher than the current designated OMRD of 14.9 percent).³⁴ Under the preferred alternative, the Agencies would raise the OMRD to 23.3 percent.³⁵ If future motorized use is also 14.8 percent above the proposed designated OMRD, then the actual OMRD would be 38.1 percent (i.e., a violation of the 33 percent OMRD). Such an outcome is entirely plausible for two main reasons.

First, motorized use of restricted roads has exceeded 57 trips per year, and these levels of use will continue under the preferred alternative.³⁶ Second, the Agencies justify the preferred alternative by relying heavily on closing impassable roads. Table 2.2.4 lists each road proposed for closure to meet forest plan standards with 20.25 miles out of 24.7 proposed for closure already inaccessible to motor vehicles.³⁷ Essentially, under the preferred alternative the

²⁸ Id. at 70, Table 3.1.3.

²⁹ Id.

³⁰ Id.

³¹ Subtracting the designated standard OMRD of 14.9 percent from the 2016 OMRD status of 30 percent (DEIS at 5, Table 1.2.1) results in 15.1 percent greater OMRD in 2016 than the standard. Similarly, subtracting the designated standard OMRD of 14.9 percent from the 2017 OMRD status (FEIS at 5, Table 1.2.1) results in 13.1 percent greater OMRD in 2017 than the standard.

³² FEIS at 89, 125.

³³ Id. at 70, Table 3.1.3 (showing actual OMRD ranged between 22.8 percent and 34.7 percent with the average use at 29.7 percent).

³⁴ Id.

³⁵ Id.

³⁶ Id. (the table lists actual use as “moderate” under Alternative 3 for several roads defined as “[d]oes not meet seasonal closure for Access Amendment standards (more than 57 motorized trips per bear year; administrative use only.)”).

³⁷ Id. at 26, Table 2.2.4.

Agencies will only close 4.45 miles currently open to motorized use, suggesting this will be sufficient to meet OMRD standards.³⁸ We disagree. Even if the Agencies successfully preclude future motorized use on these 4.45 miles (an unlikely outcome if those roads are not adequately treated), monitoring data demonstrates the remaining roads in the Blue-Grass BMU will continue to experience use exceeding OMRD standards regardless of their designated status. In other words, closing roads already inaccessible to motorized use will fail to meet the Access Amendment standards.

Had the Forest Service appropriately responded to our comments, perhaps the FEIS would have utilized past monitoring results to better serve as a baseline to more accurately compare each alternative. By relying on only designated, instead of actual use, the FEIS fails to appropriately analyze each alternative, or even meet the purpose and need to comply with IPNF Forest Plan standards for motorized access in grizzly bear habitat in the Blue-Grass BMU. As it stands, the FEIS fails to reasonably analyze each alternative and implementing the preferred alternative will result in a violation of NFMA.

B. The Agencies Failed to Demonstrate Compliance with the Grizzly Core Area Habitat Standard

As stated in our DEIS comments (p. 6-7), the Agencies failed to demonstrate compliance with the grizzly core area habitat standard of the Forest Plan's Access Amendment. The Access Amendment of the Idaho Panhandle National Forest Land Management Plan provides that for the Blue-Grass BMU, grizzly bear core area habitat must comprise at least 55 percent of the BMU.³⁹ Under the preferred alternative, the Agencies assert that grizzly core area habitat would comprise 55.8 percent of the BMU, thus meeting the grizzly core area habitat standard.⁴⁰ However, the Agencies note in the FEIS that the areas surrounding high-use trails are buffers that are removed from core area habitat because high-use trails have the potential to disturb and displace bears.⁴¹ "High-use" trails are trails that receive an average of more than 20 parties per week.⁴² The Blue-Grass BMU has two popular non-motorized trails that are currently being monitored to ascertain whether they should be considered high-use trails: the Upper Priest River (Trail #308) and American Falls (Trail #28).⁴³ If the Forest Service determines that these trails meet the definition of high-use trails, the buffered area surrounding these trails would be removed from habitat designated as core area grizzly bear habitat. This would reduce core area

³⁸ Id.

³⁹ USDA, Forest Service, Northern Region, Idaho Panhandle National Forests Land Management Plan (2015 Revision), at App. B, 152, Table 25.

⁴⁰ FEIS at 26, Table 2.2.4.

⁴¹ Id. at 90.

⁴² Id.

⁴³ Id. The FEIS states that monitoring has demonstrated that these trails see approximately 16 parties per week, but there is no date or year provided for that "monitoring," and thus it is not clear if it is even current.

within the Blue-Grass BMU and will bring the grizzly bear core area habitat comprising the BMU below 55 percent. Thus, the Forest Service would not be meeting this Access Amendment standard.⁴⁴

White et al. (2014) finds that participation in hiking is growing rapidly, and number of participants in hiking is projected to rise approximately 30 percent by 2030.⁴⁵ Moreover, White et al. (2014) projects that total days of hiking will increase by more than 33 percent.⁴⁶ The Forest Service has acknowledged this research and is aware that hiking participation across the nation is on the rise. Thus, the potential of the Upper Priest River trail and the American Falls trail to become high-use trails impacting the amount of grizzly core area habitat in the Blue-Grass BMU is a reasonably foreseeable action that must be accounted for in the current project proposal.

The Agencies admit that these trails are currently close to meeting the definition of a high-use trails and are likely to be designated as such in the future.⁴⁷ The Agencies also admit that if these trails are designated as high-use, areas surrounding the trail will be buffered and removed from core area habitat.⁴⁸ And the Agencies admit that removal of buffered areas from these trails would result in the Blue-Grass BMU not meeting its core area standards.⁴⁹ However, simply acknowledging that the project may not meet a Forest Plan standard is insufficient to meet the mandates of the National Forest Management Act, which requires that all projects do meet such standards. Because the Agencies have not shown that these trails will not meet the definition of a high-use trail and that the project will meet the Blue-Grass BMU's core area habitat standard for grizzlies if they are designated as high-use trails, the Agencies have violated and NFMA. See 16 U.S.C. § 1604(i) (requiring the Forest Service to ensure that site-specific management projects are consistent with the applicable forest plan).

V. The Agencies Have Failed to Take a Hard Look at Impacts to Wildlife

A. Grizzly Bears

As stated in our DEIS comments (p. 7-9), the Agencies failed to take a hard look at the impacts to grizzly bears. Grizzly bears in the Selkirk ecosystem are listed as a threatened species under

⁴⁴ Id. at 151-52, Table 3.2.33 (noting that under all three action alternatives, if buffered areas surrounding Trails #308 and Trail #28 are removed from core area grizzly bear habitat, the Blue-Grass BMU may not meet its core area standards).

⁴⁵ Eric M. White, J.M. Bowker, Ashley E. Askew, Linda L. Langner, J. Ross Arnold, Donald B.K. English, "Federal Outdoor Recreation Trends: Effects on Economic Opportunities," National Center for Natural Resources Economic Research, NCNRR Working Paper Number 1 (Oct. 2014) (Exhibit 3).

⁴⁶ Id.

⁴⁷ Id. at 90.

⁴⁸ Id.

⁴⁹ Id. at 151-152, Table 3.2.33.

the Endangered Species Act, and the Fish and Wildlife Service has found that reclassification to an endangered species is warranted but precluded by work on higher-priority species.⁵⁰ The most recent population estimate for the Selkirk Recovery Zone is 83 bears, not yet meeting the minimum population goal of 90 set forth in the Grizzly Bear Recovery Plan.⁵¹ The Recovery Plan specifically sets forth numerous subgoals that would demonstrate a minimum population of at least 90 bears: (a) 6 females with cubs over a running 6-year average both inside the Recovery Zone and within a 10 mile area immediately surrounding it; (b) 7 of the 10 BMUs on the U.S. side occupied by females with young from a running 6-year sum of observations; and (c) known, human-caused mortality not to exceed 4 percent of the population estimate based on the most recent 3-year sum of females with cubs; and (d) no more than 30 percent of this 4 percent mortality limit shall be females. These mortality limits cannot be exceeded during any 2 consecutive years for recovery to be achieved.⁵² According to Table 3.2.4 in the FEIS, the only recovery target that has been reached is the distribution of females with young in 7 of 10 BMUs in the most recent 6 years.⁵³ None of the other recovery targets have been met for grizzly bears in the Selkirk Recovery Zone.

Although the FEIS presents this information in Table 3.2.4, the Agencies fail to discuss the import of this information at all. Instead, the Agencies deflect attention by discussing “recent sightings of grizzly bears . . . where they have not been observed for decades,” and “[i]mprovements to grizzly bear secure habitat conditions.”⁵⁴ However, the failure of currently meeting recovery criteria in this Recovery Zone is particularly significant where, as here, the Agencies have identified meeting the Grizzly Bear Recovery Plan goals as a specific purpose and need of the project.⁵⁵ However, a close look at the project shows that it will certainly not help grizzly bears in the Selkirk Recovery Zone to meet the goals set forth in the Grizzly Bear Recovery Plan. Rather, the negative impacts from this project will only ensure that the grizzly bear population backslides from the progress made toward meeting these goals.

For example, the Agencies acknowledge that the Selkirk grizzly bear population has low genetic diversity, and thus there is a need to facilitate open movement and connectivity with other bear populations.⁵⁶ But bears avoid roads and the majority of human-caused grizzly bear mortalities have occurred in close proximity to roads.⁵⁷ Indeed, habitat fragmentation is one of the biggest issues facing grizzly bears in the Selkirk Recovery Zone, and this project will severely

⁵⁰ 40 Fed. Reg. 31,734 (July 28, 1975); 64 Fed. Reg. 26,725 (May 17, 1999).

⁵¹ FEIS at 86; U.S. Fish and Wildlife Service, Grizzly Bear Recovery Plan (1993) (hereinafter, “Grizzly Bear Recovery Plan”), at 101.

⁵² Grizzly Bear Recovery Plan at 101.

⁵³ FEIS at 87, Table 3.2.4.

⁵⁴ *Id.* at 87.

⁵⁵ *See id.* at 7.

⁵⁶ *Id.* at 86.

⁵⁷ *Id.* at 81-82.

exacerbate fragmentation concerns. Looking at the map of the project area, Bog Creek Road will create a barrier from grizzlies in the Continental Mountain area from grizzlies to the north, including grizzlies in Canada that are important to maintain the sustainability of this population.⁵⁸ Blue Joe Creek Road will similarly bifurcate grizzlies in the Continental Mountain area from grizzlies in the Grass Mountain area from the border of Canada to nearly the southern border of the designated Blue-Grass BMU.⁵⁹ As the map reveals, grizzlies in areas surrounding Continental Mountain will be 100 percent surrounded by roads, with open roads to the north, east, west, and southwest, and a seasonally restricted road to the southeast.⁶⁰ The additional habitat fragmentation caused by these two roads and the negative impact that this may have on bears in the Blue-Grass BMU cannot be overstated.

The Agencies, however, don't adequately analyze how detrimental the restricted movement for grizzlies in the western portion of the Blue-Grass BMU could be to this population. By severely limiting safe movement for these grizzlies, this project is likely to further lower the genetic diversity of bears in the Selkirk Recovery Zone and further prevent the potential for bears to connect to other grizzly bear populations. These outcomes do anything but advance the goals of the Grizzly Bear Recovery Plan. However, the Agencies try to downplay the negative impacts.

For example, the Agencies admit that the construction of Bog Creek Road may inhibit bear movement and decrease genetic flow between the U.S. and Canadian portion of the population, but suggest the decrease in the genetic flow would just be a "short term" issue.⁶¹ However, this conclusion is not in sync with the Agencies' admission just one paragraph later that Bog Creek Road would result in a "long-term semipermeable barrier."⁶²

The Agencies also focus on the planned closure of roads as being beneficial for bears. But the Agencies' assertion that the project will help grizzly bears by closing roads is erroneous for three reasons. First, all nine roads to be closed as part of the Preferred Alternative are already seasonally restricted, with motorized access only occurring from November 16-March 31 plus limited motorized administrative use.⁶³ Seasonally restricted roads are only open November 16-March 31 because grizzly bears are generally denning during this time frame, and thus are minimally disturbed by use of the roads over the winter season. By comparison, the Bog Creek Road and Blue Joe Creek Road will not be seasonally restricted.⁶⁴ Thus, these closures do not come close to offsetting the negative impacts to grizzly bears.

⁵⁸ Id. at 27, Figure 2.2.4.

⁵⁹ Id.

⁶⁰ See, e.g., id.; id. at 84, Figure 3.2.7.

⁶¹ Id. at 113.

⁶² Id.

⁶³ Id. at 26.

⁶⁴ Id. at 25.

Moreover, closure activities—which will include heavy and loud equipment to recounter the road prism, rip the road surface, remove culverts, and recounter stream crossings, among other things—will occur for up to three seasons from June 16-Nov 15 (i.e., during seasons in which grizzly bears are not denning).⁶⁵ The fact that these closure activities will occur simultaneously to construction and reconstruction activities on Bog Creek Road and Blue Joe Creek Road will essentially turn the entire western portion of the Blue-Grass BMU into a construction zone for up to three years.⁶⁶ And the Agencies acknowledge that short-term effects from road construction and closure activities can last up to five to ten years following the three-year construction period.⁶⁷ Thus, the construction and closure activities planned as part of this project could disturb and displace grizzly bears in the project area for up to 13 years.

Second, eight of the nine roads planned for “closure” are already undriveable and thus are not being used.⁶⁸ More specifically, of the 24.7 miles planned for road closure activities, more than 20 miles are already heavily brushed in and completely impassable.⁶⁹ These impassable roads, though “not formally closed, . . . are overgrown with trees or brush, or gated, and so do not allow for motorized travel . . . [and] are functioning as grizzly bear core habitat because of their current undrivable status.”⁷⁰ Thus, the Agencies’ assertion that the project will create more core area for grizzlies and benefit the species is exaggerated at best, and completely false at worst.

Finally, the Agencies focus largely on the miles of roads to be closed but put less emphasis on the location of road closures, which can actually be more important for grizzly bears. For example, as part of the preferred alternative, the Agencies will close Roads 1322 and 1322A for a total of 5.6 miles.⁷¹ Both of these roads are currently heavily brushed in and undrivable.⁷² The Agencies, however, will leave Road 1013 open.⁷³ Road 1013 runs essentially parallel and adjacent to 1322A for the full length of 1322A.⁷⁴ Thus, closing Road 1322A will not add any core area habitat for grizzlies, and grizzly travel to the west from Continental Mountain is still fragmented by an open road.⁷⁵ Roads 1013D and 1013C to the south of Continental Mountain similarly have roads adjacent to them that will remain open.⁷⁶

⁶⁵ Id. at 22.

⁶⁶ To decrease the negative impacts on wildlife from simultaneous construction and closure activities, Objectors suggested an alternative in comments on the DEIS in which closure activities would be completed before construction and reconstruction activities on Bog Creek Road and Blue Joe Creek Road would occur. The Agencies did not respond to this suggested alternative.

⁶⁷ Id. at 67.

⁶⁸ Id. at 26, Table 2.2.4.

⁶⁹ Id.

⁷⁰ Id. at 89.

⁷¹ Id. at 26.

⁷² Id.

⁷³ Id. at 27, Figure 2.2.4.

⁷⁴ Id.

⁷⁵ Id. at 26.

⁷⁶ Id. at 27, Figure 2.2.4.

The Agencies also rely on obsolete research from the 1980s to predict when bears will be using higher and lower elevations in the BMU so that they can allegedly base their work season around when grizzly bears may be using the areas surrounding the roads under construction.⁷⁷ This outdated research does not necessarily present an accurate account of what grizzly bears are doing on the ground now. For example, climate change may now be causing bears to emerge from their dens earlier and to use low elevation lands later in the season and may move to higher elevations later than they did in the 1980s. NEPA requires that agencies use “high quality” information and “accurate scientific analysis.” Relying on decades-old research does not meet this bar.

While this project is sure to have negative impacts to grizzly bears, the Agencies often overstate the potential benefits of the project to grizzlies (as explained above) and only mention the negative impacts in a vague manner, rather than providing the necessary analysis so the public can truly determine the impacts on grizzly bears. For example, the Agencies do not provide any estimates as to how goals of the Recovery Plan will be affected, aside from asserting vaguely that connectivity and genetic diversity will be negatively impacted. The Agencies also do not, for example, estimate the potential increase in human-caused mortality from the project, despite low human-caused mortality rates being an important benchmark in the Recovery Plan. The Agencies do not estimate the percentage of male versus female bears that may be impacted by the project, even though low female mortality rates are highlighted as an important target necessary to reach recovery objectives.

Because the Agencies failed to take a hard look at the negative impacts to grizzly bears from this project, the Agencies have violated NEPA.

B. Woodland Caribou

As stated in our DEIS comments (p. 9-11), the Agencies failed to take a hard look at the impacts to woodland caribou. In 1983, the southern Selkirk Mountain population of woodland caribou was emergency listed as endangered under the Endangered Species Act, and the caribou was finally listed as endangered on February 29, 1984.⁷⁸ These caribou are also listed as a state endangered species and an Idaho Tier 1 Species of Greatest Conservation Need.⁷⁹ The 1985 Recovery Plan set an intermediate population target of 100 to 109 caribou, and the 1994 Recovery Plan set a goal of maintaining two herds in British Columbia and Idaho, with the stated

⁷⁷ *Id.* at 88-89.

⁷⁸ 49 Fed. Reg. 7390 (Feb. 29, 1984).

⁷⁹ Idaho Dep’t of Fish and Game, Species of Greatest Conservation Need, at <https://idfg.idaho.gov/species/taxa/list/sgcn> (last visited Mar. 14, 2019).

goal to establish a third herd in Washington as well.⁸⁰ FWS found it was necessary to manage for an increasing population and manage at least 443,000 acres of habitat in the Selkirks to support a self-sustaining caribou population.⁸¹ Importantly, FWS noted that the loss and fragmentation of habitat was one of the major factors causing the caribou's population decline.⁸²

None of these goals have been achieved, and in 2017, approximately 12 caribou were detected during monitoring efforts.⁸³ By spring of 2018, only three South Selkirk mountain caribou were found.⁸⁴ Unfortunately, the woodland caribou population had been spiraling toward extinction without pause, and finally hit that point this winter. This winter, Canadian officials penned the few remaining caribou in the Selkirk Mountains. On January 14, 2019, Canadian officials took the sole surviving member of the South Selkirk caribou into captivity.⁸⁵ Despite this important recent development, which occurred before the release of the FEIS, the FEIS fails to acknowledge these recent events and current absence of caribou in Idaho. This is a serious omission demonstrating the Agencies' failure to adequately analyze impacts to caribou and caribou habitat.

But that is not all that the Agencies failed to acknowledge when discussing caribou. The FEIS notes that the status of the woodland caribou is under review by FWS, and that critical habitat has been designated approximately one mile west of the caribou analysis area.⁸⁶ But this information is not up to date and is not adequate to inform the public as to the current status of woodland caribou. FWS's current proposal would declare that the southern Selkirk herd is actually part of a larger population known as the southern mountain caribou distinct population segment ("DPS") and that this population warrants protection as a threatened species.⁸⁷ This Southern Mountain Caribou DPS would include caribou found in southern British Columbia, northern Idaho, and northeastern Washington.⁸⁸ Thus, even though caribou are currently

⁸⁰ U.S. Fish and Wildlife Service, Recovery Plan for Selkirk Mountain Woodland Caribou (1994), at https://ecos.fws.gov/docs/recovery_plan/940304.pdf (last visited Mar. 14, 2019).

⁸¹ *Id.*

⁸² *Id.*

⁸³ Eli Frankovich, The Spokesman Review, "Sole surviving member of the South Selkirk caribou herd captured, Gray Ghosts are no more in Lower 48," (Jan. 18, 2019), at www.spokesman.com/stories/2019/jan/18/sole-surviving-member-of-the-south-selkirk-caribou/ (last visited Mar. 14, 2019).

⁸⁴ Eli Frankovich, The Spokesman Review, "South Selkirk mountain caribou herd possibly extinct," (April 21, 2018), www.spokesman.com/stories/2018/apr/19/south-selkirk-mountain-caribou-herd-possibly-extinct/ (last visited Mar. 14, 2019).

⁸⁵ Eli Frankovich, The Spokesman Review, "Sole surviving member of the South Selkirk caribou herd captured, Gray Ghosts are no more in Lower 48," (Jan. 18, 2019), at www.spokesman.com/stories/2019/jan/18/sole-surviving-member-of-the-south-selkirk-caribou/ (last visited Mar. 14, 2019).

⁸⁶ FEIS at 91.

⁸⁷ 79 Fed. Reg. 26,504, 26,504 (May 8, 2014).

⁸⁸ *Id.*; *id.* at 26,514-26,528.

extirpated, the hope is that this new DPS will be able to repopulate its historic range, including the project area in northern Idaho. This project will make that far less likely to happen, especially given Bog Creek Road runs essentially parallel to the Canadian border and its construction and use will decrease opportunities for caribou to safely cross from British Columbia into northern Idaho.⁸⁹

Moreover, though technically the Agencies are correct that FWS designated critical habitat for woodland caribou, the Agencies ignore the fact that a judge in the District Court of Idaho vacated FWS's designation and remanded that rule to the agency to remedy procedural errors made in finalizing the original designation. See Ctr. for Biological Diversity v. Kelly, 93 F. Supp. 3d 1193 (Mar. 23, 2015). The court found that FWS erroneously changed the proposed critical habitat designation (which included 375,562 acres of habitat) in the final rule (which only included 30,101 acres) without holding a public comment period on the significant departure from the proposed rule's designation. Id. The court remanded the rule to FWS. Id.

To comply with the court's order, on April 19, 2016, FWS opened a comment period on the 2012 critical habitat designation.⁹⁰ Several commenters urged FWS to designate as critical habitat the 375,562 acres as originally proposed by FWS, which would include the Bog Creek Road project area. So far FWS has not finalized a new critical habitat designation.

On February 13, 2019, the Center for Biological Diversity, The Lands Council, and Defenders of Wildlife issued a 60-day notice of intent to sue FWS over its failure to make a final listing determination for the Southern Mountains Caribou DPS and its failure to finalize a critical habitat designation. FWS has not yet responded to the notice.

This is all crucial information about how the Bog Creek Road project may impact caribou and caribou habitat that must be considered by the Agencies. Instead, the Agencies rely on stale information to determine that the project will not impact caribou critical habitat. If FWS reverts to designating critical habitat as originally proposed, the Bog Creek Road project area would lie within in the critical habitat designation. However, even if FWS designates the same critical habitat it had designated in 2012, that critical habitat designation would lie directly to the west of, and just approximately one mile from, the project area.

Also, as the FEIS acknowledges, the project coincides with three Caribou Management Units ("CMUs"): Upper Priest, Grass, and Cow.⁹¹ The caribou analysis area consists of 67,960 acres, 93 percent of which is considered caribou habitat.⁹² Caribou have been documented both

⁸⁹ See, e.g., FEIS at 27, Figure 2.2.4.

⁹⁰ 81 Fed. Reg. 22,961 (Apr. 19, 2016).

⁹¹ FEIS at 74.

⁹² Id.; id. at 93-94.

historically and recently in all three CMUs included in the project's caribou analysis area, including along the Bog Creek Road corridor.⁹³

According to the FEIS, under all action alternatives, road maintenance and decommissioning may last up to three years.⁹⁴ Remoteness from human presence, low road densities, and limited motorized access are all important factors impacting caribou habitat selection and survival.⁹⁵ In addition to causing displacement as caribou avoid human presence, roads may also increase predation upon caribou by wolves and other predators.⁹⁶ Notably, law enforcement patrol, because exceptions to winter motorized closures and road use are often made, is listed as a specific factor that has impacted and may continue to impact the destruction and fragmentation of caribou habitat.⁹⁷ Roads may also impact modeled travel corridors necessary to achieve the goals of the Recovery Plan.⁹⁸

Although a court order closed roads in the project area to public recreational snowmobiling, nevertheless illegal snowmobiling in this area still continues.⁹⁹ Although this issue has been raised to the Forest Service both through this commenting process and outside of this process, the Agencies simply state that “[t]he agencies’ effects analysis does not include analysis of illegal activities.”¹⁰⁰ However, NEPA does not provide an exemption allowing agencies to ignore illegal activities that impact the environment. Moreover, the Agencies’ tactic to ignore illegal snowmobile use is in contradiction with its analysis that considers the potential for increased poaching of wildlife—an illegal activity—elsewhere in the FEIS. Because illegal snowmobile use is prevalent and is negatively impacting wildlife and the environment in this project area, the Agencies’ refusal to analyze this reality violates NEPA’s mandate to take a hard look at the impacts of the project.

Due to the negative impacts that roads can have upon woodland caribou and their habitat, we believe that this project will jeopardize the potential for the recovery of caribou in the Selkirks. A road that parallels the Canadian border, as Bog Creek Road does, will most certainly prevent the ability of caribou to safely enter the United States again in the future, preventing caribou from repopulating the area.

⁹³ Id.

⁹⁴ See, e.g., id. at 20, 25, 68.

⁹⁵ Id. at 94.

⁹⁶ Id.

⁹⁷ Id. at 95.

⁹⁸ Id.

⁹⁹ See, e.g., Idaho Panhandle Avalanche Center, “Small Avalanche in WestFork cabin drainage,” at www.idahopanhandleavalanche.org/observation/avalanche/2019/feb/16/small-avalanche-westfork-cabin-drainage (last visited Mar. 26, 2019) (snowmobilers in area closed to snowmobiling reporting avalanche activity).

¹⁰⁰ Id., App. C at 27 (Resp. to Comment 48-89).

C. Bull Trout

As stated in our DEIS comments (p. 11-13), the Agencies failed to take a hard look at the impacts to bull trout. The FEIS lacks sufficient analysis of the environmental consequences to bull trout and its designated critical habitat under each alternative, specifically with regard to sedimentation from Bog Creek Road. Bull trout in the project area are listed as threatened under the Endangered Species Act and are considered to be in decline across their range.¹⁰¹ Designated bull trout critical habitat exists in the project area, downstream from numerous tributaries that Bog Creek Road crosses.¹⁰² The Agencies recognize that historic road construction, timber harvest, and mining that have occurred in the analysis area have likely reduced the habitat quality and connectivity of streams occupied by bull trout and streams designated as bull trout critical habitat.¹⁰³ Road construction and increased use—as proposed under all action alternatives—threatens to increase sedimentation into streams occupied by bull trout and mapped as designated critical habitat, including Upper Priest River, Malcom Creek, and Lime Creek.¹⁰⁴ Indeed, road related sedimentation is one of the greatest factors affecting bull trout survival.¹⁰⁵ Sedimentation can reduce habitat complexity and pool depth, reduce egg survival and emergence, kill young bull trout, and can impact insect larvae preyed upon by bull trout.¹⁰⁶

Roads often contribute to degraded baseline conditions in watersheds containing bull trout. Roads are a primary source of sediment impacts to developed watersheds.¹⁰⁷ Accumulation of fine sediment is detrimental to bull trout habitat. Studies have found a pattern of decreasing strong populations of cold water fish such as bull trout with increasing road density.¹⁰⁸ Sediment delivered to streams is greatest in riparian areas where roads cross the streams.¹⁰⁹ Fords and approaches to the crossings deliver sediment directly to streams. Travel management decisions affecting roads and trails are most likely to affect substrate embeddedness and stream bank condition.¹¹⁰ Plus roads and trails paralleling streams can interfere with large wood reaching the stream and cause increased erosion and decreased stream bank condition.¹¹¹

¹⁰¹ Id. at 102.

¹⁰² Id. at 101.

¹⁰³ Id. at 102.

¹⁰⁴ Id. at 125, Table 3.2.21.

¹⁰⁵ Id. at 102.

¹⁰⁶ Id. at 101, 110.

¹⁰⁷ See The Wilderness Society, Transportation Infrastructure and Access on National Forests and Grasslands: A Literature Review (May 2014) (DEIS Comments (Exhibit 1), Attachment A at 2).

¹⁰⁸ Id. at 7-9; see also Dunham, J.B. and B.E. Rieman, “Metapopulation Structure of Bull Trout: Influences of Physical, Biotic, and Geometrical Landscape Characteristics.” Ecological Applications, Vol. 9, No. 2 1999, at p. 642 (Exhibit 4).

¹⁰⁹ DEIS comments (Exhibit 1), Attachment A at 4.

¹¹⁰ Substrate embeddedness can be measured as change in total acreage open to motorized use, based on the assumption that embeddedness is related to the total area susceptible to erosion. Stream bank condition can be measured as an inverse of stream crossings.

¹¹¹ DEIS comments (Exhibit 1), Attachment A at 3.

Culverts can produce a large amount of sediment if the culvert plugs and fails. The FEIS explains the following consequence under the No Action Alternative:

Without removal or replacement, the culverts could potentially fail or blow out along Bog Creek Road and the roads proposed for motorized closure under the action alternatives. There is the potential that culvert failure or blowout could occur in streams occupied by bull trout or upstream of bull trout DCH, which would catastrophically release sediment downstream (Furniss et al. 1998).¹¹²

In our DEIS comments (p. 12-13), we raised concerns with past and future management of the culverts along Bog Creek Road. The FEIS explains that a culvert failure and resulting road washout made the road completely impassable at Spread Creek.¹¹³ We explained this washout demonstrates the lack of maintenance by the Agencies on existing culverts, and despite the known and demonstrated risk of culvert washouts, both the DEIS and FEIS fail to analyze the potential of road-related sedimentation from the lack of adequate road maintenance. Instead, the bull trout analysis limits its scope to short term effects caused by downstream sedimentation from in-stream work (culvert removal and replacement) on Continental Creek, which could temporarily directly affect mapped designated critical habitat on Malcom Creek.¹¹⁴ This includes installation of six new culverts and replacement of six out of 67 existing corrugated metal pipe culverts located along the length of the roadway.¹¹⁵

The Agencies discount the environmental consequences of the culvert replacement and installation explaining the effects from culvert replacement or removal would be temporary (less than 24 hours),¹¹⁶ and that bull trout are located over 4,000 feet downstream from the proposed in-stream work to remove or replace culverts.¹¹⁷ The analysis also asserts the design features listed in the FEIS Appendix B would successfully limit potential sedimentation to “less than one shovelful.”¹¹⁸ Even if the design features are as successful as the Agencies assert (an assumption the FEIS fails to prove in the context of climate change), their use does not alleviate the Agencies’ responsibilities to appropriately analyze the potential for road-related sedimentation. Here the FEIS fails because it skews the impacts analysis in favor of the preferred alternative by focusing on culvert replacement and removal, while conveniently ignoring sedimentation from the road infrastructure and impacts that will result from the lack of maintenance. Proposing new

¹¹² FEIS at 109.

¹¹³ Id.

¹¹⁴ Id. at 124.

¹¹⁵ Id. at 20.

¹¹⁶ Id.

¹¹⁷ Id. at 124-25 (also explaining that sedimentation from culvert replacement could be measurable to 800 feet downstream, while sedimentation from culvert removals could be measurable 3,000 feet downstream).

¹¹⁸ Id.

culverts ignores the Agencies' limited capacity to maintain even the existing culverts, much less ensure protection of bull trout and water quality in bull trout critical habitat downstream. The FEIS repeats the DEIS's failure to acknowledge or address the fact that culvert washouts are just as likely under the preferred alternatives (given that the number of culverts will actually increase and the Forest Service's maintenance funding continues to decrease) as the no action alternative.¹¹⁹ For context, the Agencies state that under the No Action alternative, "culvert failure or blowout could catastrophically release sediment downstream" with detrimental impacts for the following 5-10 years to downstream bull trout and designated bull trout critical habitat (Upper Priest River, Malcom Creek, and Lime Creek).¹²⁰ Moreover, the section analyzing the environmental consequences to bull trout from long term maintenance and use limits its scope regarding sedimentation to only culvert cleaning.¹²¹ The Agencies' analysis arbitrarily and capriciously omits the consequences of keeping 67 culverts on Bog Creek Road under the action alternatives. These culverts are subject to catastrophic failure, as explained in the No Action alternative analysis.

Had the Agencies considered and responded to our comments, perhaps the FEIS would have better analyzed the potential for future culvert failure in the context of previous inadequate maintenance and lack of funding in future budgets. As it stands, the FEIS lacks sufficient analysis of the potential environmental consequences from the 67 remaining culverts on Bog Creek Road that will be subject to increased use under the preferred alternative.

D. Failure to Analyze Impacts from Forest Roads in the Context of Climate Change

In our DEIS comments (p. 15-17), we explained at length the need to fully analyze the environmental consequences from the Forest Service road system, especially in the context of climate change. The Agencies failed to consider or respond to our comments.

The best available science shows that roads cause significant adverse impacts to National Forest resources.¹²² A 2014 literature review from The Wilderness Society surveys the extensive and best available scientific literature—including the Forest Service's General Technical Report synthesizing the scientific information on forest roads (Gucinski 2001)—on a wide range of road-related impacts to ecosystem processes and integrity on National Forest lands.¹²³ Erosion, compaction, and other alterations in forest geomorphology and hydrology associated with roads seriously impair water quality and aquatic species viability. Roads disturb and fragment wildlife

¹¹⁹ *Id.* at 125 (stating that "[t]here would be a lower long-term potential, compared with the No-Action Alternative, for culvert failure . . . following culvert replacement or removal.").

¹²⁰ *Id.* at 51, Table 2.4.4.

¹²¹ *Id.* at 139.

¹²² *See, e.g.*, 66 Fed. Reg. at 3208 ("Scientific evidence compiled to date [2001] suggests that roads are a significant source of erosion and sedimentation and are, in part, responsible for a decline in the quality of fish and wildlife habitat.").

¹²³ *See* DEIS Comments (Exhibit 1), Attachment A.

habitat, altering species distribution, interfering with critical life functions such as feeding, breeding, and nesting, and resulting in loss of biodiversity. Roads facilitate increased human intrusion into sensitive areas, resulting in poaching of rare plants and animals, human-ignited wildfires, introduction of exotic species, and damage to archaeological resources.¹²⁴

Roads contribute to the spread of invasive species. Roads themselves, regardless of whether they are open or closed to public access, split apart the forest landscape, creating more buffers where invasive species are likely to grow.¹²⁵ The Agencies should have included in the FEIS an assessment of how the proposed roads (even absent vehicles and regardless of maintenance level) provide a vector for the spread of invasive species by fragmenting the landscape and creating buffers that are less resistant and resilient to stressors like invasive species.

Science shows that roads and trails play a role in affecting wildfire occurrence.¹²⁶ Closed roads remain on the landscape and thus continue to allow for human-caused wildfires. Moreover, roads that remain on the landscape can affect where and how forests burn.¹²⁷ In taking a hard look at this proposal, the Agencies should have considered how opening Bog Creek Road and Blue Joe Creek Road to year-round access is likely to increase the risk of wildfire occurrence in this area.

Finally, a robust analysis under NEPA of the forest roads is especially critical in the context of climate change. Climate change is a major challenge for natural resource managers because of the magnitude of potential effects and the related uncertainty of those effects. Climate change intensifies the impacts associated with roads. For example, as the warming climate alters species distribution and forces wildlife migration, landscape connectivity becomes even more critical to species survival and ecosystem resilience.¹²⁸ Climate change is also expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes.¹²⁹ Many National Forest roads are poorly located and designed to be temporarily on the landscape, making them particularly vulnerable to these climate alterations.¹³⁰ Even those designed for storms and water flows typical of past decades may fail under future weather scenarios, further exacerbating adverse ecological impacts, public safety concerns, and maintenance needs.¹³¹ At

¹²⁴ Id.

¹²⁵ See DEIS Comments, Attachment A at 11.

¹²⁶ See DEIS Comments, Attachment A at 9 (noting human-ignited wildfires account for more than 90% of fires on national lands and are almost five times more likely in areas with roads).

¹²⁷ See DEIS Comments, Attachment A at 11.

¹²⁸ See DEIS Comments, Attachment A at 9-14.

¹²⁹ See, e.g., Halofsky, J.E. et al. eds., USDA, Forest Service, Pacific Northwest Research Station, Adapting to Climate Change at Olympic National Forest and Olympic National Park, PNW-GTR-844 (2011), pages 21-27 (DEIS Comments, Attachment B).

¹³⁰ See, e.g., id. at 36-38.

¹³¹ See, e.g., Strauch, R.L. et al., Adapting transportation to climate change on federal lands in Washington State, Climate Change 130(2), 185-199 (2015) (noting the biggest impacts to roads and trails

bottom, climate change predictions affect all aspects of road management, including planning and prioritization, operations and maintenance, and design.¹³² Rather than properly analyze the forest road system in the project area in the context of climate change, the Agencies focus solely on how project activities may affect greenhouse gas emission, concluding there would be no effect and then dismissing climate change from further analysis.¹³³

In the FEIS, the Agencies failed to analyze in detail the impact of climate change on forest roads and forest resources. The analysis should have started with a vulnerability assessment, to determine the project area's exposure and sensitive to climate change, as well as its adaptive capacity.¹³⁴ For example, the Agencies should have considered the risk of increased disturbance due to climate change when analyzing this proposed project. They also should have included existing and reasonably foreseeable climate change impacts as part of the affected environment, assessing them as part of the Agencies' hard look at impacts, and integrating them into each of the alternatives, including the no action alternative. Additionally, the Agencies should have considered the cumulative impacts likely to result from the proposed project, proposed road activities, and climate change.¹³⁵ In planning for climate change impacts and the proposed road activities, the Agencies should have considered: (1) protecting large, intact, natural landscapes and ecological processes; (2) identifying and protecting climate refugia that will provide for climate adaptation; and (3) maintaining and establishing ecological connectivity.¹³⁶

E. Impacts from Snowmobile Use (grizzly bears, caribou, lynx, wolverine)

As noted in our DEIS comments (p. 17-21), the Agencies fail to take a hard look at the impacts from snowmobile use on grizzly bears, woodland caribou, Canada lynx, and wolverines. The FEIS and DEIS note that winter restrictions do not apply to law enforcement activities and thus CBP may have unlimited access to developed roads via snowmobile during the winter.¹³⁷ In our DEIS we noted the Agencies must consider and disclose impacts from the proposal to allow snowmobile use along Bog Creek Road, including impacts to imperiled wildlife. Toward this

are expected from temperature-induced changes in hydrologic regimes that enhance autumn flooding and reduce spring snowpack) (Exhibit 5).

¹³² See Halofsky, J.E. et al. eds., USDA, Forest Service, Pacific Northwest Research Station, Adapting to Climate Change at Olympic National Forest and Olympic National Park, PNW-GTR-844 (2011) (DEIS Comments (Exhibit 1), Attachment B at 21-27).

¹³³ FEIS at 13.

¹³⁴ DEIS Comments, Attachment B at 36 ("potential climate change effects underscore the need to increase activity and be proactive in priority areas to avoid impacts associated with infrastructure failure.").

¹³⁵ *Id.* ("Managers will likely need to evaluate the density, location, design, and maintenance intensity of roads and related structures in the context of climate change to avoid escalating road maintenance costs associated with [climate change] impacts").

¹³⁶ See Schmitz, O.J. and A.M. Trainor, Adaptation Approaches for Conserving Ecosystem Services and Biodiversity in Dynamic Landscapes Caused by Climate Change, USDA Forest Service RMRS-P-71 (2014), pp. 301-303, at <https://www.fs.usda.gov/treearch/pubs/46590> (last visited Mar. 29, 2019).

¹³⁷ FEIS at 21.

end we provided best management practices to follow in order to reduce the environmental consequences from over-snow vehicle use.¹³⁸ Had the Agencies fully considered and responded to our comments as required, then perhaps the FEIS may have provided appropriate analysis of over-snow vehicle (“OSV”) use on grizzly bear, woodland caribou, Canada lynx and wolverine, and incorporated the OSV BMPs per our suggestion. As it stands, the FEIS fails on both accounts.

1. Grizzly Bears

Our DEIS list numerous potential impacts harmful to grizzly bears from increased over-snow vehicle use by CBP patrols. Possible effects include den abandonment, loss of young, increased energetic costs while bears are in dens or displaced away from suitable habitat if outside dens, learned displacement from suitable habitat resulting from exposure to disturbance, and death. A comprehensive review found human disturbance within one kilometer of a den site has a significant risk of causing abandonment, especially early in the denning season.¹³⁹ Snowmobiles may have direct harmful effects to emergent bears, mainly females and cubs. Because females with cubs have high energetic needs and cubs have limited mobility for several weeks after leaving the den, they remain in the den site area for several weeks after emergence from dens. Disturbance levels that cause a female to prematurely leave the den in spring or move from the den area could impair the fitness of the female and safety of the cubs.¹⁴⁰ It is important to provide secure habitat—areas free of motorized access—so bears are able to fully use available resources.¹⁴¹

The FEIS notes the following in regards to grizzly bear denning:

Three different bears (two females and one male) have denned in the Blue-Grass BMU on seven different occasions between 2012 and 2016.... Within denning habitat on NFS lands, nine of 20 known denning sites from 1983 to 2001 occurred in this BMU (Forest Service 2011a)... In 2017, 12 credible sightings of females with cubs were made in the SRZ, including two of these sightings occurring in the Blue- Grass BMU; since 2011,

¹³⁸ A. Switalski, Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Wildlife*, 12 *Journal of Conservation Planning* 13 (2016) (DEIS Comments (Exhibit 1), Attachment C).

¹³⁹ J.D.C. Linnell *et al.*, How vulnerable are denning bears to disturbance? 28 *Wildlife Society Bulletin* (Exhibit 6).

¹⁴⁰ U.S. Forest Service, Forest Service’s Biological Opinion on the Effects of the 2015 Revision of the Idaho Panhandle National Forest Land and Resource Management Plan on Grizzly Bears (2013), at II-14 (Exhibit 7).

¹⁴¹ U.S. Dep’t of Agriculture, Forest Service, Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests Record of Decision (2006) at 7, at https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187774.pdf (last visited Mar. 24, 2019).

females with young have been sighted every year in the Blue- Grass BMU (Kasworm et al. 2018a).¹⁴²

Given the history of grizzly bear denning in the Blue-Grass BMU and potential for increased winter patrols by CBP, the analysis should have done more to disclose the related potential environmental consequences. The FEIS acknowledges that, “CBP may occasionally access these roads [Bog and Blue Joe Creek] via snowmobile during the winter, as winter restrictions do not apply to law enforcement activities; CBP snowmobile use of these roads could increase from that of the No-Action Alternative.”¹⁴³ Yet, the Agencies conclude, “[d]isplacement of an individual or family group would not be likely to affect species at the population level,” without ever discussing impacts to grizzly bear denning habitat and den emergence from CBP winter motorized patrols.¹⁴⁴

2. Woodland Caribou

Our DEIS comments noted the sensitivity ungulate species have to winter motorized use, and that limiting the duration and spatial footprint of the disturbance is the appropriate management approach.¹⁴⁵ The FEIS acknowledges that for the proposed action and preferred alternative, “..., if CBP conducts winter motorized patrol within the caribou analysis area, there may be an increase in periodic caribou displacement and the likelihood of predators using the compacted trails, compared with the No-Action Alternative.”¹⁴⁶ The analysis discusses the importance of population connectivity for the Selkirk Mountain woodland caribou herd, yet the Agencies still propose to allow unlimited winter patrols in the analysis area.¹⁴⁷ Given the importance of providing secure winter habitat for the Woodland caribou herd, the FEIS should have considered limiting winter patrols or other management options that we provided in our DEIS comments.

3. Canada Lynx

Our DEIS comments (p.19, Attachment C) listed potential environmental consequences from increased winter motorized use on Canada lynx by CBP patrols and the need for the Agencies to fully analyze this issue. We noted snowmobiles may directly affect Canada lynx during winter months when the species is especially vulnerable by causing physiological responses like increased heart rate and elevated stress level.¹⁴⁸ The noise from snowmobiles is likely

¹⁴² FEIS at 88.

¹⁴³ *Id.* at 130-31.

¹⁴⁴ *Id.* at 130, 134 (only discussing spring, summer and fall motorized use).

¹⁴⁵ DEIS Comments (Exhibit 1) Attachment C, at 17.

¹⁴⁶ FEIS at 136.

¹⁴⁷ *Id.* at 137.

¹⁴⁸ W.L. Gaines et al., Assessing the cumulative effects of linear recreation routes on wildlife habitats on the Okanogan and Wenatchee National Forests (2003), Gen. Tech. Rep. PNW-GTR-586, at 5-6, at <http://www.fs.fed.us/pnw/pubs/gtr586.pdf> (last visited Mar. 24, 2019).

detrimental to lynx, disturbing their ability to hunt and increasing stress. Snowmobiles may disturb den sites during a time when lynx are rearing young.

The FEIS does acknowledge the proposed action and preferred alternative could increase winter CBP patrols, which would displace lynx and increase competition from coyotes using compacted routes.¹⁴⁹ Yet, the Agencies' analysis does not discuss other harmful effects from winter motorized use that we included in our DEIS comments. The FEIS should have also quantified the amount of lynx habitat affected by increased CBP patrols and the number of patrols that would result in displacement and increased competition. The FEIS should have also examined possible design criteria, per our DEIS comments, to mitigate the potential harm from increased winter motorized use.

4. Wolverines

Our DEIS comments (p.20-21) provided extensive information about the harmful effects of winter motorized use on wolverine such as disrupting natal denning areas, maternal den abandonment or relocation, increased physiological stress levels, and reduced foraging success, among others. The FEIS acknowledges that for the proposed action and preferred alternative, "CBP winter patrols via snowmobile along the roads in the analysis area may also increase the potential for temporary wolverine displacement in the winter. These would be detrimental indirect impacts."¹⁵⁰ Yet, the Agencies still assert that for all T&E species, "[d]isplacement of an individual or family group would not be likely to affect species at the population level."¹⁵¹ This conclusory statement lacks the necessary supporting analysis. The FEIS fails to address or discuss any of the potential environmental consequences with the level of specificity to demonstrate that levels of displacement from increased CBP winter patrols would not likely affect wolverine populations in the planning area. The Agencies also fail to consider any of the design criteria we proposed in our DEIS comments.

VI. The Agencies Have Failed to Adequately Analyze Cumulative Impacts

As noted in our DEIS comments (p. 22), the Agencies failed to adequately analyze cumulative impacts. NEPA requires agencies to analyze cumulative impacts in an EIS. Cumulative impacts include those "which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time." 40 C.F.R. § 1508.7. The Agencies failed to adequately analyze numerous cumulative impacts in the FEIS, thereby violating NEPA.

¹⁴⁹ FEIS at 138-39.

¹⁵⁰ Id. at 138.

¹⁵¹ Id. at 131.

A. The Agencies Failed to Analyze Cumulative Impacts From Unauthorized Use and Climate Change

The FEIS fails to consider the cumulative impacts of climate change and forest roads (i.e., how climate change is expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes).

The Agencies also omit any discussion of how unauthorized motorized use may be exacerbating the harmful environmental consequences associated with the forest road network. The analysis lacks any discussion or evidence that unauthorized use contributes to the open road densities in the project area, or poses other management challenges. The Agencies erroneously assume its closure treatments will prevent future unauthorized use without the necessary analysis to support this assumption. The FEIS focuses only on authorized use of system roads without addressing the cumulative impacts of unauthorized routes.

B. The Agencies Failed to Analyze Cumulative Impacts to Grizzly Bears

As discussed briefly above, the Agencies' admit that two trails—the Upper Priest River Trail (#308) and the American Falls Trail (#28) are on the brink of being designated as “high-use” trails.¹⁵² Because the Forest Service has acknowledged that hiking participation is on the rise and will only increase in the future, the designation of these already heavily used trails as “high-use” trails is not only reasonably foreseeable but is inevitable.¹⁵³ Once these trails are designated as “high-use” trails, buffer areas surrounding the trails will be removed from habitat considered grizzly core area habitat, and the Blue-Grass BMU would no longer be in compliance with the Forest Plan's Access Amendment standards for grizzly core area habitat.¹⁵⁴

Rather than analyze the impact of the BMU not meeting Access Amendment standards due to the inevitable designation of these trails as “high-use” trails in conjunction with the Bog Creek Road project, the Agencies just ask that the public trust that they will deal with it later.¹⁵⁵ But given the reasonably foreseeable designation will bring the Blue-Grass BMU out of compliance with the Forest Plan standard, the Agencies cannot just ignore this inevitable problem and hope that it goes away. The Agencies have a duty to analyze this reasonably foreseeable cumulative impact that will negatively impact grizzly bears in the Blue-Grass BMU and set forth actual solutions that will be implemented to deal with the problem. The creation of negative impacts to wildlife

¹⁵² *Id.* at 90.

¹⁵³ *See, e.g.*, White et al. (2014) (Exhibit 3).

¹⁵⁴ FEIS at 151-52, Table 3.2.33.

¹⁵⁵ *Id.*, App. C at 23 (Resp. to Comment 48-81) (“If, in the future, these trails are observed to have high use, then at that time, the Forest Service would evaluate approaches to ensure that the core area standard (55%) for the Blue-Grass BMU is maintained.”).

by the Agencies' shoot first, ask questions later is exactly what NEPA is designed to prevent. Failure to analyze this reasonably foreseeable impact and how, in conjunction with the Bog Creek Road project, it will negatively impact grizzly bears and violate Forest Plan standards, is a clear violation of NEPA.

C. The Agencies Failed to Analyze Cumulative Impacts From Illegally Performed Work on Bog Creek Road

In 2016, CBP spent an unknown amount of time clearing an unknown amount of vegetation from Bog Creek Road to make the previously impassable road passable to motor vehicles. CBP did not complete any NEPA analysis prior to this roadwork and now claims that the premature roadwork is “beyond the scope of this [NEPA] analysis.”¹⁵⁶ Regardless of whether CBP believes it was required to comply with NEPA before completing that work—which we believe it was—the Agencies cannot now refuse to consider the impacts of that previously completed work in this NEPA analysis. Cumulative impacts include past actions that result in incremental impacts to the environment. 40 C.F.R. § 1508.7.

Previous vegetation removal on Bog Creek Road in 2016 may have caused numerous impacts that have not been analyzed in this FEIS. The vegetation removal itself may have caused negative impacts to wildlife from human presence, noise, dust, and other effects to the environment while the roadwork was being conducted. These effects may have negatively impacted grizzly bears, Woodland caribou, Canada lynx, and wolverines. The roadwork and vegetation clearing also may have created sedimentation issues, negatively impacting water quality and bull trout habitat.

Additionally, it is possible that this roadwork made the road passable so that other agency personnel or members of the public used the road. Such use of the road could have caused negative impacts to a variety of wildlife, including grizzly bears, woodland caribou, Canada lynx, and wolverines. Road use may have also increased the likelihood of poaching as well as increased public access for hunting and trapping. Moreover, road use could cause increased sedimentation, especially given culverts on this road are not fully functional, which could negatively impact water quality and fish, including bull trout.

By failing to analyze the impacts of roadwork completed in 2016, which may negatively impact the environment, including wildlife, fish, and water, the Agencies have violated NEPA.

¹⁵⁶ *Id.*, App. C at 42 (Resp. to Comment 64-131).

VII. The Agencies Have Failed to Consider a Reasonable Range of Alternatives

As noted in our DEIS comments (p. 23-24), the Agencies failed to consider a reasonable range of alternatives. CEQ regulations implementing NEPA require that agencies “(r)igorously explore and objectively evaluate all reasonable alternatives.” 40 C.F.R. § 1502.14(a). The importance of this mandate cannot be downplayed, as a rigorous review of alternatives is considered “the heart of the environmental impact statement.” 40 C.F.R. § 1502.14. According to CEQ regulations, agencies must “use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.” 40 C.F.R. § 1500.1(e).

Furthermore:

The primary purpose of an environmental impact statement is to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the Federal Government. It shall provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.

40 C.F.R. § 1500.2(1). “NEPA’s requirement that alternatives be studied, developed, and described both guides the substance of the environmental decisionmaking and provides evidence that the mandated decisionmaking process has actually taken place.” Bob Marshall Alliance v. Hodel, 852 F.2d 1223, 1228 (9th Cir. 1988) (citation omitted). This analysis, for example, must include a reasonable range of alternatives that would meet the defined purpose and need of the project. See, e.g., Idaho Conservation League v. Mumma, 956 F.2d 1508, 1520 (9th Cir. 1992) (“nature and scope of proposed action” determines the range of reasonable alternatives agency must consider).

As described below, the Agencies here failed to analyze a reasonable range of alternatives for the Bog Creek Road project proposal, thereby violating NEPA.

A. The Agencies Arbitrarily Modified the Purpose and Need So That Only the Preferred Alternative Would Meet the Modified Purpose and Need

As described in Section II above, the Agencies made last minute changes to the purpose and need for the project noted for the first time in the FEIS, which requires that the Agencies ensure the project adheres to the Grizzly Bear Recovery Plan. The Agencies, however, did not propose additional alternatives that would meet this newly stated purpose. Instead the Agencies continued to analyze the alternatives proposed in the DEIS, altering two alternatives slightly, and

concluding that its new preferred alternative was now the only alternative that would meet the purpose and need of the project.¹⁵⁷

The Agencies failed to undertake an analysis evaluating a reasonable range of alternatives as required under NEPA. Several other alternatives could have been put forward that would have met the purpose and need—even as revised—but the Agencies refused to analyze them. Some of these alternatives are described below. The Agencies’ tactic, to analyze just a single alternative that meets the elaborate purpose and need laid out defeats the entire purpose of NEPA.

B. The Agencies Failed to Analyze the Alternative Proposed by Objectors

In our DEIS comments (p. 23-24), we suggested a reasonable alternative for the Agencies to consider. Specifically, we suggested that the Agencies consider an alternative under which the Forest Service would work to close open roads and meet the Access Amendment standards before moving forward to repair and open to increased use Bog Creek and Blue Joe Creek roads. Under this alternative, work throughout the Blue-Grass BMU would be staggered so that there is less human presence and negative impact to wildlife at any given time. This is a reasonable alternative that the Agencies should have considered.

The Agencies did not consider this alternative, nor even explain why it was not considered. As noted above, the Agencies did not acknowledge, consider, or respond to any of the issues raised in our comments, even though we have confirmation that the Agencies received them. Consideration of our proposed reasonable alternative is no exception. The FEIS discusses various alternatives proposed by the public during the DEIS comment period that were eliminated from detailed study and the rationale for not analyzing them in depth.¹⁵⁸ Our proposed alternative is not acknowledged in this section.

The Agencies’ failure to consider and analyze Objectors’ reasonable alternative violates NEPA.

C. The Agencies Arbitrarily Eliminated Alternatives With Seasonal Use Restrictions

In our DEIS comments (p.24), we noted that the Agencies arbitrarily eliminated analyzing alternatives with seasonal use restrictions. As noted above, the Agencies’ latest proposal expands and alters the project by, inter alia, eliminating the seasonal restrictions on Bog Creek Road and Blue Joe Creek Road. An alternative reflecting the action as originally proposed during scoping in May 2016 – that would maintain season restricted designations on Bog Creek

¹⁵⁷ Id. at 42, Table 2.4.1.

¹⁵⁸ Id. at 42.

Road and Blue Joe Creek Road, limiting administrative motorized access to 57 trips per active bear year – is reasonable and should be considered in detail.¹⁵⁹

Without supporting evidence, the Agencies determined that a seasonally restricted designation for Bog Creek Road would not be sufficient to ensure border security in the area. Similarly, the Agencies determined it is necessary to remove the seasonally restricted designation from the Blue Joe Creek Road without adequate justification or explanation. There is no reasoning to explain why seasonal restrictions will prevent the Agencies from achieving the stated purpose and need for this proposal. Simply providing conclusory statements without supporting evidence is arbitrary and capricious, and a violation of NEPA.

VIII. The Agencies Failed to Demonstrate Compliance with the Endangered Species Act

As stated in our DEIS comments (p. 25), the Agencies have failed to demonstrate compliance with the ESA. Although it is difficult to analyze the Agencies’ purported compliance without the benefit of reviewing the biological opinion prepared for this project, we would like to point out some potential violations of the ESA that we believe will occur should this project move forward under the preferred alternative.

First, we believe that this project will result in the “take” of listed species in violation of Section 9 of the ESA. See 16 U.S.C. § 1538(a)(1)(B). “Taking” under the ESA “means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” *Id.* § 1532(19). The “take” prohibited by Section 9 need not be the result of purposeful action. See Nat’l Wildlife Fed. V. Burlington Northern Railroad, 23 F.3d 1508, 1509 (9th Cir. 1994) (trains accidentally hitting and thereby taking grizzly bears constitutes an ESA violation). Grizzly bears are likely to be harmed by implementation of any of the action alternatives as they are displaced from areas where construction and closure activities are taking place. Canada lynx may also be harmed and displaced from these areas. Additionally, road construction and use are likely to cause sedimentation which will harm bull trout. Thus, the Agencies are in danger of violating Section 9’s take prohibition.

Second, Section 7(a)(1) of the ESA provides that all federal agencies shall “utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species listed” 16 U.S.C. § 1536(a)(1). We believe that the Forest Service and CPB would be violating the ESA by implementing any of the action alternatives for the Bog Creek Road project, which would impede rather than further conservation of numerous listed species, including grizzly bears, caribou, Canada lynx, and bull trout.

¹⁵⁹ *Id.* at 36.

We will evaluate the Biological Opinion and any Incidental Take Statements upon release to determine if the Agencies have complied with the ESA's consultation requirements.

IX. The Agencies Failed to Demonstrate Compliance with the Clean Water Act

As stated in our DEIS comments (p. 25-26), the Agencies have failed to demonstrate compliance with the Clean Water Act ("CWA"). In our DEIS comments we explained that the CWA establishes a comprehensive program "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" by reducing and eventually eliminating the discharge of pollutants into those waters. 33 U.S.C. § 1251(a). The CWA program includes a regulatory scheme of permits, technology controls, and water quality-based pollution controls. States are responsible for developing water quality standards to protect the desired conditions of each waterway within a state's regulatory jurisdiction. 33 U.S.C. § 1313(c). A water quality standard includes three elements: (1) one or more designated uses, such as fish propagation; (2) numeric and narrative criteria specifying the water quality condition necessary to protect the designated uses; and (3) an anti-degradation policy that ensures that uses are protected and that high quality waters will be maintained and protected. 33 U.S.C. §§ 1313(c)(2) 1313(d)(4)(B); 40 C.F.R. §§ 131.6, 131.10-12. Waters that do not meet water quality standards are deemed "water quality-limited" and placed on the CWA's § 303(d) list. States must develop total maximum daily loads ("TMDLs") for all § 303(d)-listed waterbodies to bring them back into compliance with applicable water quality standards. All federal agencies must comply with state water quality standards, including a state's anti-degradation policy. 33 U.S.C. § 1323(a); Idaho Sporting Congress v. Thomas, 137 F.3d 1146 (9th Cir. 1998).

Here several waters in the project area are 303(d) listed as impaired for temperature.¹⁶⁰ The Agencies fail to ensure that the project will comply with the CWA by not causing or contributing to a violation of Idaho's water quality standards. This failure rests upon an over-reliance on best management practices (BMPs) to mitigate any potential harm to water quality from management activities: "[d]esign features proposed to control erosion and sedimentation include leaving riparian vegetation along water bodies whenever feasible."¹⁶¹ The Agencies fail to explain when it will leave riparian vegetation in place, (e.g. "feasible"), or demonstrate how the project will not cause or contribution to a violation of water quality standards (temperature) despite vegetation removal, and the anticipated increases of sedimentation into receiving waters and a lack of future maintenance plans for these roads. The FEIS does note the design standards direct, "immediate revegetation following wetland crossing or culvert installation, and installation of streamside erosion control structures until the banks have reestablished vegetation."¹⁶² Yet the analysis cites only one study to support the assertion these design criteria will be effective and

¹⁶⁰ Id. at 249, Table 3.6.1.

¹⁶¹ Id. at 256.

¹⁶² Id. at 257.

lacks any actual evidence such as previous monitoring data or best management practice audit reports.¹⁶³ This is especially important in the context of increased storm events, and late winter/early spring snow melt due to human-induced climate change. Design criteria, such as the what the Agencies propose, must be able to function properly with new climate conditions, a fact the FEIS fails to address.

X. Conclusion and Proposed Resolution

As detailed above, the FEIS and Draft ROD fail to fully comply with numerous federal laws and regulations. We believe that the only possible resolution to right these legal failures is to choose the No Action Alternative or to issue a supplemental NEPA analysis. We also believe that a supplemental analysis is required due to the Agencies' failure to include and respond to our DEIS comments. The Agencies cannot approve any of the action alternatives described in the FEIS unless and until compliance with all laws is demonstrated.

Submitted this 1st day of April, 2019.

/s/ Andrea Santarsiere

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Email: captmayo@eoni.com

EXHIBIT 1

From: **Marla Fox** <mfox@wildearthguardians.org>
Date: Mon, Jul 16, 2018 at 5:35 PM
Subject: Comments re DEIS for Bog Creek Road Project #41296
To: <SPWBogCreekEIS@cbp.dhs.gov>, <sdekome@fs.fed.us>

Hello,

Attached please find a comment letter on the Bog Creek DEIS from multiple conservation organizations. The comment letter includes Attachments A, B, and C.

Thank you,
Marla Fox

4 Attachments



PDF2018 07 16 Bog Cr...



PDFAttachment A - Lit...



PDFAttachment B - 20...



PDFAttachment C - Swi...

----- Forwarded message -----

From: **SPWBOGCREEKEIS** <spwbogcreekeis@cbp.dhs.gov>

Date: Wed, Jul 18, 2018 at 10:26 AM

Subject: RE: Comments re DEIS for Bog Creek Road Project #41296

To: Marla Fox <mfox@wildearthguardians.org>, sdekome@fs.fed.us <sdekome@fs.fed.us>

Thanks for the comments.



July 16, 2018

Responsible Official

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Bog Creek Road EIS

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Re: Comments re Draft Environmental Impact Statement for the Bog Creek Road Project #41296

To Whom it May Concern:

In May 2016, the undersigned groups submitted scoping concerning the repair and maintenance of Bog Creek Road and closure of certain roads within the Blue-Grass Bear Management Unit in the Selkirk Mountains in Boundary County, Idaho. These groups all have a substantial interest in this proposal given its potential impacts to wildlife, including grizzly bears, Woodland caribou, and Canada lynx, all listed under the Endangered Species Act (“ESA”). Due largely to concerns about the impact of repairing and opening Bog Creek Road, the undersigned groups opposed the project proposal.

Now, the Forest Service (“USFS”) and U.S. Customs and Border Protection (“CBP”) (collectively, “the Agencies”) have released a Draft Environmental Impact Statement (“DEIS”)

that expands and alters the proposal in a manner that will cause even greater harm to sensitive wildlife in the project area.¹ For example, the Proposed Action during scoping in May 2016 would maintain season restricted designations on Bog Creek Road and Blue Joe Creek Road, limiting administrative motorized access to 57 trips per active bear year.² Now, suddenly, the Agencies have determined that a seasonally restricted designation would not be sufficient to ensure border security in the area, and thus have removed the seasonally restricted designation for Bog Creek Road from all alternatives.³ Furthermore, the Agencies have now determined that it is necessary to remove the seasonally restricted designation from the Blue Joe Creek Road to “better allow the agency to meet the Access Amendment standards and their legal obligation to provide access to private property within the Blue-Grass BMU.”⁴ What the Agencies fail to provide is information as to why CBP suddenly feels it needs year-round, unlimited access on these roads, and why the Agencies feel it needs to open Blue Joe Creek Road to allow private property owners to access the Continental Mine when the Agencies have seemingly met the requirement to provide access to the mine with a seasonal restriction on Blue Joe Creek Road in the past. What is apparent is that the Agencies listened to the concerns of CBP and private property owners and ignored the concerns of environmentalists who wish to protect wildlife and wildlife habitat in this region. Moreover, while the Agencies assert that CBP needs continuous access to the border via Bog Creek Road and Blue Joe Creek Road to deal with “legitimate threats,” there is no discussion anywhere in the DEIS as to what these legitimate threats might entail.⁵

For the reasons described herein, we believe that the DEIS fails to comply with law and we support the No Action Alternative.

I. CBP’s Vegetation Removal Work on Bog Creek Road Was Performed Illegally

A. The Agencies Have Violated NEPA By Conducting Work on Bog Creek Road Before Completing a NEPA Analysis

The Agencies held two scoping periods to evaluate the proposal to repair and maintain Bog Creek Road: one in 2013 and one in 2016.⁶ In response to scoping, the Agencies received several comment letters, including from environmental groups opposing the project. Without completing the required analysis under the National Environmental Policy Act, CBP went forward and conducted vegetation-clearing activities on the eastern portion of the Bog Creek

¹ U.S. Department of Homeland Security, U.S. Customs and Border Protection & U.S. Department of Agriculture, Idaho Panhandle National Forest, Bonners Ferry and Priest Lake Ranger Districts, Draft Environmental Impact Statement, Bog Creek Road Project (June 2018) (hereinafter, “DEIS”).

² *Id.* at 36.

³ *Id.*

⁴ *Id.*

⁵ *Id.* at 6.

⁶ *Id.* at Executive Summary, xv.

Road corridor in 2016.⁷ According to the DEIS, “[v]egetation removal was performed on an approximately 6-foot-wide x 1-mile-long corridor on the east end of the roadway.”⁸ It is unclear if there was any public notice or an opportunity to comment before this “vegetation removal” was performed, and it is completely clear that no NEPA analysis was approved or completed before CBP undertook these activities on public lands. What is clear is that the Agencies have taken the first steps in repairing Bog Creek Road, as proposed in the DEIS, before the NEPA analysis is complete.

NEPA’s twin objectives are (1) to ensure that agencies take a “hard look” at every significant aspect of the environmental impact of a proposed action, and (2) to guarantee that relevant information is available to the public to promote well-informed public participation. “NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.” 40 C.F.R. § 1500.1(b) (emphasis added). An agency cannot take any action or make any commitment of resources before making its final decision that would have an adverse environmental impact or prejudice or limit the choice of reasonable alternatives. Id. §§ 1502.2(f), 1506.1(a). Thus, NEPA requires that an agency take a “hard look” at the impacts of its actions before the point of commitment so that it does not deprive itself of the ability “to foster excellent action.” See id. § 1500.1(c). Thus, agencies must commence the NEPA process “at the earliest possible time to insure that planning and decisions reflect environmental values.” Id. § 1501.2. In this way, NEPA ensures that the agency will not act on incomplete information only to regret its decision after it is too late to correct.

CBP’s work on the Bog Creek Road is a clear violation of NEPA. Before completing this work, CBP failed to conduct any NEPA. CBP did not prepare an environmental impact statement, an environmental assessment, a finding of no significant impact, or a categorical exclusion for the road work. CBP failed to take the requisite “hard look” at the environmental impacts of its decision, including by properly involving the public and by studying the direct, indirect, and cumulative impacts of its actions, and alternatives that might be less environmentally destructive.

We request that the Agencies complete a supplemental environmental impact statement for the work already completed on Bog Creek Road. Agencies must prepare supplements to either draft or final EISs when the agency makes substantial changes in the proposed action that are relevant to environmental concerns or when there are significant new circumstances or information relevant to environmental concerns bearing on the proposed action or its impacts. Id. § 1502.9(c)(1). CBP must prepare a supplement environmental impact statement on the work completed on Bog Creek Road, which reflects a change in the proposed action and significant new information.

⁷ Id. at 2.

⁸ Id.

B. The Agencies Have Violated the Endangered Species Act By Conducting Work on Bog Creek Road

CBP's work on the Bog Creek Road is also a violation of the Endangered Species Act ("ESA"), because CBP failed to consult with the Fish and Wildlife Service on the impacts of its actions on grizzly bears, Woodland caribou, Canada lynx, and bull trout – all of which are federally listed species. Section 7 of the ESA requires each federal agency, in consultation with the Fish and Wildlife Service ("FWS"), to insure that any proposed action is not likely to jeopardize the continued existence of a threatened or endangered species, or result in the destruction or adverse modification of its critical habitat. 16 U.S.C. § 1536(a)(2). To facilitate compliance with Section 7, the agency must first inquire with FWS to determine whether any listed or proposed species may be present in the area of the proposed action. *Id.* § 1536(c)(1). When a listed or proposed species may be present in the action area, the agency must prepare a "biological assessment" to determine whether the species or their critical habitat may be affected by the action. *Id.* If the agency determines that the proposed action may affect any listed species or critical habitat, it must engage in formal consultation with FWS. 50 C.F.R. § 402.14.

During consultation, FWS must review all relevant information, evaluate the current status of the species or critical habitat, and evaluate the effects and cumulative effects of the proposed action on the listed species and their critical habitat. 16 U.S.C. § 1536(b)(3)(A); 50 C.F.R. § 402.14(g)(1)–(3). For the purposes of the ESA, "[e]ffects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline." 50 C.F.R. § 402.02. Cumulative effects "are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." *Id.* Throughout its analysis, the consulting agency must utilize the "best scientific and commercial data available." 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14(d). By failing to consult before completing work on the Bog Creek Road, the Agencies have violated the ESA's consultation requirements.

Section 9 requires that agencies insure that the proposed action does not result in the "take" of any listed species. 16 U.S.C. § 1538(a)(1)(B). "Taking" under the ESA "means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." *Id.* § 1532(19). The "take" prohibited by Section 9 need not be the result of purposeful action. *Nat'l Wildlife Fed. v. Burlington Northern Railroad*, 23 F.3d 1508, 1509 (9th Cir. 1994) (trains accidentally hitting and thereby taking grizzly bears constitutes an ESA violation). It is highly likely that CBP's road work harmed and harassed listed species, including grizzly bears, Woodland caribou, Canada lynx, and bull trout.

CBP's road work violates both Section 7 and Section 9 of the ESA.

C. The Agencies Must Reclaim Bog Creek Road

In order to avoid litigation on CBP's illegal road work, we urge the Agencies to reclaim the work done on Bog Creek Road and return the road to its pre-project condition. This may include the placing of boulders, seeding, and/or shrub planting to prevent motorized equipment from using the old existing route. The Agencies must provide a written agreement to the undersigned organizations of its intent to reclaim the road. Furthermore, the Agencies must agree in writing to do no more repair work, including but not limited to vegetation clearing, on the Bog Creek Road or the Blue Joe Creek Road until a NEPA analysis and ESA consultation is complete. If no action is taken, the undersigned organizations may initiate a lawsuit to seek judicial remedies.

II. The Agencies Fail to Ensure Compliance with the National Forest Management Act

The Agencies must comply with National Forest Management Act ("NFMA") and its implementing regulations. NFMA requires the Forest Service to ensure that site-specific management projects are consistent with the applicable forest plan. 16 U.S.C. § 1604(i). Thus, the Agencies must ensure that all aspects of the proposed action comply with the Idaho Panhandle National Forests Land Management Plan.⁹ The following examples demonstrate how the Agencies fails to make that assurance for this proposal.

A. None of the Action Alternatives Would Meet the Access Amendment Standards

Specifically, the Service must ensure the project complies with all forestwide standards and guidelines, including the Grizzly Bear Access Amendment.

The Access Amendment adopted the following standards for the Blue-Grass BMU:

1. Open motorized route density (OMRD) of greater than 1 mile per square mile on no more than 33 percent of the BMU;
2. Total motorized route density (TMRD) of greater than 2 miles per square mile on no more than 26 percent of the BMU; and
3. Grizzly bear core area habitat comprising at least 55 percent of the BMU.¹⁰

According to Table 1.2.1 in the DEIS, in 2016 the OMRD in the Blue-Grass MMU was 30 percent, the TMRD was 29 percent, and the grizzly bear core area habitat was 48 percent.¹¹

⁹ USDA, Forest Service, Northern Region, Idaho Panhandle National Forests Land Management Plan (2015 Revision).

¹⁰ DEIS at 4.

However, the Agencies rely on lower numbers represented in Table 2.2.1, which shows OMRD at 14.87 percent, TMRD at 28.95 percent, and grizzly bear core habitat at 48.25 percent.¹² While the difference in the tables is not entirely clear, the DEIS asserts that Table 2.2.1 “reflects route designations . . . , not monitoring results from prior years.”¹³ Moreover, the DEIS explains that OMRD is not static, but rather is modeled based on the open motorized route density for a specific year and changes from year to year.¹⁴ Over the past ten years, OMRD in the Blue-Grass BMU has ranged from a low of 22.76 percent to a high of 34.65 percent, with the high obviously being above that permitted under the Access Amendment standard.¹⁵ This is largely because “[s]ometimes motorized administrative use exceeds the trip limit restrictions for individual road segments.”¹⁶

In any event, the Agencies cannot ignore the monitoring results from 2016, which is a true reflection of what is happening on the ground. Furthermore, the Agencies fail to explain the drastic difference between the 2016 monitoring results and the current designations. The large difference between the 2016 monitoring results and route designations, however, implies that either the public is unaware of or is ignoring closure designations, or that closure designations are insufficiently marked and not being enforced. Under either scenario, the Agencies must adequately explain the difference between the 2016 monitoring results and the current designations and explain why it is appropriate to ignore the 2016 monitoring results while relying instead on the current designations.

Because what is happening on the ground—as opposed to designations on paper—is what impacts wildlife and wildlife habitat, we believe the Agencies should be using the 2016 monitoring results as the appropriate baseline to assess the impacts of the proposed alternatives in the DEIS. Failure to use an appropriate baseline constitutes a NEPA violation. Furthermore, if the Agencies use the 2016 monitoring results as the appropriate baseline, none of the action alternatives would meet the Access Amendment standards, and thus fail to meet the purpose and need of the project. We therefore recommend that the Agencies propose new action alternatives that would meet the Access Amendment standards using the 2016 monitoring results as the appropriate baseline to assess impacts to wildlife and wildlife habitat in the Blue-Grass BMU.

B. Failure to Demonstrate Compliance with the Grizzly Core Habitat Buffer

¹¹ Id. at 5, Table 1.2.1.

¹² Id. at 16, Table 2.2.1.

¹³ Id.

¹⁴ Id. at 73.

¹⁵ Id. at 74.

¹⁶ Id. at 74.

Under the action alternatives, the DEIS notes the Agencies will monitor the use of Bog Creek Road for potential high use after repair. If an average of more than 20 parties per week use the trail, it would be considered a high use trail and a buffer would be removed from grizzly bear core area habitat.¹⁷ High-use trails have the potential to disturb or displace bears, and are buffered in the same fashion as drivable roads.¹⁸ The buffered area surrounding high-use trails is removed from core area habitat.¹⁹ The Agencies fail to explain how it would still meet the core area habitat requirements of the Access Amendment standards under the action alternatives when this happens, because presumably a buffer will be removed.

III. The Agencies Failed to Take a Hard Look at Impacts to Wildlife

A. Grizzly Bears

Grizzly bears in the Selkirk ecosystem are listed as a threatened species under the Endangered Species Act, and the Fish and Wildlife Service has found that reclassification to an endangered species is warranted but precluded by work on higher-priority species.²⁰ The most recent population estimate for the Selkirk Recovery Zone is 83 bears, under the minimum population goal of 90 set forth in the Grizzly Bear Recovery Plan.²¹ This population estimate includes just 25 bears residing in the U.S.²² However, this population estimate is over five years old and must be updated with more recent data.²³ Because these grizzly bears have the lowest genetic diversity of any grizzly bears in the lower 48 states, it is of primary importance to protect connectivity corridors and linkage zones so that these bears can breed with bears outside of the confines of the Selkirk Recovery Zone.²⁴

For these reasons, in addition to adopting the Access Amendment standards discussed above, the Idaho Panhandle National Forest Plan aims to ensure that “[a]ll grizzly BMUs have low levels of disturbance to facilitate denning activities, spring use, limit displacement, and reduce human/bear conflicts and potential bear mortality.”²⁵ The Forest Plan favors that “[r]ecover of the grizzly bear is promoted by motorized access management within the IPNF portion of the Cabinet-Yaak and Selkirk recovery zones,” and asserts that the agency shall apply the Interagency Grizzly Bear Guidelines to management activities.²⁶

¹⁷ See, e.g., *id.* at 42, 115.

¹⁸ *Id.* at 77.

¹⁹ *Id.*

²⁰ *Id.* at 73.

²¹ *Id.* at 75.

²² *Id.*

²³ *Id.*

²⁴ See *id.*

²⁵ United States Department of Agriculture, United States Forest Service, Land Management Plan: Idaho Panhandle National Forests (2015 Revision) (hereinafter, “Forest Plan”), at 29.

²⁶ *Id.* at 29, 32.

The Interagency Grizzly Bear Guidelines call on the Forest Service to “emphasize actions which contribute toward conservation and recovery of the bear within areas identified in the Grizzly Bear Recovery Plan” and “to maintain and enhance habitat and to minimize potential for grizzly-human conflicts.”²⁷ The agency will manage these lands for multiple land use benefits, but only “to the extent these land uses are compatible with the goal of grizzly recovery.”²⁸ “Land uses which cannot be made compatible with the goal of grizzly recovery, and are under FS control, will be redirected or discontinued.”²⁹ The Blue-Grass BMU has been designated Management Situation 1, meaning that managing for grizzly bears shall receive “the highest management priority,” and land management decisions must favor the needs of grizzly bears over other competing land use values.³⁰ Other land uses will only be permitted if they can be made compatible with grizzly needs.³¹

None of the action alternatives in the DEIS are compatible with grizzly bear needs, as building and repairing the Bog Creek Road and increasing access and motorized use on the Blue Joe Creek Road will cause disturbance, avoidance, and is likely to displace bears currently using the area. Current data shows extensive use by grizzly bears of the Blue-Grass BMU, including breeding bears and denning habitat.³² While the Agencies admit that all of the action alternatives would cause both short-term and long-term detrimental impacts to grizzly bears, the Agencies fail to follow the mandates of the Forest Plan and the Interagency Grizzly Bear Guidelines to prioritize grizzly recovery over other land use values in the Blue-Grass BMU.³³ The Agencies cannot justify its actions by creating and Purpose and Need statement that prioritizes other land use values, including the stated goal to improve border access.³⁴

In addition, the project area contains lands in the Priest Lake Geographic Area and the Lower Kootenai Geographic Area, both of which have Forest Plan desired conditions to maintain low levels of human disturbance in grizzly bear habitat and to retain linkage corridors for grizzly bears and other wildlife.³⁵ The Project Area also includes Management Areas 1b (Recommended Wilderness) and 5 (Backcountry), both of which contain large remote areas with little human disturbance that should be retained and contribute habitat for species with large home ranges such as wide ranging carnivores (e.g., grizzly bears).³⁶ In other words, these large expanses of habitat should remain remote with little human disturbance to provide secure habitat and connectivity corridors for grizzly bears.³⁷

²⁷ Interagency Grizzly Bear Committee, Interagency Grizzly Bear Guidelines (1986), at 2.

²⁸ *Id.* at 2.

²⁹ *Id.* at 2.

³⁰ *Id.* at 3; DEIS at 75.

³¹ Interagency Grizzly Bear Committee, Interagency Grizzly Bear Guidelines (1986), at 3.

³² DEIS at 75-76.

³³ See DEIS at 40-43, Table 2.4.2 (comparing impacts to grizzly bears by alternative).

³⁴ *Id.* at 6.

³⁵ *Id.* at 91-92, Table 3.2.6; Forest Plan at 84-85, 92-93.

³⁶ DEIS at 91, Table 3.2.6; Forest Plan at 46-47, 69.

³⁷ Forest Plan at 46-47, 69.

As the DEIS admits, however, the action alternatives have the potential to disrupt grizzly bear movement through linkage corridors, and therefore do not meet the desired conditions as described in the Forest Plan.³⁸ Specifically, the Blue-Grass BMU is an important connectivity corridor for grizzly bears.³⁹ But the repair, motorized closure activities, and increased motorized use of Bog Creek and Blue Joe Creek roads will significantly impact bear movements throughout the BMU, which bears use as a movement corridor between other BMUs in the Selkirk and Recovery Zone, including bears that move in a north-south direction to reach the Canadian portion of the Selkirk Recovery Zone.⁴⁰ The Agencies acknowledge that the proposed activities will “reduc[e] the permeability of the movement corridor as a whole” and may decrease the genetic flow between the U.S. and Canadian bear populations.⁴¹ This avoidance behavior could continue indefinitely given the long-term administrative motorized use proposed.⁴²

By reconstructing a currently overgrown and impassible road and opening another seasonally restricted road up to unrestricted access, the Agencies fail to comply with the Desired Conditions in the Forest Plan laid out for these geographic and management areas. The action alternatives will simply add more disturbance to an area considered necessary habitat for grizzly bear recovery, and thus cannot be aligned with the goals of the Forest Plan.

Furthermore, the Agencies rely on research from the 1980s in attempts to predict when bears will be using higher and lower elevations in the BMU, and to predicate its assertions that it will base its work season around when grizzly bears may be using the areas surrounding the roads under construction.⁴³ This research, however, is woefully outdated and does not present an accurate account of what grizzly bears are doing on the ground now. For example, this research does not account for climate change, which may be causing bears to emerge from their dens and use low elevations lands later in the season than they did in the 1980s. NEPA requires that agencies use “high quality” information and “accurate scientific analysis,” and thus we request that the Agencies update this section of the EIS with timely and up-to-date science and data.

B. Woodland Caribou

In 1983, the southern Selkirk Mountain population of woodland caribou was emergency listed as endangered under the Endangered Species Act, and the caribou was finally listed as endangered on February 29, 1984.⁴⁴ These caribou are also listed as a state endangered species and an Idaho

³⁸ DEIS at 98.

³⁹ *Id.* at 99.

⁴⁰ *Id.* at 99, 115.

⁴¹ *Id.* at 99.

⁴² *Id.*

⁴³ *Id.* at 76.

⁴⁴ *Id.* at 78.

Tier 1 Species of Greatest Conservation Need.⁴⁵ The 1985 Recovery Plan set an intermediate population target of 100 to 109 caribou, and the 1994 Recovery Plan set a goal of maintaining two herds – one in British Columbia and Idaho – with the stated goal to establish a herd in Washington as well.⁴⁶ None of these goals have been achieved, and in 2016, only 12 caribou were detected during monitoring efforts.⁴⁷ Unfortunately, this Woodland caribou population has been spiraling toward extinction without pause. As of the spring 2018 census there were only three females in the Southern Selkirk Herd, none of which were pregnant. There are four remaining caribou in the S. Purcell herd (three bulls and one cow). According to the Fish and Wildlife Service, past and ongoing habitat destruction and fragmentation and motorized road access to caribou habitat are two of the six greatest threats to this struggling population.⁴⁸

Although it is critically important to protect caribou habitat in the Selkirks, the project coincides with three Caribou Management Units (“CMUs”): Upper Priest, Grass, and Cow.⁴⁹ The caribou analysis area consists of 67,960 acres, 93 percent of which is considered caribou habitat.⁵⁰ Caribou have been documented both historically and recently in all three CMUs included in the project’s caribou analysis area, including along the Bog Creek Road corridor.⁵¹

The Agencies also acknowledge that limited genetic exchange between this population and adjacent populations threatens the long-term population viability of the Woodland caribou.⁵² The action alternatives have the potential to further decrease gene flow for caribou in the project area.⁵³

According to the DEIS, under all action alternatives, road maintenance and decommissioning may last up to three seasons.⁵⁴ With just a dozen caribou documented as remaining in this population, however, it is unknown whether this population—so close to the brink of extinction—could survive three full seasons of road work. Remoteness from human presence, low road densities, and limited motorized access are all important factors impacting caribou habitat selection and survival.⁵⁵ In addition to causing displacement as caribou avoid human presence, roads may also increase predation upon caribou by wolves and other predators.⁵⁶ Notably, law enforcement patrol, because exceptions to winter motorized closures and road use are often made, is listed as a specific factor that has impacted and may continue to impact the

⁴⁵ Id.

⁴⁶ Id. at 79.

⁴⁷ Id.

⁴⁸ Id. at 79-80.

⁴⁹ Id. at 80.

⁵⁰ Id. at 81.

⁵¹ Id.

⁵² Id. at 80.

⁵³ Id. at 97.

⁵⁴ See, e.g., id. at 19.

⁵⁵ Id. at 82.

⁵⁶ Id.

destruction and fragmentation of caribou habitat.⁵⁷ Roads may also impact modeled travel corridors necessary to achieve the goals of the Recovery Plan.⁵⁸

The action alternatives also do not comply with the Forest Plan guideline to avoid or minimize disturbance in occupied caribou summer habitat from July 8 to October 16.⁵⁹ Rather than follow this guidelines, the Agencies propose road construction and repair work from July 16 to November 15 for up to three years in known occupied caribou habitat, and would increase road use in the same area in perpetuity.⁶⁰

Due to the small size of the Woodland caribou population in the Selkirks and the negative impacts that roads can have upon caribou and their habitat, we believe that this project will jeopardize the recovery and continued survival of this Woodland caribou population. We believe that the Agencies must take a closer look at the impacts to Woodland caribou and the likelihood that this project may accelerate the extinction of this small population.

C. Bull Trout

Bull trout are a cold-water fish of relatively pristine streams and lakes. They have specific habitat requirements: cold, clean, complex and connected habitat. Primary threats to bull trout include habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management, and the introduction of non-native species such as brown, lake, and brook trout. Effects resulting from climate change also threaten bull trout, because a warming climate is expected to shrink cool spawning and rearing areas. Bull trout occur over a large area, but their distribution and abundance has declined and scientists have documented several local extinctions. Remaining populations tend to be small and isolated from each other, making the species more susceptible to local extinctions.

Bull trout in the project area are listed as threatened under the Endangered Species Act and are considered to be in decline across their range.⁶¹ Designated bull trout critical habitat exists in the project area, downstream from numerous tributaries that Bog Creek Road crosses.⁶² The Agencies recognize that historic road construction, timber harvest, and mining that have occurred in the analysis area have likely reduced the habitat quality and connectivity of streams occupied by bull trout and streams designated as bull trout critical habitat.⁶³ Road construction and increased use—as proposed under all action alternatives—threatens to increase sedimentation into streams occupied by bull trout and mapped as designated critical habitat, including Upper

⁵⁷ *Id.*

⁵⁸ *Id.* at 82-83.

⁵⁹ *Id.* at 91.

⁶⁰ *See, e.g., id.* at 19.

⁶¹ *Id.* at 88-89.

⁶² *Id.* at 72 (map of bull trout critical habitat in project area).

⁶³ *Id.* at 89.

Priest River, Malcom Creek, and Lime Creek.⁶⁴ Indeed, road construction is one of the greatest factors affecting bull trout survival.⁶⁵ Sedimentation can reduce habitat complexity and pool depth, reduce egg survival and emergence, kill young bull trout, and can impact insect larvae preyed upon by bull trout.⁶⁶

Roads often contribute to degraded baseline conditions in watersheds containing bull trout. Roads are a primary source of sediment impacts to developed watersheds. Accumulation of fine sediment is detrimental to bull trout habitat. Studies have found a pattern of decreasing strong populations of bull trout with increasing road density. Sediment delivered to streams is greatest in riparian areas where roads cross the streams. Fords and approaches to the crossings deliver sediment directly to streams.

Culverts can produce a large amount of sediment if the culvert plugs and fails. Travel management decisions affecting roads and trails are most likely to effect substrate embeddedness⁶⁷ and stream bank condition.⁶⁸ Plus roads and trails paralleling streams can interfere with large wood reaching the stream and cause increased erosion and decreased stream bank condition.

The Agencies note that repair and maintenance of Bog Creek Road would include installation of six new culverts and replacement of six out of 67 existing corrugated metal pipe culverts located along the length of the roadway.⁶⁹ The Agencies further assert that a culvert failure and resulting road washout made the road completely impassable at Spread Creek.⁷⁰ The fact that this washout exists demonstrates the lack of maintenance by the Agencies on existing culverts, despite the known and demonstrated risk of culvert washouts. Proposing *new* culverts ignores the Agencies' limited capacity to maintain even the existing culverts, much less ensure protection of bull trout and water quality in bull trout critical habitat downstream from culverts. This, despite the Agencies' historic lack of maintenance and resulting culvert washouts. It fails to disclose that culvert washouts are just as likely under the action alternatives (given that the number of culverts will actually *increase* and the agency's maintenance funding continues to decrease) as the no action alternative.⁷¹

For the action alternatives, the Agencies' state sedimentation from culvert replacement could be measurable to 800 feet downstream, while sedimentation from culvert removals could be

⁶⁴ See *id.* at 72, Figure 3.2.5; *id.* at 88, Table 3.2.5.

⁶⁵ *Id.* at 89.

⁶⁶ *Id.* at 89, 96.

⁶⁷ Which can be measured as change in total acreage open to motorized use, based on the assumption that embeddedness is related to the total area susceptible to erosion.

⁶⁸ Which can be measured as an inverse of stream crossings.

⁶⁹ DEIS at xiii.

⁷⁰ *Id.*

⁷¹ *Id.* at 47 (stating that "[t]here would be a lower long-term potential, compared with the No-Action Alternative, for culvert failure . . . following culvert replacement or removal," while ignoring the continuing potential for culvert failure from the 67 remaining culverts on Bog Creek Road that will be subject to increased use by opening the road).

measurable 3,000 feet downstream.⁷² The DEIS also states the effects from culvert replacement or removal would be temporary (less than 24 hours).⁷³ And it states that bull trout are located over 4,000 feet downstream from the proposed in-stream work to remove or replace culverts.⁷⁴

The Agencies improperly skew the impacts analysis in favor of the action alternatives by conveniently ignoring impacts that will result under all of the alternatives. For example, the DEIS makes no mention of the ongoing risk of culvert failure from the 67 culverts remaining on Bog Creek Road even after maintenance under each of the action alternatives. In contrast, the agency states that under the No Action alternative “culvert failure or blowout could catastrophically release sediment downstream” with detrimental impacts for the following 5-10 years to downstream bull trout and designated bull trout critical habitat (Upper Priest River, Malcom Creek, and Lime Creek).⁷⁵ The Agencies’ analysis arbitrarily and capriciously omits the impact of keeping 67 culverts on Bog Creek Road under the action alternatives. These culverts are subject to catastrophic failure, as explained in the No Action alternative analysis.

D. Canada Lynx

The Agencies must thoroughly disclose, analyze, and vet impacts to Canada lynx and its habitat before any final decision is made on this project. They also must ensure that the project complies with all aspects of the Northern Rockies Lynx Amendment (NRLA). Lynx move between boreal habitats in Canada and the contiguous United States. Immigration of lynx from Canada plays a vital role in sustaining lynx in the contiguous United States.⁷⁶ The Canada Lynx Conservation Assessment and Strategy (LCAS) initially identified 17 risk factors, including roads, thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements.⁷⁷

Lynx in the contiguous United States may exist as several smaller, effectively isolated populations. Metapopulation stability depends on habitat quality and successful dispersal between isolated habitat patches. The likelihood of subpopulation persistence declines with increasing fragmentation and isolation. Maintaining habitats to provide for dispersal movements and interchange among individuals and subpopulations may be the most important provision for maintenance of population viability in the LCAS.⁷⁸

⁷² Id.

⁷³ Id.

⁷⁴ Id.

⁷⁵ Id.

⁷⁶ McKelvey et al., Theoretical insights into the population viability of lynx, pages 21-38 in L.F. Ruggiero et al., Ecology and conservation of lynx in the contiguous United States, University Press of Colorado, Boulder (2000).

⁷⁷ U.S. Fish and Wildlife Service, Species Status Assessment for the Canada Lynx Contiguous United States Distinct Population Segment (Oct. 2017) (hereinafter, “Species Status Assessment”), page 54.

⁷⁸ Interagency Lynx Biology Team (ILBT), Canada lynx conservation assessment and strategy (3d ed. 2013), Forest Service Publication R1-13-19. The LCAS continues to fulfill important roles in promoting conservation of the species on federal lands like the Payette National Forest. Id. at 4.

Roads associated with forest management fragment habitat and can increase access by competing predators and humans, both potentially affecting lynx habitats and populations.⁷⁹ In Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx.⁸⁰ In another study, lynx denned farther from all roads compared to random expectation.⁸¹ Roads can result in direct mortality of lynx through collision, and also provide human access into lynx habitat where incidental trapping or illegal shooting can occur.⁸² In Maine, 22 out of 54 lynx mortalities occurred on dirt logging roads with low traffic volumes and lower speed limits.⁸³

The Agencies mention the action alternatives will remove vegetation that may provide snowshoe hare habitat (which is prey for lynx).⁸⁴ In a study in Maine, lynx killed fewer hares near logging roads, likely because hare density was lower there than in adjacent un-roaded habitats or possibly because of increased potential for interactions with generalist competitors like coyotes.⁸⁵ At bottom, roads of all sizes may have direct and indirect effects to lynx, including habitat loss and fragmentation, vehicle collisions, increasing human access, increased incidental trapping and illegal shooting, and reduced prey. Impacts to Canada lynx from the snowmobile use authorized for CBP enforcement is addressed below.

E. Wolverines

Wolverines exist in the project area and are currently proposed for listing as threatened under the ESA. The species was originally proposed for listing in 2013 due to risk of eventual habitat and range loss due to climate warming, with secondary threats from trapping and wolverine harvest, human development, transportation corridors, and loss of genetic stochasticity due to isolation between snowy habitats caused by climate change.⁸⁶ The U.S. Fish and Wildlife Service (FWS) withdrew the 2013 proposed listing rule in 2014, but in 2016 a Federal district court ordered FWS to reconsider protections for wolverines under the ESA, moving the wolverine back to the proposed list. The wolverine is also identified as a Sensitive Species by the Forest Service in Region 1, and therefore is subject to the laws and regulations regarding Sensitive Species.

Wolverines appear to avoid transportation corridors in their daily movements.⁸⁷ Most roads in wolverine habitat are low-traffic volume dirt or gravel roads. Wolverines tend to locate natal

⁷⁹ DEIS at 85.

⁸⁰ Id. at 100.

⁸¹ Id. at 101.

⁸² Id.

⁸³ Id.

⁸⁴ Id. at 106.

⁸⁵ Species Status Assessment at 101.

⁸⁶ 78 Fed. Reg. 7864 (Feb. 4, 2013).

⁸⁷ Id. at 7879.

dens a distance from public (greater than 4.6 miles) and private (greater than 1.9 miles) roads.⁸⁸ Impacts to wolverine from the snowmobile use authorized for CBP enforcement is addressed below. The Agencies fail to fully assess these direct, indirect, and cumulative impacts to wolverine from its proposal to open and authorize use on Bog Creek Road and Blue Joe Creek Road.

F. Impacts from Forest Roads

The best available science shows that roads cause significant adverse impacts to National Forest resources.⁸⁹ A 2014 literature review from The Wilderness Society surveys the extensive and best available scientific literature—including the Forest Service’s General Technical Report synthesizing the scientific information on forest roads (Gucinski 2001)—on a wide range of road-related impacts to ecosystem processes and integrity on National Forest lands.⁹⁰ Erosion, compaction, and other alterations in forest geomorphology and hydrology associated with roads seriously impair water quality and aquatic species viability. Roads disturb and fragment wildlife habitat, altering species distribution, interfering with critical life functions such as feeding, breeding, and nesting, and resulting in loss of biodiversity. Roads facilitate increased human intrusion into sensitive areas, resulting in poaching of rare plants and animals, human-ignited wildfires, introduction of exotic species, and damage to archaeological resources.

Roads contribute to the spread of invasive species. Roads themselves, regardless of whether they are open or closed to public access, split apart the forest landscape, creating more buffers where invasive species are likely to grow.⁹¹ The Agencies should include in the EIS an assessment of how the proposed roads (even absent vehicles and regardless of maintenance level) provide a vector for the spread of invasive species by fragmenting the landscape and creating buffers that are less resistant and resilient to stressors like invasive species.

Science shows that roads and trails play a role in affecting wildfire occurrence. See Attachment A at 9 (noting human-ignited wildfires account for more than 90% of fires on national lands and are almost five times more likely in areas with roads). Closed roads remain on the landscape and thus continue to allow for human-caused wildfires. What’s more, roads that remain on the landscape can affect where and how forests burn.⁹² In taking a hard look at this proposal, the Agencies must consider how opening Bog Creek Road and Blue Joe Creek Road to year-round access is likely to increase the risk of wildfire occurrence in this area.

⁸⁸ Id. at 7878.

⁸⁹ See, e.g., 66 Fed. Reg. at 3208 (“Scientific evidence compiled to date [2001] suggests that roads are a significant source of erosion and sedimentation and are, in part, responsible for a decline in the quality of fish and wildlife habitat.”).

⁹⁰ See The Wilderness Society, *Transportation Infrastructure and Access on National Forests and Grasslands: A Literature Review* (May 2014) (Attachment A).

⁹¹ See Attachment A at 11.

⁹² Id.

Finally, a robust analysis under NEPA of the forest roads proposed here is especially critical in the context of climate change. Climate change is a major challenge for natural resource managers because of the magnitude of potential effects and the related uncertainty of those effects.

Climate change intensifies the impacts associated with roads. For example, as the warming climate alters species distribution and forces wildlife migration, landscape connectivity becomes even more critical to species survival and ecosystem resilience.⁹³ Climate change is also expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes.⁹⁴ Many National Forest roads are poorly located and designed to be temporarily on the landscape, making them particularly vulnerable to these climate alterations.⁹⁵ Even those designed for storms and water flows typical of past decades may fail under future weather scenarios, further exacerbating adverse ecological impacts, public safety concerns, and maintenance needs.⁹⁶ At bottom, climate change predictions affect all aspects of road management, including planning and prioritization, operations and maintenance, and design.⁹⁷

The Forest Service has a substantive duty under its own Forest Service Manual to establish resilient ecosystems in the face of climate change.⁹⁸ More broadly, the Forest Service has a mission to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The agency's own climate change science identified above demonstrates how climate change places ecosystems on our national forests at risk. Thus to fulfill this mission, the Agencies must address the risks of climate change when managing activities involving roadwork on our national forests.⁹⁹

Here, the Agencies improperly dismiss climate change impacts in the context of greenhouse gas

⁹³ Attachment A at 9-14.

⁹⁴ See, e.g., Halofsky, J.E. et al. eds., USDA, Forest Service, Pacific Northwest Research Station, *Adapting to Climate Change at Olympic National Forest and Olympic National Park*, PNW-GTR-844 (2011), pages 21-27 (Attachment B).

⁹⁵ See, e.g., *id.* at 36-38.

⁹⁶ See, e.g., Strauch, R.L. et al., *Adapting transportation to climate change on federal lands in Washington State*, Climate Change 130(2), 185-199 (2015) (noting the biggest impacts to roads and trails are expected from temperature-induced changes in hydrologic regimes that enhance autumn flooding and reduce spring snowpack).

⁹⁷ Attachment B at 35.

⁹⁸ See, e.g., FSM 2020.2(2) (directing forests to “[r]estore and maintain resilient ecosystems that will have greater capacity to withstand stressors and recover from disturbances, especially those under changing and uncertain environmental conditions and extreme weather events”); FSM 2020.3(4) (“[E]cological restoration should be integrated into resource management programs and projects . . . Primary elements of an integrated approach are identification and elimination or reduction of stressors that degrade or impair ecological integrity.”).

⁹⁹ USDA, Forest Service, *National Roadmap for Responding to Climate Change* at 26 (2011), available at <http://www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf>, page 4 (outlining the agency's plans to respond to climate change through assessing risks and vulnerabilities, engaging to seek solutions, and managing for resilience).

emissions, stating project emissions would be negligible.¹⁰⁰ The only place the agencies' analysis comes close to assess the impacts of climate change and forest roads is in its discussion of cumulative impacts to wildlife.¹⁰¹ But even there, the analysis fails to consider how climate change may result in changing weather patterns, which is likely to directly and indirectly affect the forest roads proposed herein as well as result in cumulative impacts when combined with forest roads on the landscape and wildlife.

The Agencies must analyze in detail the impact of climate change on forest roads and forest resources. The analysis should start with a vulnerability assessment, to determine the project area's exposure and sensitive to climate change, as well as its adaptive capacity.¹⁰² For example, the Agencies should consider the risk of increased disturbance due to climate change when analyzing this proposed project. It should include existing and reasonably foreseeable climate change impacts as part of the affected environment, assess them as part of the Agencies' hard look at impacts, and integrate them into each of the alternatives, including the no action alternative. The Agencies should also consider the cumulative impacts likely to result from the proposed project, proposed road activities, and climate change.¹⁰³ In planning for climate change impacts and the proposed road activities, the Agencies should consider: (1) protecting large, intact, natural landscapes and ecological processes; (2) identifying and protecting climate refugia that will provide for climate adaptation; and (3) maintaining and establishing ecological connectivity.¹⁰⁴

G. Impacts from Snowmobile Use

The DEIS notes that winter restrictions do not apply to law enforcement activities and thus CBP may access the developed roads via snowmobile during the winter.¹⁰⁵ The Agencies must consider and disclose impacts from the proposal to allow snowmobile use along Bog Creek Road, including impacts to imperiled wildlife.¹⁰⁶

Grizzly Bears

¹⁰⁰ DEIS at 12-13.

¹⁰¹ *Id.* at 171.

¹⁰² Attachment B at 36 ("potential climate change effects underscore the need to increase activity and be proactive in priority areas to avoid impacts associated with infrastructure failure.").

¹⁰³ *Id.* ("Managers will likely need to evaluate the density, location, design, and maintenance intensity of roads and related structures in the context of climate change to avoid escalating road maintenance costs associated with [climate change] impacts").

¹⁰⁴ See Schmitz, O.J. and A.M. Trainor, *Adaptation Approaches for Conserving Ecosystem Services and Biodiversity in Dynamic Landscapes Caused by Climate Change*, USDA Forest Service RMRS-P-71 (2014), pages 301-303.

¹⁰⁵ DEIS at 113.

¹⁰⁶ A. Switalski, Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Wildlife*, 12 Journal of Conservation Planning 13 (2016) (Attachment C).

Effects of snowmobiles on grizzly bears occur primarily when bears are entering or leaving their dens. Possible effects include den abandonment, loss of young, increased energetic costs while bears are in dens or displaced away from suitable habitat if outside dens, learned displacement from suitable habitat resulting from exposure to disturbance, and death. Grizzly bear denning habitat often overlaps with winter recreation areas, making them susceptible to disturbance, thereby increasing energy expenditures and the potential for den abandonment.¹⁰⁷ Grizzly bears typically den in relatively high elevation areas with more stable snow conditions and steep slopes.¹⁰⁸ Direct mortality is possible if an avalanche is triggered on a slope where bears are hibernating.¹⁰⁹ In general, grizzlies avoid roads¹¹⁰ and select den sites one to two kilometers from human activity.¹¹¹ Snowmobiles can easily access these remote sites and therefore pose a potential for disturbance. A comprehensive review found human disturbance within one kilometer of a den site has a significant risk of causing abandonment, especially early in the denning season.¹¹²

Snowmobiles may have direct harmful effects to emergent bears, mainly females and cubs. Because females with cubs have high energetic needs and cubs have limited mobility for several weeks after leaving the den, they remain in the den site area for several weeks after emergence from dens. Disturbance levels that cause a female to prematurely leave the den in spring or move from the den area could impair the fitness of the female and safety of the cubs.¹¹³ The mean week of den emergence ranged from the third week in March to the fourth week in May.¹¹⁴ It is important to provide secure habitat—areas free of motorized access—so bears are able to fully use available resources.¹¹⁵

Woodland Caribou

It is well established that undisturbed “winter range” is essential for ungulates survival.¹¹⁶ Snowmobiles cause both a physiological and behavioral response on ungulate species, resulting

¹⁰⁷ J.D.C. Linnell *et al.*, How vulnerable are denning bears to disturbance? 28 Wildlife Society Bulletin 2 (2000).

¹⁰⁸ *Id.*

¹⁰⁹ G.V. Hilderbrand *et al.*, A Denning Brown Bear, *Ursus arctos*, Sow and Two Cubs Killed in an Avalanche on the Kenai Peninsula, Alaska, 114 Canadian Field-Naturalist 3 (2000).

¹¹⁰ R.D. Mace *et al.*, Relationships Among Grizzly Bears, Roads and Habitat in the Swan Mountains, MT, 33 Journal of Applied Ecology (1996).

¹¹¹ Linnell (2000).

¹¹² *Id.*

¹¹³ USDI, Fish and Wildlife Service, Endangered Species Act Section 7 Consultation Supplement to the Biological Opinion (2010) on the Effects of the 2009 Revision of the Beaverhead-Deerlodge National Forest Land and Resource Management Plan on Grizzly Bears (2013).

¹¹⁴ M. Haroldson and F.T. van Manen, Estimating Number of Females with Cubs, in Yellowstone grizzly bear investigation: annual report of the Interagency Grizzly Bear Study Team (F.T. van Manen *et al.*, eds. 2014).

¹¹⁵ USDA Forest Service, Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests (2006), page 7.

¹¹⁶ Attachment C at 17.

in disturbance and displacement.¹¹⁷ Limiting disturbance – including limiting the duration and spatial footprint – to woodland caribou, especially in winter range, is a key management strategy for protecting the species.

Canada Lynx

For Canada lynx, the Agencies state that snowmobile trails allowed by the court-ordered closure within the Blue-Grass BMU would not change under the No Action alternative, but it fails to consider the impacts of newly authorized snowmobile use (for CBP) on Canada lynx under each of the action alternatives.¹¹⁸ Snowmobiles may directly affect Canada lynx during winter months when the species is especially vulnerable by causing physiological responses like increased heart rate and elevated stress level.¹¹⁹ The noise from snowmobiles is likely detrimental to lynx, disturbing their ability to hunt and increasing stress. Studies on other large mammals that reside in lynx habitat indicate that snowmobiles elicit an even higher stress response than off road vehicles.¹²⁰ Snowmobiles may disturb den sites during a time when lynx are rearing young.¹²¹ Snowmobiles may also displace lynx and disrupt otherwise quiet winter habitat by facilitating human access into historically remote winter forest landscapes, increasing lynx interactions with humans, and increasing hunting, trapping, and poaching mortality.¹²² This in turn may result in direct collisions, death, habitat fragmentation, and potential population declines.¹²³

Snow compaction from snowmobiles is another threat to lynx. Snow compaction may suffocate or alter the subnivean movements of small mammals on which lynx prey.¹²⁴ Compacted snow trails may also allow coyotes to move into lynx habitat that coyotes previously used only seasonally. Lynx are well adapted to travel and hunt in the deep, powdery snow where snowshoe hares reside and benefit from a natural spatial segregation from other carnivores.¹²⁵ One study in Montana found limited use of snowmobile trails by coyotes.¹²⁶ But studies in Utah and Wyoming found extensive use of compacted snowmobile trails by coyotes, resulting in potential

¹¹⁷ Id.

¹¹⁸ DEIS at 44.

¹¹⁹ W.L. Gaines *et al.*, Assessing the cumulative effects of linear recreation routes on wildlife habitats on the Okanogan and Wenatchee National Forests (2003), Gen. Tech. Rep. PNW-GTR-586, *available at* <http://www.fs.fed.us/pnw/pubs/gtr586.pdf> (last accessed August 22, 2017), pages 5-6.

¹²⁰ S. Creel *et al.*, Snowmobile Activity and Glucocorticoid Stress Responses in Wolves and Elk, 16 *Conservation Biology* 809, 812 (2002).

¹²¹ J.J. Claar *et al.*, Carnivores, *in* Effects of recreation on Rocky Mountain wildlife: a review for Montana (G. Joslin and H. Youmans, eds., 1999).

¹²² Gaines (2003) at 11. *See also* 2008 Main Salmon BA at 7.

¹²³ Gaines (2003) at 11-12.

¹²⁴ W.D. Schmid, Snowmobile activity, subnivean microclimate and winter mortality of small mammals, 53 *Bulletin of the Ecological Society of America*, 37 (1972).

¹²⁵ K.D. Bunnell *et al.*, Potential impacts of coyotes and snowmobiles on lynx conservation in the intermountain west, 34 *Wildlife Society Bulletin* 828 (2006).

¹²⁶ J.A. Kolbe *et al.*, The effect of snowmobile trails on coyote movements within lynx home ranges, 71 *Journal of Wildlife Management* 1409 (2007).

competition with and displacement of lynx.¹²⁷ The differing results are likely due to different snow characteristics, predator communities, and snowmobile use at the various sites.¹²⁸ Under the LCAS, the Forest Service assesses the potential for snowmobile trails to provide routes for competitors such as coyotes, bobcats and cougars based on the density of groomed or commonly used snowmobile routes in LAUs.¹²⁹

Wolverine

Snowmobile use commonly overlaps with wolverine denning habitat.¹³⁰ Dispersed recreational activities like motorized winter recreation have the potential to negatively impact wolverine by disrupting natal denning areas.¹³¹ Wolverines have one of the lowest successful reproductive rates known to mammals, and this is hypothesized as linked to winter energy constraints. Female wolverines select and enter dens and give birth in February to mid-March¹³² and the overlap of winter recreation with this energetically taxing period is highly concerning. Any disturbance during this important winter period can negatively affect productivity and other vital rates.¹³³

Researchers have reported that female wolverines may be sensitive to human disturbance in the vicinity of natal and maternal dens, and disturbance from foot and snowmobile traffic has been purported to cause maternal females to abandon or move dens.¹³⁴ Preliminary findings from the ongoing study suggest wolverine exposed to higher levels of winter recreation in their home range may avoid recreated areas and move at higher rates in higher intensity recreation areas. In particular, denning female wolverines showed higher movement rate increases in response to higher intensity recreation areas, which causes higher expenditure of energy and reduced ability

¹²⁷ Bunnell (2006); E. Gese *et al.*, The Influence of Snowmobile Trails on Coyote Movements During Winter in High-Elevation Landscapes, 8 Plos One 1 (2013).

¹²⁸ J.L.B. Dowd *et al.*, Winter Space Use of Coyotes in High-Elevation Environments: Behavioral Adaptations to Deep-Snow Landscapes, 32 Journal of Ethology 29 (2014).

¹²⁹ See LCAS (3d ed. 2013).

¹³⁰ A. Switalski, Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Wildlife*, 12 Journal of Conservation Planning 13 (2016).

¹³¹ See, e.g., R.M. Inman *et al.*, Wolverine reproductive chronology, *In: Wildlife Conservation Society, Greater Yellowstone Wolverine Program, Cumulative Report* (2007a); J. Krebs *et al.*, Multiscale habitat use by wolverines in British Columbia, Canada, 71 Journal of Wildlife Management 2180 (2007); E.C. Lofroth and J. Krebs, The Abundance and Distribution of Wolverines in British Columbia, Canada, 71 Journal of Wildlife Management 2159 (2007); L.F. Ruggiero *et al.*, Wolverine conservation and management, 71 Journal of Wildlife Management 2145 (2007).

¹³² A.J. Magoun and J.P. Copeland, Characteristics of wolverine reproductive den sites, 62 Journal of Wildlife Management 1313 (1998).

¹³³ R. May *et al.*, Impact of infrastructure on habitat selection of wolverines *Gulo gulo*, 12 Wildlife Biology 285 (2006); Krebs (2007).

¹³⁴ S. Myrberget, The breeding den of the wolverine, 21 Fauna 108 (1968); Magoun and Copeland (1998); R.M. Inman *et al.*, Wolverine reproductive rates and maternal habitat in Greater Yellowstone, *In: Wildlife Conservation Society, Greater Yellowstone Wolverine Program, Cumulative Report* (2007b).

to hunt for food.¹³⁵

These behavioral changes can negatively affect individuals' physiological stress levels and reproductive capacity in several ways, as evidenced in numerous studies on different species.¹³⁶ It may reduce the amount of time and thus ability of female wolverines to hunt or to utilize food caches. This would result in significant additive energetic effects, reducing foraging success for adult females already stressed by the demands of bearing and raising a litter.¹³⁷ In addition, this could reduce kit survival rates by increasing the potential for predation and exposure to cold temperatures. These results indicate that winter recreation may impact wolverines in as yet unknown ways.

As snowmobiling continues to grow in popularity and as snowpack continues to decline due to climate change, there is increasing concern that wolverine denning habitat may become limiting. Recent warming has already led to substantial reductions in spring snow cover in the mountains of western North America.¹³⁸ Numerous recent and sophisticated studies support the conclusion that climate changes caused by global climate change are likely to negatively affect wolverine habitat.¹³⁹ Protection of denning habitat may be critical for the persistence of the species.

An additional concern related to snowmobile use is that motorized access leads to increased trapping pressure (direct or indirect capture) for some furbearers that prefer more mesic habitat conditions generally found at higher elevations or in riparian habitats, such as marten, fisher, lynx, and wolverine. Trapping season for these species is limited to the winter months, and most trappers prefer the relatively easy access to suitable habitat provided by snowmobiles. Wolverine populations in small, isolated mountain ranges can be very susceptible to trapping pressure.¹⁴⁰ Trapping pressure for these species is dramatically reduced if there is less snowmobile access.

¹³⁵ K. Heinmeyer and J. Squires, *Wolverine – Winter Recreation Research Project: Investigating the Interactions Between Wolverines and Winter Recreation 2014 Progress Report* (Oct. 27, 2014). The 2015 Progress Report did not include an executive summary of preliminary results like in previous reports.

¹³⁶ S.J. Creel *et al.*, *Snowmobile activity and glucocorticoid stress responses in wolves and elk*, 16 *Conservation Biology* 809 (2002).

¹³⁷ K. Heinmeyer and J. Squires, *Wolverine – Winter Recreation Research Project: Investigating the interactions between wolverines and winter recreation use 2013 Progress Report* (2013).

¹³⁸ P. Mote *et al.*, *Declining mountain snowpack in western North America*, 86 *Bulletin of the American Meteorological Society* 1 (2005); G.T. Pederson *et al.*, *A century of climate and ecosystem change in Western Montana: what do temperature trends portend?* 96 *Climatic Change* (2010).

¹³⁹ P. Gonzales *et al.*, *Wolverines and Climate Change*, Unpublished report (2008); J.F. Brodie and E. Post, *Nonlinear responses of wolverine populations to declining winter snowpack*, 52 *Population Ecology* 279 (2010); J.P. Copeland *et al.*, *The bioclimatic envelope of the wolverine (Gulo gulo): do climate constraints limit its geographic distribution?* 88 *Canadian Journal of Zoology* 233 (2010); K.S. McKelvey *et al.*, *Climate change predicted to shift wolverine distributions, connectivity, and dispersal corridors*, 21 *Ecological Applications* 2882 (2011); S. Peacock, *Projected 21st century climate change for wolverine habitats within the contiguous United States*, *Environmental Research Letters* (2011); K.M. Johnston *et al.*, *Projected range shifting by montane mammals under climate change: implications for Cascadia's National Parks*, 3 *Ecosphere* 11 (2012).

¹⁴⁰ J.R. Squires *et al.*, *Sources and patterns of wolverine mortality in western Montana*, 71 *Journal of Wildlife Management* 2213 (2007).

H. Cumulative Impacts

NEPA's implementing regulations require that when agencies prepare an EIS, that document must consider the cumulative impacts of the action under consideration, and defines cumulative impacts as "the incremental impact[s] of the action when added to other past, present, and reasonably foreseeable future actions."¹⁴¹ The Agencies state the effects of past and ongoing activities are reflected in the description of existing conditions for each resource.¹⁴² This is insufficient under NEPA's requirements. "In a cumulative impacts analysis, an agency must take a 'hard look' at *all* actions" that may combine with the action under consideration to affect the environment.¹⁴³ By clumping past and present actions into the environmental baseline, the Agencies fail to take the required hard look at cumulative impacts. There is no detailed discussion about these impacts, nor is there a quantified assessment of those impacts.

The Agencies also fail to consider various cumulative impacts. As just one example, the DEIS fails to consider the cumulative impacts of climate change and forest roads (i.e., how climate change is expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes).

IV. The Agencies Must Consider Induced Growth Likely to Result from Year-round Access as Part of its Hard Look

NEPA requires agencies to consider the growth-inducing effects of proposed actions.¹⁴⁴ An agency may not simply state that growth will increase with or without the project, or that development is inevitable; the agency must provide an adequate discussion of growth-inducing impacts.¹⁴⁵ Here, all of the action alternatives contemplate giving owners of Continental Mine unfettered year-round access. The Agencies must consider and disclose the extent to which this year-round access may lead to growth-inducing impacts, such as development of the mine. If so, the agencies must also consider the potential induced growth and development of Continental Mine as a connected action in this analysis.

V. We Support the No Action Alternative

¹⁴¹ 40 C.F.R. § 1508.7.

¹⁴² DEIS at 62.

¹⁴³ *Te-Moak Tribe of W. Shoshone of Nev. v. U.S. Dep't of Interior*, 608 F.3d 592, 603 (9th Cir. 2010).

¹⁴⁴ 40 C.F.R. § 1508.8(b); *City of Carmel-by-the-Sea v. United States Dep't of Transp.*, 123 F.3d 1142, 1162 (9th Cir. 1997).

¹⁴⁵ *Laguna Greenbelt, Inc. v. United States Dep't of Transp.*, 42 F.3d 517, 526 (9th Cir. 1994).

Due to the significant negative impacts to wildlife and their habitat, we support the No Action alternative. Through this project proposal, the Agencies seek to undertake road construction and repair and increase motorized use in areas that contain sensitive habitat for sensitive wildlife and fish, including grizzly bears, Woodland caribou, Canada lynx, wolverine, and bull trout. By reconstructing Bog Creek Road and repairing and increasing use on Blue Joe Creek Road, the Agencies threaten to adversely modify and fragment important habitat in the project area. While the Agencies combine this proposal with the closure of other roads, most of those roads are “legacy” roads that are not currently subject to a great deal of motorized use. For example, the Proposed Action would close FSR 1322 and FSR 1332A; while not “formally closed to motorized access,” these roads are already gated and blocked with boulders.¹⁴⁶ Thus, even the closure of these roads will not fully mitigate the increased human presence, construction, and increase in motorized use in the project area.

Additionally, the DEIS states that because the current OMRD is modeled at just 14.87 percent, over 18 percent below the Access Amendment standard of 33, the No Action alternative would give the agencies motorized access flexibility throughout the BMU to accomplish law enforcement activities, as well as other land management needs.¹⁴⁷ By comparison, the Agencies would have only half as much flexibility under the action alternatives.¹⁴⁸ Thus, we believe the No Action alternative could meet the purpose and need of the project proposal.

If the Agencies approve the No Action alternative as suggested here, the Forest Service will still be responsible for complying with the Access Amendment standards, which will further benefit grizzly bears and other wildlife.¹⁴⁹ Because the Forest Service would need to comply with the Access Amendment standards under the No Action alternative, the Agencies should have evaluated road closures to comply with those standards as part of this alternative. By failing to do so, the Agencies have failed to fully analyze the No Action alternative. We request that the Agencies remedy this failure by evaluating proposed road closures to comply with the Access Amendment standards as part of the No Action alternative in a supplemental EIS.

VI. We Suggest Evaluation of Another Reasonable Alternative

Although we support the No Action alternative as stated above, we would also urge the Agencies to consider another reasonable alternative. Under our proposed alternative, the Agencies would work to close open roads and meet the Access Amendment standards before moving forward to repair and open to increased use Bog Creek and Blue Joe Creek roads. By closing roads before conducting construction and repair activities, the Agencies could lessen the negative impacts to

¹⁴⁶ *Id.* at 103.

¹⁴⁷ *Id.* at 95.

¹⁴⁸ *Id.* at 98.

¹⁴⁹ See, e.g., *id.* at 95 (explaining that under the No Action alternative, the Forest Service would continue to work toward meeting the Access Amendment standards).

wildlife by limiting where human activity is conducted in the Blue-Grass BMU. As all three action alternatives stand now, construction, repair, and closure activity all takes place during the same time over up to three years, thus unnecessarily decreasing undisturbed areas in the BMU where displaced wildlife can seek refuge. Although extending the life of the project may have some pitfalls, we believe that spreading out the impacts over a longer period of time is more beneficial than having increased human activity throughout the BMU by overlapping construction/repair work and closure work.

CEQ regulations implementing NEPA require that agencies “©igorously explore and objectively evaluate all reasonable alternatives.” 40 C.F.R. § 1502.14(a). The importance of this mandate cannot be downplayed, as a rigorous review of alternatives is considered “the heart of the environmental impact statement.” 40 C.F.R. § 1502.14. According to CEQ regulations, the ARS must “use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.” 40 C.F.R. § 1500.1(e). Because the alternative proposed is a reasonable one and could accomplish the purpose and need of the project while simultaneously decreasing the negative impacts to wildlife, the Agencies have a duty to evaluate and analyze this reasonable alternative.

VII. The Agencies Impermissibly Eliminate a Reasonable Alternative

The alternatives analysis is the “heart” of NEPA, and therefore “an agency must *on its own initiative* study all alternatives that appear reasonable and appropriate for study at the time, and must also look into other significant alternatives that are called to its attention by other agencies, or by the public during the comment period afforded for that purpose.”¹⁵⁰ Here, the Agencies improperly eliminated viable alternatives from its analysis. As noted above, the Agencies’ latest proposal expands and alters the project by, *inter alia*, eliminating the seasonal restrictions on Bog Creek Road and Blue Joe Creek Road. An alternative reflecting the action as originally proposed during scoping in May 2016 – that would maintain season restricted designations on Bog Creek Road and Blue Joe Creek Road, limiting administrative motorized access to 57 trips per active bear year – is reasonable and should be considered in detail.¹⁵¹ Without justification or explanation, the Agencies determined that a seasonally restricted designation for Bog Creek Road would not be sufficient to ensure border security in the area. Similarly, the Agencies determined it is necessary to remove the seasonally restricted designation from the Blue Joe Creek Road without justification or explanation. There is no reasoning to explain why seasonal restrictions will prevent the Agencies from achieving the stated purpose and need for this proposal.

¹⁵⁰ Dubois v. Dep’t of Agriculture, 102 F.3d 1273, 1291 (1st Cir. 1996), quoting Seacoast Anti-Pollution League, v. Nuclear Reg. Comm’n, 598 F.2d 1221, 1231 (1st Cir. 1979) (emphasis from Dubois court) (internal citations omitted).

¹⁵¹ Id. at 36.

VIII. The Agencies Must Demonstrate Compliance with the Endangered Species Act

Section 7 of the ESA imposes a substantive obligation on federal agencies to “insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of” habitat that has been designated as critical for the species. 16 U.S.C. § 1536(a)(2); *Nat’l Wildlife Fed’n v. Nat’l Marine Fisheries Serv.*, 524 F.3d 917, 924 (9th Cir. 2008). Here, the Agencies must consult with the U.S. Fish and Wildlife Service under section 7 of the ESA as to the impacts of the project on species listed under the ESA and designated critical habitat, including grizzly bear, Canada lynx, Woodland caribou, bull trout, and wolverine (conference required). It must ensure the proposed road maintenance and use of roads will not harm listed wildlife or degrade its critical habitat.

The analysis states the Agencies initiated consultation with the FWS on April 3, 2013, and have met to discuss potential ESA issues periodically.¹⁵² The DEIS also states that a Biological Assessment is being prepared to determine whether the repair and maintenance of Bog Creek Road and motorized closure of other roads would have any effects on ESA listed species.¹⁵³ It states that results from consultation with FWS will be provided in the FEIS.¹⁵⁴

We encourage the Agencies to be transparent about any consultation process and affirmatively post all consultation documents, including any Biological Evaluations or Assessments by the Agencies, any letters seeking concurrence, and any responses or Biological Opinions from FWS. Without these records, we are unable to assess the agency’s analysis of impacts to wildlife and habitat in light of FWS’s expert opinion. Providing this information will allow the public to view these critical documents, and other documents in the project record, without the need to submit a formal Freedom of Information Act request. Without this information being publicly available during the notice and comment period, we are unable to meaningfully comment on the Agencies’ determinations or analysis.

VIII. The Agencies Must Demonstrate Compliance with the Clean Water Act

The Clean Water Act (“CWA”) establishes a comprehensive program “to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” by reducing and eventually eliminating the discharge of pollutants into those waters. 33 U.S.C. § 1251(a). The CWA program includes a regulatory scheme of permits, technology controls, and water quality-based pollution controls.

¹⁵² DEIS at 303.

¹⁵³ Id.

¹⁵⁴ Id.

States are responsible for developing water quality standards to protect the desired conditions of each waterway within a state's regulatory jurisdiction. 33 U.S.C. § 1313(c). A water quality standard includes three elements: (1) one or more designated uses, such as fish propagation; (2) numeric and narrative criteria specifying the water quality condition necessary to protect the designated uses; and (3) an antidegradation policy that ensures that uses are protected and that high quality waters will be maintained and protected. 33 U.S.C. §§ 1313(c)(2), 1313(d)(4)(B); 40 C.F.R. §§ 131.6, 131.10-12. Waters that do not meet water quality standards are deemed "water quality-limited" and placed on the CWA's § 303(d) list. States must develop total maximum daily loads ("TMDLs") for all § 303(d)-listed waterbodies to bring them back into compliance with applicable water quality standards. All federal agencies must comply with state water quality standards, including a state's antidegradation policy. 33 U.S.C. § 1323(a), Idaho Sporting Congress v. Thomas, 137 F.3d 1146 (9th Cir. 1998). Here several waters in the project area are 303(d) listed as impaired for temperature. The Agencies must ensure that the project will comply with the CWA by not causing or contributing to a violation of Idaho's water quality standards. Reliance on best management practices (BMPs) is insufficient; the Agencies must demonstrate how the project will not cause or contribution to a violation of water quality standards despite anticipated increases of sedimentation into receiving waters and a lack of future maintenance plans for these roads.

CONCLUSION

The Idaho Panhandle National Forest's current road system is over-sized and unaffordable. We strongly urge the Agencies to revise the analysis in this DEIS to provide a thoughtful, strategic approach to this proposal, reducing negative impacts from forest roads to water quality, aquatic habitats, and wildlife habitat, and improving watersheds and forest resiliency by returning expensive, deteriorating, and seldom used forest roads to the wild. At bottom, due to the significant negative impacts to wildlife and their habitat, we support the No Action alternative.

Sincerely,



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/s/ Josh Osher
Public Policy and Montana Director
Western Watersheds Project

ATTACHMENTS

Attachment A: The Wilderness Society, *Transportation Infrastructure and Access on National Forests and Grasslands: A Literature Review* (May 2014).

Attachment B: Halofsky, J.E. et al. eds., USDA, Forest Service, Pacific Northwest Research Station, *Adapting to Climate Change at Olympic National Forest and Olympic National Park*, PNW-GTR-844 (2011).

Attachment C: A. Switalski, Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Wildlife*, 12 Journal of Conservation Planning 13 (2016).

All References May Be Provided Upon Request

ATTACHMENT A



Transportation Infrastructure and Access on National Forests and Grasslands A Literature Review May 2014

Introduction

The Forest Service transportation system is very large with 374,883 miles (603,316 km) of system roads and 143,346 miles (230,693 km) of system trails. The system extends broadly across every national forest and grasslands and through a variety of habitats, ecosystems and terrains. An impressive body of scientific literature exists addressing the various effects of roads on the physical, biological and cultural environment – so much so, in the last few decades a new field of “road ecology” has emerged. In recent years, the scientific literature has expanded to address the effects of roads on climate change adaptation and conversely the effects of climate change on roads, as well as the effects of restoring lands occupied by roads on the physical, biological and cultural environments.

The following literature review summarizes the most recent thinking related to the environmental impacts of forest roads and motorized routes and ways to address them. The literature review is divided into three sections that address the environmental effects of transportation infrastructure on forests, climate change and infrastructure, and creating sustainable forest transportation systems.

- I. [Impacts of Transportation Infrastructure and Access to the Ecological Integrity of Terrestrial and Aquatic Ecosystems and Watersheds](#)
- II. [Climate Change and Transportation Infrastructure Including the Value of Roadless Areas for Climate Change Adaptation](#)
- III. [Sustainable Transportation Management in National Forests as Part of Ecological Restoration](#)

I. Impacts of Transportation Infrastructure and Access to the Ecological Integrity of Terrestrial and Aquatic Ecosystems and Watersheds

It is well understood that transportation infrastructure and access management impact aquatic and terrestrial environments at multiple scales, and, in general, the more roads and motorized routes the greater the impact. In fact, in the past 20 years or so, scientists have realized the magnitude and breadth of ecological issues related to roads; entire books have been written on the topic, e.g., Forman et al. (2003), and a new scientific field called “road ecology” has emerged. Road ecology research centers have been created including the Western

Transportation Institute at Montana State University and the Road Ecology Center at the University of California - Davis.¹

Below, we provide a summary of the current understanding on the impacts of roads and access allowed by road networks to terrestrial and aquatic ecosystems, drawing heavily on Gucinski et al. (2000). Other notable recent peer-reviewed literature reviews on roads include Trombulak and Frissell (2000), Switalski et al. (2004), Coffin (2007), Fahrig and Rytwinski (2009), and Robinson et al. (2010). Recent reviews on the impact of motorized recreation include Joslin and Youmans (1999), Gaines et al. (2003), Davenport and Switalski (2006), Ouren et al. (2007), and Switalski and Jones (2012). These peer-reviewed summaries provide additional information to help managers develop more sustainable transportation systems

Impact on geomorphology and hydrology

The construction or presence of forest roads can dramatically change the hydrology and geomorphology of a forest system leading to reductions in the quantity and quality of aquatic habitat. While there are several mechanisms that cause these impacts (Wemple et al. 2001 , Figure 1), most fundamentally, compacted roadbeds reduce rainfall infiltration, intercepting and concentrating water, and providing a ready source of sediment for transport (Wemple et al. 1996, Wemple et al. 2001). In fact, roads contribute more sediment to streams than any other land management activity (Gucinski et al. 2000). Surface erosion rates from roads are typically at least an order of magnitude greater than rates from harvested areas, and three orders of magnitude greater than erosion rates from undisturbed forest soils (Endicott 2008).

¹ See <http://www.westerntransportationinstitute.org/research/roadecology> and <http://roadecology.ucdavis.edu/>

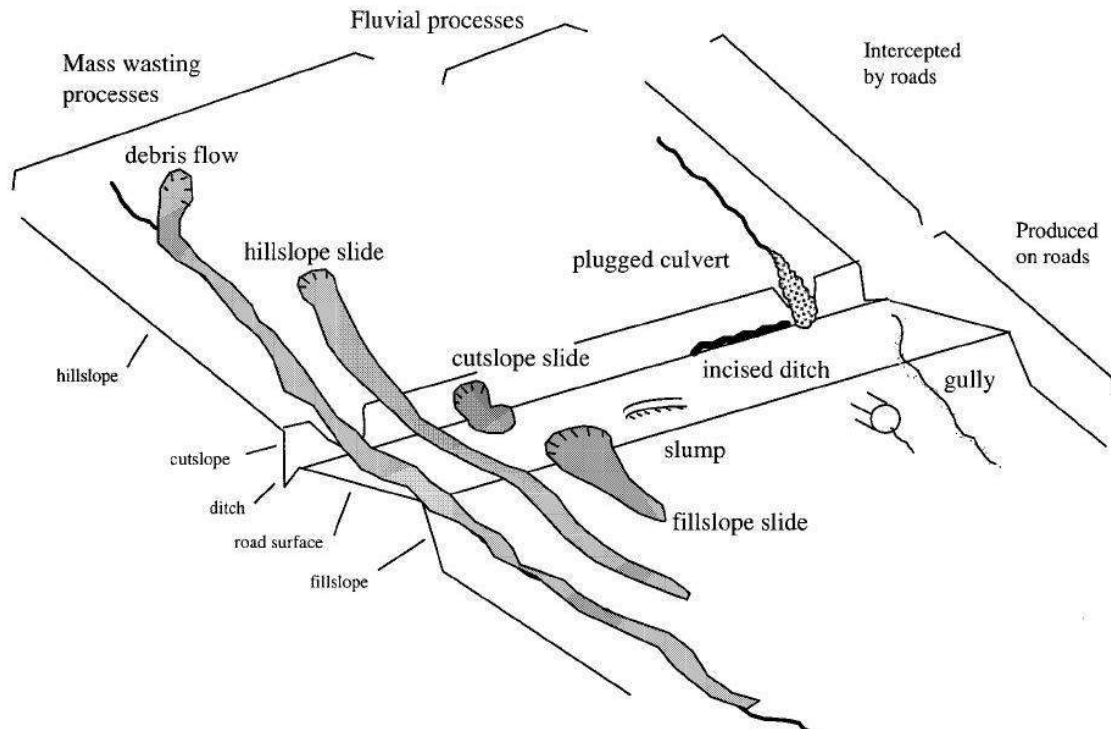


Figure 1: Typology of erosional and depositional features produced by mass-wasting and fluvial processes associated with forest roads (reprinted from Wemple et al. 2001)

Erosion of sediment from roads occurs both chronically and catastrophically. Every time it rains, sediment from the road surface and from cut- and fill-slopes is picked up by rainwater that flows into and on roads (fluvial erosion). The sediment that is entrained in surface flows are often concentrated into road ditches and culverts and directed into streams. The degree of fluvial erosion varies by geology and geography, and increases with increased motorized use (Robichaud et al. 2010). Closed roads produce less sediment, and Foltz et al. (2009) found a significant increase in erosion when closed roads were opened and driven upon.

Roads also precipitate catastrophic failures of road beds and fills (mass wasting) during large storm events leading to massive slugs of sediment moving into waterways (Endicott 2008; Gucinski et al. 2000). This typically occurs when culverts are undersized and cannot handle the volume of water, or they simply become plugged with debris. The saturated roadbed can fail entirely and result in a landslide, or the blocked stream crossing can erode the entire fill down to the original stream channel.

The erosion of road- and trail-related sediment and its subsequent movement into stream systems affects the geomorphology of the drainage system in a number of ways. The magnitude of their effects varies by climate, geology, road age, construction / maintenance practices and storm history. It directly alters channel morphology by embedding larger gravels as well as filling pools. It can also have the opposite effect of increasing peak discharges and scouring channels, which can lead to disconnection of the channel and floodplain, and lowered base flows (Furniss et al. 1991; Joslin and Youmans 1999). The width/depth ratio of the stream changes which then can trigger changes in water temperature, sinuosity and other geomorphic factors important for aquatic species survival (Joslin and Youmans 1999; Trombulak and Frissell 2000).

Roads also can modify flowpaths in the larger drainage network. Roads intercept subsurface flow as well as concentrate surface flow, which results in new flowpaths that otherwise would not exist, and the extension of the drainage network into previously unchannelized portions of the hillslope (Gucinski et al. 2000; Joslin and Youmans 1999). Severe aggradation of sediment at stream structures or confluences can force streams to actually go subsurface or make them too shallow for fish passage (Endicott 2008; Furniss et al. 1991).

Impacts on aquatic habitat and fish

Roads can have dramatic and lasting impacts on fish and aquatic habitat. Increased sedimentation in stream beds has been linked to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes, and reductions in macro-invertebrate populations that are a food source to many fish species (Rhodes et al. 1994, Joslin and Youmans 1999, Gucinski et al. 2000, Endicott 2008). On a landscape scale, these effects can add up to: changes in the frequency, timing and magnitude of disturbance to aquatic habitat and changes to aquatic habitat structures (e.g., pools, riffles, spawning gravels and in-channel debris), and conditions (food sources, refugi, and water temperature) (Gucinski et al. 2000).

Roads can also act as barriers to migration (Gucinski et al. 2000). Where roads cross streams, road engineers usually place culverts or bridges. Culverts in particular can and often interfere with sediment transport and channel processes such that the road/stream crossing becomes a barrier for fish and aquatic species movement up and down stream. For instance, a culvert may scour on the downstream side of the crossing, actually forming a waterfall up which fish cannot move. Undersized culverts and bridges can infringe upon the channel or floodplain and trap sediment causing the stream to become too shallow and/or warm such that fish will not migrate past the structure. This is problematic for many aquatic species but especially for anadromous species that must migrate upstream to spawn. Well-known native aquatic species affected by roads include salmon such as coho (*Oncorhynchus kisutch*), chinook (*O. tshawytscha*), and chum (*O. keta*); steelhead (*O. mykiss*); and a variety of trout species including bull trout (*Salvelinus confluentus*) and cutthroat trout (*O. clarki*), as well as other native fishes and amphibians (Endicott 2008).

Impacts on terrestrial habitat and wildlife

Roads and trails impact wildlife through a number of mechanisms including: direct mortality (poaching, hunting/trapping) changes in movement and habitat use patterns (disturbance/avoidance), as well as indirect impacts including alteration of the adjacent habitat and interference with predatory/prey relationships (Wisdom et al. 2000, Trombulak and Frissell 2000). Some of these impacts result from the road itself, and some result from the uses on and around the roads (access). Ultimately, roads have been found to reduce the abundance and distribution of several forest species (Fayrig and Ritwinski 2009, Benítez-López et al. 2010).

Table 1: Road- and recreation trail-associated factors for wide-ranging carnivores (Reprinted from Gaines et al. (2003)²

² For a list of citations see Gaines et al. (2003)

Focal species	Road-associated factors	Motorized trail-associated factors	Nonmotorized trail-associated factors
Grizzly bear	Poaching	Poaching	Poaching
	Collisions	Negative human interactions	Negative human interactions
	Negative human interactions	Displacement or avoidance	Displacement or avoidance
	Displacement or avoidance		
Lynx	Down log reduction	Disturbance at a specific site	Disturbance at a specific site
	Trapping	Trapping	
	Collisions		
	Disturbance at a specific site		
Gray wolf	Trapping	Trapping	Trapping
	Poaching	Disturbance at a specific site	Disturbance at a specific site
	Collisions		
	Negative human interactions		
	Disturbance at a specific site		
	Displacement or avoidance		
Wolverine	Down log reduction	Trapping	Trapping
	Trapping	Disturbance at a specific site	Disturbance at a specific site
	Disturbance at a specific site		
	Collisions		

Direct mortality and disturbance from road and trail use impacts many different types of species. For example, wide-ranging carnivores can be significantly impacted by a number of factors including trapping, poaching, collisions, negative human interactions, disturbance and displacement (Gaines et al. 2003, Table 1). Hunted game species such as elk (*Cervus canadensis*), become more vulnerable from access allowed by roads and motorized trails resulting in a reduction in effective habitat among other impacts (Rowland et al. 2005, Switalski and Jones 2012). Slow-moving migratory animals such as amphibians, and reptiles who use roads to regulate temperature are also vulnerable (Gucinski et al. 2000, Brehme et al. 2013).

Habitat alteration is a significant consequence of roads as well. At the landscape scale, roads fragment habitat blocks into smaller patches that may not be able to support successfully interior forest species. Smaller habitat patches also results in diminished genetic variability, increased inbreeding, and at times local extinctions (Gucinski et al. 2000; Trombulak and Frissell 2000). Roads also change the composition and structure of ecosystems along buffer zones, called edge-affected zones. The width of edge-affected zones varies by what metric is being discussed; however, researchers have documented road-avoidance zones a kilometer or more away from a road (Table 2). In heavily roaded landscapes, edge-affected acres can be a significant fraction of total acres. For example, in a landscape area where the road density is 3 mi/mi² (not an uncommon road density in national forests) and where the edge-affected zone is estimated to be 500 ft from the center of the road to each side, the edge-affected zone is 56% of the total acreage.

Table 2: A summary of some documented road-avoidance zones for various species (adapted from Robinson et al. 2010).

Species	Avoidance zone		Reference
	m (ft)	Type of disturbance	
Snakes	650 (2133)	Forestry roads	Bowles (1997)
Salamander	35 (115)	Narrow forestry road, light traffic	Semlitsch (2003)
Woodland birds	150 (492)	Unpaved roads	Ortega and Capen (2002)
Spotted owl	400 (1312)	Forestry roads, light traffic	Wasser et al. (1997)
Marten	<100 (<328)	Any forest opening	Hargis et al. (1999)
Elk	500–1000 (1640-3281)	Logging roads, light traffic	Edge and Marcum (1985)
	100–300 (328-984)	Mountain roads depending on traffic volume	Rost and Bailey (1979)
Grizzly bear	3000 (9840)	Fall	Mattson et al. (1996)
	500 (1640)	Spring and summer	
	883 (2897)	Heavily traveled trail	Kasworm and Manley (1990)
	274 (899)	Lightly traveled trail	
	1122 (3681)	Open road	Kasworm and Manley (1990)
Black bear	665 (2182)	Closed road	
	274 (899)	Spring, unpaved roads	Kasworm and Manley (1990)
	914 (2999)	Fall, unpaved roads	

Roads and trails also affect ecosystems and habitats because they are also a major vector of non-native plant and animal species. This can have significant ecological and economic impacts when the invading species are aggressive and can overwhelm or significantly alter native species and systems. In addition, roads can increase harassment, poaching and collisions with vehicles, all of which lead to stress or mortality (Wisdom et al. 2000).

Recent reviews have synthesized the impacts of roads on animal abundance and distribution. Fahrig and Rytwinski (2009) did a complete review of the empirical literature on effects of roads and traffic on animal abundance and distribution looking at 79 studies that addressed 131 species and 30 species groups. They found that the number of documented negative effects of roads on animal abundance outnumbered the number of positive effects by a factor of 5. Amphibians, reptiles, most birds tended to show negative effects. Small mammals generally showed either positive effects or no effect, mid-sized mammals showed either negative effects or no effect, and large mammals showed predominantly negative effects. Benítez-López et al. (2010) conducted a meta-analysis on the effects of roads and infrastructure proximity on mammal and bird populations. They found a significant pattern of avoidance and a reduction in bird and mammal populations in the vicinity of infrastructure.

Road density³ thresholds for fish and wildlife

³ We intend the term “road density” to refer to the density all roads within national forests, including system roads, closed roads, non-system roads administered by other jurisdictions (private, county, state), temporary roads and motorized trails. Please see Attachment 2 for the relevant existing scientific information supporting this approach.

It is well documented that beyond specific road density thresholds, certain species will be negatively affected, and some will be extirpated. Most studies that look into the relationship between road density and wildlife focus on the impacts to large endangered carnivores or hunted game species, although high road densities certainly affect other species – for instance, reptiles and amphibians. Gray wolves (*Canis lupus*) in the Great Lakes region and elk in Montana and Idaho have undergone the most long-term and in depth analysis. Forman and Hersperger (1996) found that in order to maintain a naturally functioning landscape with sustained populations of large mammals, road density must be below 0.6 km/km² (1.0 mi/mi²). Several studies have since substantiated their claim (Robinson et al. 2010, Table 3).

A number of studies at broad scales have also shown that higher road densities generally lead to greater impacts to aquatic habitats and fish density (Table 3). Carnefix and Frissell (2009) provide a concise review of studies that correlate cold water fish abundance and road density, and from the cited evidence concluded that “1) no truly “safe” threshold road density exists, but rather negative impacts begin to accrue and be expressed with incursion of the very first road segment; and 2) highly significant impacts (e.g., threat of extirpation of sensitive species) are already apparent at road densities on the order of 0.6 km/km² (1.0 mi/mi²) or less” (p. 1).

Table 3: A summary of some road-density thresholds and correlations for terrestrial and aquatic species and ecosystems (reprinted from Robinson et al. 2010).

Species (Location)	Road density (mean, guideline, threshold, correlation)	Reference
Wolf (Minnesota)	0.36 km/km ² (mean road density in primary range); 0.54 km/km ² (mean road density in peripheral range)	Mech et al. (1988)
Wolf	>0.6 km/km ² (absent at this density)	Jalkotzy et al. (1997)
Wolf (Northern Great Lakes region)	>0.45 km/km ² (few packs exist above this threshold); >1.0 km/km ² (no pack exist above this threshold)	Mladenoff et al. (1995)
Wolf (Wisconsin)	0.63 km/km ² (increasing due to greater human tolerance)	Wydeven et al. (2001)
Wolf, mountain lion (Minnesota, Wisconsin, Michigan)	0.6 km/km ² (apparent threshold value for a naturally functioning landscape containing sustained populations)	Thiel (1985); van Dyke et al. (1986); Jensen et al. (1986); Mech et al. (1988); Mech (1989)
Elk (Idaho)	1.9 km/km ² (density standard for habitat effectiveness)	Woodley 2000 cited in Beazley et al. 2004
Elk (Northern US)	1.24 km/km ² (habitat effectiveness decline by at least 50%)	Lyon (1983)
Elk, bear, wolverine, lynx, and others	0.63 km/km ² (reduced habitat security and increased mortality)	Wisdom et al. (2000)
Moose (Ontario)	0.2-0.4 km/km ² (threshold for pronounced response)	Beyer et al. (2013)
Grizzly bear (Montana)	>0.6 km/km ²	Mace et al. (1996); Mattson et al. (1996)
Black bear (North Carolina)	>1.25 km/km ² (open roads); >0.5 km/km ² (logging roads); (interference with use of habitat)	Brody and Pelton (1989)
Black bear	0.25 km/km ² (road density should not exceed)	Jalkotzy et al. (1997)
Bobcat (Wisconsin)	1.5 km/km ² (density of all road types in home range)	Jalkotzy et al. (1997)

Large mammals	>0.6 km/km ² (apparent threshold value for a naturally functioning landscape containing sustained populations)	Forman and Hersperger (1996)
Bull trout (Montana)	Inverse relationship of population and road density	Rieman et al. (1997); Baxter et al. (1999)
Fish populations (Medicine Bow National Forest)	(1) Positive correlation of numbers of culverts and stream crossings and amount of fine sediment in stream channels (2) Negative correlation of fish density and numbers of culverts	Eaglin and Hubert (1993) cited in Gucinski et al. (2001)
Macroinvertebrates	Species richness negatively correlated with an index of road density	McGurk and Fong (1995)
Non-anadromous salmonids (Upper Columbia River basin)	(1) Negative correlation likelihood of spawning and rearing and road density (2) Negative correlation of fish density and road density	Lee et al. (1997)

Where both stream and road densities are high, the incidence of connections between roads and streams can also be expected to be high, resulting in more common and pronounced effects of roads on streams (Gucinski et al. 2000). For example, a study on the Medicine Bow National Forest (WY) found as the number of culverts and stream crossings increased, so did the amount of sediment in stream channels (Eaglin and Hubert 1993). They also found a negative correlation with fish density and the number of culverts. Invertebrate communities can also be impacted. McGurk and Fong (1995) report a negative correlation between an index of road density with macroinvertebrate diversity.

The U.S. Fish and Wildlife Service's Final Rule listing bull trout as threatened (USDI Fish and Wildlife Service 1999) addressed road density, stating:

"... assessment of the interior Columbia Basin ecosystem revealed that increasing road densities were associated with declines in four non-anadromous salmonid species (bull trout, Yellowstone cutthroat trout, westslope cutthroat trout, and redband trout) within the Columbia River Basin, likely through a variety of factors associated with roads (Quigley & Arbelbide 1997). Bull trout were less likely to use highly roaded basins for spawning and rearing, and if present, were likely to be at lower population levels (Quigley and Arbelbide 1997). Quigley et al. (1996) demonstrated that when average road densities were between 0.4 to 1.1 km/km² (0.7 and 1.7 mi/mi²) on USFS lands, the proportion of subwatersheds supporting "strong" populations of key salmonids dropped substantially. Higher road densities were associated with further declines" (USDI Fish and Wildlife Service 1999, p. 58922).

Anderson et al. (2012) also showed that watershed conditions tend to be best in areas protected from road construction and development. Using the US Forest Service's Watershed Condition Framework assessment data, they showed that National Forest lands that are protected under the Wilderness Act, which provides the strongest safeguards, tend to have the healthiest watersheds. Watersheds in Inventoried Roadless Areas – which are protected from road building and logging by the Roadless Area Conservation Rule – tend to be less healthy than watersheds in designated Wilderness, but they are considerably healthier than watersheds in the managed landscape.

Impacts on other resources

Roads and motorized trails also play a role in affecting wildfire occurrence. Research shows that human-ignited wildfires, which account for more than 90% of fires on national lands, is almost five times more likely in areas with roads (USDA Forest Service 1996a; USDA Forest Service 1998). Furthermore, Baxter (2002) found that off-road vehicles (ORVs) can be a significant source of fire ignitions on forestlands. Roads can affect where and how forests burn and, by extension, the vegetative condition of the forest. See Attachment 1 for more information documenting the relationship between roads and wildfire occurrence.

Finally, access allowed by roads and trails can increase of ORV and motorized use in remote areas threatening archaeological and historic sites. Increased visitation has resulted in intentional and unintentional damage to many cultural sites (USDI Bureau of Land Management 2000, Schiffman 2005).

II. Climate Change and Transportation Infrastructure including the value of roadless areas for climate change adaptation

As climate change impacts grow more profound, forest managers must consider the impacts on the transportation system as well as from the transportation system. In terms of the former, changes in precipitation and hydrologic patterns will strain infrastructure at times to the breaking point resulting in damage to streams, fish habitat, and water quality as well as threats to public safety. In terms of the latter, the fragmenting effect of roads on habitat will impede the movement of species which is a fundamental element of adaptation. Through planning, forest managers can proactively address threats to infrastructure, and can actually enhance forest resilience by removing unneeded roads to create larger patches of connected habitat.

Impact of climate change and roads on transportation infrastructure

It is expected that climate change will be responsible for more extreme weather events, leading to increasing flood severity, more frequent landslides, changing hydrographs (peak, annual mean flows, etc.), and changes in erosion and sedimentation rates and delivery processes. Roads and trails in national forests, if designed by an engineering standard at all, were designed for storms and water flows typical of past decades, and hence may not be designed for the storms in future decades. Hence, climate driven changes may cause transportation infrastructure to malfunction or fail (ASHTO 2012, USDA Forest Service 2010). The likelihood is higher for facilities in high-risk settings—such as rain-on-snow zones, coastal areas, and landscapes with unstable geology (USDA Forest Service 2010).

Forests fragmented by roads will likely demonstrate less resistance and resilience to stressors, like those associated with climate change (Noss 2001). First, the more a forest is fragmented (and therefore the higher the edge/interior ratio), the more the forest loses its inertia characteristic, and becoming less resilient and resistant to climate change. Second, the more a forest is fragmented characterized by isolated patches, the more likely the fragmentation will interfere with the ability of species to track shifting climatic conditions over time and space. Noss (2001) predicts that weedy species with effective dispersal mechanisms might benefit from fragmentation at the expense of native species.

Modifying infrastructure to increase resilience

To prevent or reduce road failures, culvert blow-outs, and other associated hazards, forest managers will need to take a series of actions. These include replacing undersized culverts with larger ones, prioritizing maintenance and upgrades (e.g., installing drivable dips and more outflow structures), and obliterating roads that are no longer needed and pose erosion hazards (USDA Forest Service 2010, USDA Forest Service 2012a, USDA Forest Service 2011, Table 4).

Olympic National Forest has developed a number of documents oriented at protecting watershed health and species in the face of climate change, including a 2003 travel management strategy and a report entitled *Adapting to Climate Change in Olympic National Park and National Forest*. In the travel management strategy, Olympic National Forest recommended that 1/3rd of its road system be decommissioned and obliterated (USDA Forest Service 2011a). In addition, the plan called for addressing fish migration barriers in a prioritized and strategic way – most of these are associated with roads. The report calls for road decommissioning, relocation of roads away from streams, enlarging culverts as well as replacing culverts with fish-friendly crossings (USDA Forest Service 2011a, Table 4).

Table 4: Current and expected sensitivities of fish to climate change on the Olympic Peninsula, associated adaptation strategies and action for fisheries and fish habitat management and relevant to transportation management at Olympic National Forest and Olympic National Park (excerpt reprinted from USDA Forest Service 2011a).

Current and expected sensitivities	Adaptation strategies and actions
Changes in habitat quantity and quality	• Implement habitat restoration projects that focus on re-creating watershed processes and functions and that create diverse, resilient habitat.
Increase in culvert failures, fill-slope failures, stream adjacent road failures, and encroachment from stream-adjacent road segments	• Decommission unneeded roads. • Remove sidecast, improve drainage, and increase culvert sizing on remaining roads. • Relocate stream-adjacent roads.
Greater difficulty disconnecting roads from stream channels	• Design more resilient stream crossing structures.
Major changes in quantity and timing of streamflow in transitional watersheds	• Make road and culvert designs more conservative in transitional watersheds to accommodate expected changes.
Decrease in area of headwater streams	• Continue to correct culvert fish passage barriers. • Consider re-prioritizing culvert fish barrier correction projects.
Decrease in habitat quantity and connectivity for species that use headwater streams	• Restore habitat in degraded headwater streams that are expected to retain adequate summer streamflow (ONF).

In December 2012, the USDA Forest Service published a report entitled “Assessing the Vulnerability of Watersheds to Climate Change.” This document reinforces the concept expressed by Olympic National Forest that forest managers need to be proactive in reducing erosion potential from roads:

“Road improvements were identified as a key action to improve condition and resilience of watersheds on all the pilot Forests. In addition to treatments that reduce erosion, road improvements can reduce the delivery of runoff from road segments to channels, prevent diversion of flow during large events, and restore aquatic habitat connectivity by providing for passage of aquatic organisms. As stated previously, watershed sensitivity is determined by both inherent and management-related factors. Managers have no control over the inherent factors, so to improve resilience, efforts must be directed at anthropogenic influences such as instream flows, roads, rangeland, and vegetation management....

[Watershed Vulnerability Analysis] results can also help guide implementation of travel management planning by informing priority setting for decommissioning roads and road reconstruction/maintenance. As with the Ouachita NF example, disconnecting roads from the stream network is a key objective of such work. Similarly, WVA analysis could also help prioritize aquatic organism passage projects at road-stream crossings to allow migration by aquatic residents to suitable habitat as streamflow and temperatures change” (USDA Forest Service 2012a, p. 22-23).

Reducing fragmentation to enhance aquatic and terrestrial species adaptation

Decommissioning and upgrading roads and thus reducing the amount of fine sediment deposited on salmonid nests can increase the likelihood of egg survival and spawning success (McCaffery et al. 2007). In addition, this would reconnect stream channels and remove barriers such as culverts. Decommissioning roads in riparian areas may provide further benefits to salmon and other aquatic organisms by permitting reestablishment of streamside vegetation, which provides shade and maintains a cooler, more moderated microclimate over the stream (Battin et al. 2007).

One of the most well documented impacts of climate change on wildlife is a shift in the ranges of species (Parmesan 2006). As animals migrate, landscape connectivity will be increasingly important (Holman et al. 2005). Decommissioning roads in key wildlife corridors will improve connectivity and be an important mitigation measure to increase resiliency of wildlife to climate change. For wildlife, road decommissioning can reduce the many stressors associated with roads. Road decommissioning restores habitat by providing security and food such as grasses and fruiting shrubs for wildlife (Switalski and Nelson 2011).

Forests fragmented by roads and motorized trail networks will likely demonstrate less resistance and resilience to stressors, such as weeds. As a forest is fragmented and there is more edge habitat, Noss (2001) predicts that weedy species with effective dispersal mechanisms will increasingly benefit at the expense of native species. However, decommissioned roads when seeded with native species can reduce the spread of invasive species (Grant et al. 2011), and help restore fragmented forestlands. Off-road vehicles with large knobby tires and large undercarriages are also a key vector for weed spread (e.g., Rooney 2006). Strategically closing and decommissioning motorized routes, especially in roadless areas, will reduce the spread of weeds on forestlands (Gelbard and Harrison 2003).

Transportation infrastructure and carbon sequestration

The topic of the relationship of road restoration and carbon has only recently been explored. There is the potential for large amounts of carbon (C) to be sequestered by reclaiming roads. When roads are decompacted during reclamation, vegetation and soils can develop more

rapidly and sequester large amounts of carbon. A recent study estimated total soil C storage increased 6 fold to $6.5 \times 10^7 \text{ g C/km}$ (to 25 cm depth) in the northwestern US compared to untreated abandoned roads (Lloyd et al. 2013). Another recent study concluded that reclaiming 425 km of logging roads over the last 30 years in Redwood National Park in Northern California resulted in net carbon savings of 49,000 Mg carbon to date (Madej et al. 2013, Table 5).

Kerekvliet et al. (2008) published a Wilderness Society briefing memo on the impact to carbon sequestration from road decommissioning. Using Forest Service estimates of the fraction of road miles that are unneeded, the authors calculated that restoring 126,000 miles of roads to a natural state would be equivalent to revegetating an area larger than Rhode Island. In addition, they calculate that the net economic benefit of road treatments are always positive and range from US\$0.925-1.444 billion.

Table 5. Carbon budget implications in road decommissioning projects (reprinted from Madej et al. 2013).

Road Decommissioning Activities and Processes	Carbon Cost	Carbon Savings
Transportation of staff to restoration sites (fuel emissions)	X	
Use of heavy equipment in excavations (fuel emissions)	X	
Cutting trees along road alignment during hillslope recontouring	X	
Excavation of road fill from stream crossings		X
Removal of road fill from unstable locations		X
Reduces risk of mass movement		X
Post-restoration channel erosion at excavation sites	X	
Natural revegetation following road decompaction		X
Replanting trees		X
Soil development following decompaction		X

Benefits of roadless areas and roadless area networks to climate change adaptation

Undeveloped natural lands provide numerous ecological benefits. They contribute to biodiversity, enhance ecosystem representation, and facilitate connectivity (Loucks et al. 2003; Crist and Wilmer 2002, Wilcove 1990, The Wilderness Society 2004, Strittholt and Dellasala 2001, DeVelice and Martin 2001), and provide high quality or undisturbed water, soil and air (Anderson et al. 2012, Dellasalla et al. 2011). They also can serve as ecological baselines to help us better understand our impacts to other landscapes, and contribute to landscape resilience to climate change.

Forest Service roadless lands, in particular, are heralded for the conservation values they provide. These are described at length in the preamble of the Roadless Area Conservation Rule (RACR)⁴ as well as in the Final Environmental Impact Statement (FEIS) for the RACR⁵, and

⁴ Federal Register .Vol. 66, No. 9. January 12, 2001. Pages 3245-3247.

include: high quality or undisturbed soil, water, and air; sources of public drinking water; diversity of plant and animal communities; habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land; primitive, semi-primitive non- motorized, and semi-primitive motorized classes of dispersed recreation; reference landscapes; natural appearing landscapes with high scenic quality; traditional cultural properties and sacred sites; and other locally identified unique characteristics (e.g., include uncommon geological formations, unique wetland complexes, exceptional hunting and fishing opportunities).

The Forest Service, National Park Service, and US Fish and Wildlife Service recognize that protecting and connecting roadless or lightly roaded areas is an important action agencies can take to enhance climate change adaptation. For example, the Forest Service National Roadmap for Responding to Climate Change (USDA Forest Service 2011b) establishes that increasing connectivity and reducing fragmentation are short and long term actions the Forest Service should take to facilitate adaptation to climate change.⁶ The National Park Service also identifies connectivity as a key factor for climate change adaptation along with establishing “blocks of natural landscape large enough to be resilient to large-scale disturbances and long-term changes” and other factors. The agency states that: “The success of adaptation strategies will be enhanced by taking a broad approach that identifies connections and barriers across the landscape. Networks of protected areas within a larger mixed landscape can provide the highest level of resilience to climate change.”⁷ Similarly, the National Fish, Wildlife and Plants Climate Adaptation Partnership’s Adaptation Strategy (2012) calls for creating an ecologically-connected network of conservation areas.⁸

⁵ Final Environmental Impact Statement, Vol. 1, 3–3 to 3–7

⁶ Forest Service, 2011. *National Roadmap for Responding to Climate Change*. US Department of Agriculture. FS-957b. Page 26.

⁷ National Park Service. *Climate Change Response Program Brief*. <http://www.nature.nps.gov/climatechange/adaptationplanning.cfm>. Also see: National Park Service, 2010. *Climate Change Response Strategy*. http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf. Objective 6.3 is to “Collaborate to develop cross-jurisdictional conservation plans to protect and restore connectivity and other landscape-scale components of resilience.”

⁸ See <http://www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Chapter-3.pdf>. Pages 55- 59. The first goal and related strategies are:

Goal 1: Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.

Strategy 1.1: identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.

Strategy 1.2: Secure appropriate conservation status on areas identified in Strategy 1.1 to complete an ecologically-connected network of public and private conservation areas that will be resilient to climate change and support a broad range of species under changed conditions.

Strategy 1.4: Conserve, restore, and as appropriate and practicable, establish new ecological connections among conservation areas to facilitate fish, wildlife, and plant migration, range shifts, and other transitions caused by climate change.

Crist and Wilmer (2002) looked at the ecological value of roadless lands in the Northern Rockies and found that protection of national forest roadless areas, when added to existing federal conservation lands in the study area, would 1) increase the representation of virtually all land cover types on conservation lands at both the regional and ecosystem scales, some by more than 100%; 2) help protect rare, species-rich, and often-declining vegetation communities; and 3) connect conservation units to create bigger and more cohesive habitat “patches.”

Roadless lands also are responsible for higher quality water and watersheds. Anderson et al. (2012) assessed the relationship of watershed condition and land management status and found a strong spatial association between watershed health and protective designations. Dellasalla et al. (2011) found that undeveloped and roadless watersheds are important for supplying downstream users with high-quality drinking water, and developing these watersheds comes at significant costs associated with declining water quality and availability. The authors recommend a light-touch ecological footprint to sustain the many values that derive from roadless areas including healthy watersheds.

III. Sustainable Transportation Management in National Forests as Part of Ecological Restoration

At 375,000 miles strong, the Forest Service road system is one of the largest in the world – it is eight times the size of the National Highway System. It is also indisputably unsustainable – that is, roads are not designed, located, or maintained according to best management practices, and environmental impacts are not minimized. It is largely recognized that forest roads, especially unpaved ones, are a primary source of sediment pollution to surface waters (Endicott 2008, Gucinski et al. 2000), and that the system has about 1/3rd more miles than it needs (USDA Forest Service 2001). In addition, the majority of the roads were constructed decades ago when road design and management techniques did not meet current standards (Gucinski et al. 2000, Endicott 2008), making them more vulnerable to erosion and decay than if they had been designed today. Road densities in national forests often exceed accepted thresholds for wildlife.

Only a small portion of the road system is regularly used. All but 18% of the road system is inaccessible to passenger vehicles. Fifty-five percent of the roads are accessible only by high clearance vehicles and 27% are closed. The 18% that is accessible to cars is used for about 80% of the trips made within National Forests.⁹ Most of the road maintenance funding is directed to the passenger car roads, while the remaining roads suffer from neglect. As a result, the Forest Service currently has a \$3.7 billion road maintenance backlog that grows every year. In other words, only about 1/5th of the roads in the national forest system are used most of the time, and the fraction that is used often is the best designed and maintained because they are higher level access roads. The remaining roads sit generally unneeded and under-maintained – arguably a growing ecological and fiscal liability.

Current Forest Service management direction is to identify and implement a sustainable transportation system.¹⁰ The challenge for forest managers is figuring out what is a sustainable road system and how to achieve it – a challenge that is exacerbated by climate change. It is

⁹ USDA Forest Service. Road Management Website Q&As. Available online at http://www.fs.fed.us/eng/road_mgt/qanda.shtml.

¹⁰ See Forest Service directive memo dated March 29, 2012 entitled “Travel Management, Implementation of 36 CFR, Part 202, Subpart A (36 CFR 212.5(b))”

reasonable to define a sustainable transportation system as one where all the routes are constructed, located, and maintained with best management practices, and social and environmental impacts are minimized. This, of course, is easier said than done, since the reality is that even the best roads and trail networks can be problematic simply because they exist and usher in land uses that without the access would not occur (Trombulak and Frissell 2000, Carnefix and Frissell 2009, USDA Forest Service 1996b), and when they are not maintained to the designed level they result in environmental problems (Endicott 2008; Gucinski et al. 2000). Moreover, what was sustainable may no longer be sustainable under climate change since roads designed to meet older climate criteria may no longer hold up under new climate scenarios (USDA Forest Service 2010, USDA Forest Service 2011b, USDA Forest Service 2012a, AASHTO 2012).

Forest Service efforts to move toward a more sustainable transportation system

The Forest Service has made efforts to make its transportation system more sustainable, but still has considerable work to do. In 2001, the Forest Service tried to address the issue by promulgating the Roads Rule¹¹ with the purpose of working toward a sustainable road system (USDA 2001). The Rule directed every national forest to identify a minimum necessary road system and identify unneeded roads for decommissioning. To do this, the Forest Service developed the Roads Analysis Process (RAP), and published Gucinski et al. (2000) to provide the scientific foundation to complement the RAP. In describing the RAP, Gucinski et al. (2000) writes:

“Roads Analysis is intended to be an integrated, ecological, social, and economic approach to transportation planning. It uses a multiscale approach to ensure that the identified issues are examined in context. Roads Analysis is to be based on science. Analysts are expected to locate, correctly interpret, and use relevant existing scientific literature in the analysis, disclose any assumptions made during the analysis, and reveal the limitations of the information on which the analysis is based. The analysis methods and the report are to be subjected to critical technical review” (p. 10).

Most national forests have completed RAPs, although most only looked at passenger vehicle roads which account for less than 20% of the system’s miles. The Forest Service Washington Office in 2010 directed that forests complete a Travel Analysis Process (TAP) by the end of fiscal year 2015, which must address all roads and create a map and list of roads identifying which are likely needed and which are not. Completed TAPs will provide a blueprint for future road decommissioning and management, they will not constitute compliance with the Roads Rule, which clearly requires the identification of the minimum roads system and roads for decommissioning. Almost all forests have yet to comply with subpart A.

The Forest Service in 2005 then tried to address the off-road portion of this issue by promulgating subpart B of the Travel Management Rule,¹² with the purpose of curbing the most serious impacts associated with off-road vehicle use. Without a doubt, securing summer-time travel management plans was an important step to curbing the worst damage. However, much work remains to be done to approach sustainability, especially since many national forests used the travel management planning process to simply freeze the footprint of motorized routes, and did not try to re-design the system to make it more ecologically or socially sustainable. Adams

¹¹ 36 CFR 215 subpart A

¹² 36 CFR 212 subpart B

and McCool (2009) considered this question of how to achieve sustainable motorized recreation and concluded that:

As the agencies move to revise [off-road vehicle] allocations, they need to clearly define how they intend to locate routes so as to minimize impacts to natural resources and other recreationists in accordance with Executive Order 11644....¹³

...As they proceed with designation, the FS and BLM need to acknowledge that current allocations are the product of agency failure to act, not design. Ideally, ORV routes would be allocated as if the map were currently empty of ORV routes. Reliance on the current baseline will encourage inefficient allocations that likely disproportionately impact natural resources and non-motorized recreationists. While acknowledging existing use, the agencies need to do their best to imagine the best possible arrangement of ORV routes, rather than simply tinkering around the edges of the current allocations.¹⁴

The Forest Service only now is contemplating addressing the winter portion of the issue, forced by a lawsuit challenging the Forest Service's inadequate management of snowmobiles. The agency is expected to issue a third rule in the fall of 2014 that will trigger winter travel management planning.

Strategies for identifying a minimum road system and prioritizing restoration

Transportation Management plays an integral role in the restoration of Forestlands. Reclaiming and obliterating roads is key to developing a sustainable transportation system. Numerous authors have suggested removing roads 1) to restore water quality and aquatic habitats (Gucinski et al. 2000), and 2) to improve habitat security and restore terrestrial habitat (e.g., USDI USFWS 1993, Hebblewhite et al. 2009).

Creating a minimum road system through road removal will increase connectivity and decrease fragmentation across the entire forest system. However, at a landscape scale, certain roads and road segments pose greater risks to terrestrial and aquatic integrity than others. Hence, restoration strategies must focus on identifying and removing/mitigating the higher risk roads. Additionally, areas with the highest ecological values, such as being adjacent to a roadless area, may also be prioritized for restoration efforts. Several methods have been developed to help prioritize road reclamation efforts including GIS-based tools and best management practices (BMPs). It is our hope that even with limited resources, restoration efforts can be prioritized and a more sustainable transportation system created.

GIS-based tools

¹³ Recent court decisions have made it clear that the minimization requirements in the Executive Orders are not discretionary and that the Executive Orders are enforceable. See

- *Idaho Conservation League v. Guzman*, 766 F. Supp. 2d 1056 (D. Idaho 2011) (Salmon-Challis National Forest TMP).
- *The Wilderness Society v. U.S. Forest Service*, CV 08-363 (D. Idaho 2012) (Sawtooth-Minidoka district National Forest TMP).
- *Central Sierra Environmental Resource Center v. US Forest Service*, CV 10-2172 (E.D. CA 2012) (Stanislaus National Forest TMP).

¹⁴ Page 105.

Girvetz and Shilling (2003) developed a novel and inexpensive way to analyze environmental impacts from road systems using the Ecosystem Management Decision Support program (EMDS). EMDS was originally developed by the United States Forest Service, as a GIS-based decision support tool to conduct ecological analysis and planning (Reynolds 1999). Working in conjunction with Tahoe National Forest managers, Girvetz and Shilling (2003) used spatial data on a number of aquatic and terrestrial variables and modeled the impact of the forest's road network. The network analysis showed that out of 8233 km of road analyzed, only 3483 km (42%) was needed to ensure current and future access to key points. They found that the modified network had improved patch characteristics, such as significantly fewer "cherry stem" roads intruding into patches, and larger roadlessness.

Shilling et al. (2012) later developed a recreational route optimization model using a similar methodology and with the goal of identifying a sustainable motorized transportation system for the Tahoe National Forest (Figure 2). Again using a variety of environmental factors, the model identified routes with high recreational benefits, lower conflict, lower maintenance and management requirements, and lower potential for environmental impact operating under the presumption that such routes would be more sustainable and preferable in the long term. The authors combined the impact and benefit analyses into a recreation system analysis "that was effectively a cost-benefit accounting, consistent with requirements of both the federal Travel Management Rule (TMR) and the National Environmental Policy Act" (p. 392).

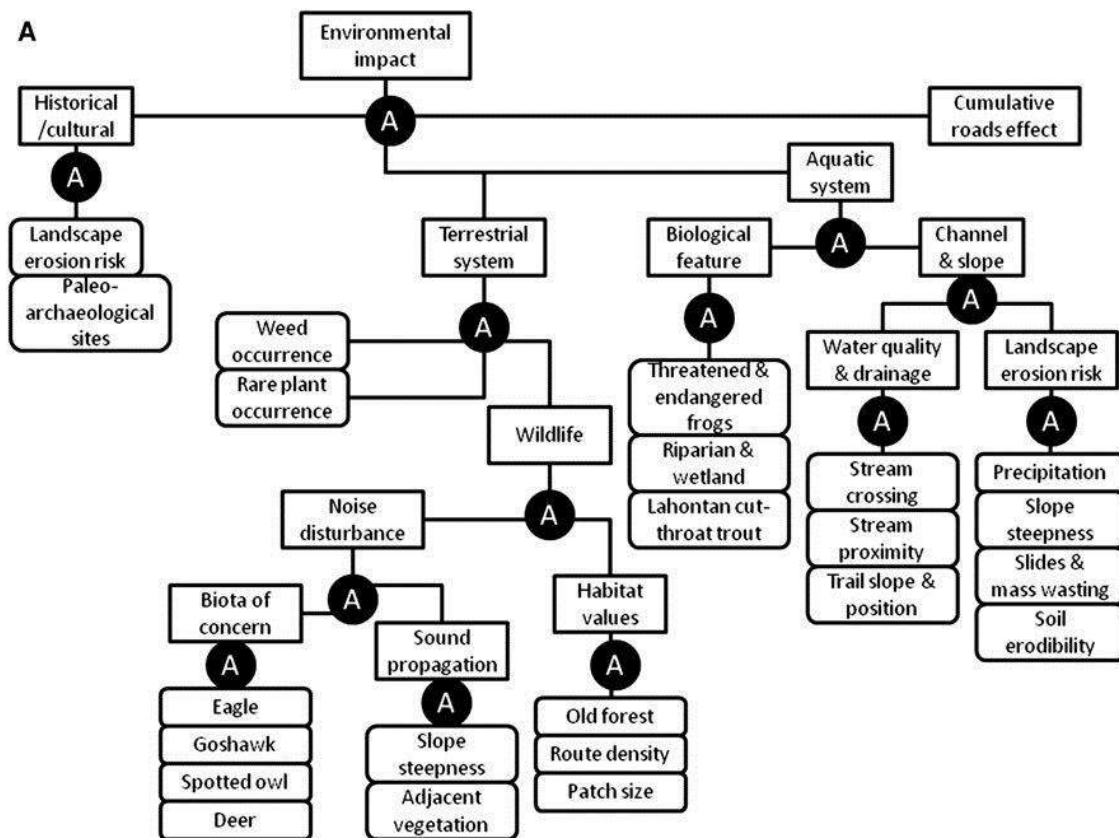


Figure 2: A knowledge base of contributions of various environmental conditions to the concept “environmental impact” [of motorized trails]. Rectangles indicate concepts, circles indicate Boolean logic operators, and rounded rectangles indicate sources of environmental data. (Reprinted from Shilling et al. 2012)

The Wilderness Society in 2012 also developed a GIS decision support tool called “RoadRight” that identifies high risk road segments to a variety of forest resources including water, wildlife, and roadlessness (The Wilderness Society 2012, The Wilderness Society 2013). The GIS system is designed to provide information that will help forest planners identify and minimize road related environmental risks. See the summary of and user guide for RoadRight that provides more information including where to access the open source software.¹⁵

¹⁵ The Wilderness Society, 2012. Rightsizing the National Forest Road System: A Decision Support Tool. Available at <http://www.landscapecollaborative.org/download/attachments/12747016/Road+decommissioning+model+-+overview+2012-02-29.pdf?version=1&modificationDate=1331595972330>.

The Wilderness Society, 2013.
RoadRight: A Spatial Decision Support System to Prioritize Decommissioning and Repairing Roads in

Best management practices (BMPs)

BMPs have also been developed to help create more sustainable transportation systems and identify restoration opportunities. BMPs provide science-based criteria and standards that land managers follow in making and implementing decisions about human uses and projects that affect natural resources. Several states have developed BMPs for road construction, maintenance and decommissioning practices (e.g., Logan 2001, Merrill and Cassaday 2003, USDA Forest Service 2012b).

Recently, BMPs have been developed for addressing motorized recreation. Switalski and Jones (2012) published, *“Off-Road Vehicle Best Management Practices for Forestlands: A Review of Scientific Literature and Guidance for Managers.”* This document reviews the current literature on the environmental and social impacts of off-road vehicles (ORVs), and establishes a set of Best Management Practices (BMPs) for the planning and management of ORV routes on forestlands. The BMPs were designed to be used by land managers on all forestlands, and is consistent with current forest management policy and regulations. They give guidance to transportation planners on where how to place ORV routes in areas where they will reduce use conflicts and cause as little harm to the environment as possible. These BMPs also help guide managers on how to best remove and restore routes that are redundant or where there is an unacceptable environmental or social cost.

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Attachments

Attachment 1: Wildfire and Roads Fact Sheet

Attachment 2: Using Road Density as a Metric for Ecological Health in National Forests: What Roads and Routes should be Included? Summary of Scientific Information



Photo: Lou Anegli Digital

Roaded Forests Are at a Greater Risk of Experiencing Wildfires than Unroaded Forests

- A wildland fire ignition is almost twice as likely to occur in a roaded area than in a roadless area. (USDA 2000, Table 3-18)
- The location of large wildfires is often correlated with proximity to busy roads. (Sierra Nevada Ecosystem Project, 1996)
- High road density increases the probability of fire occurrence due to human-caused ignitions. (Hann, W.J., et al. 1997)
- Unroaded areas have lower potential for high-intensity fires than roaded areas because they are less prone to human-caused ignitions. (DellaSala, et al. 1995)
- The median size of large fires on national forests is greater outside of roadless areas. (USDA 2000, Table 3-22)
- A positive correlation exists between lightning fire frequency and road density due to increased availability of flammable fine fuels near roads. (Arienti, M. Cecilia, et al. 2009)
- Human caused wildfires are strongly associated with access to natural landscapes, with the proximity to urban areas and roads being the most important factor (Romero-Calcerrada, et al. 2008)

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HUMAN ACTIVITY AND WILDFIRE

- Sparks from cars, off-road vehicles, and neglected campfires caused nearly 50,000 wildfire ignitions in 2000. (USDA 2000, Fuel Management and Fire Suppression Specialist Report, Table 4.)
- More than 90% of fires on national lands are caused by humans (USDA 1996 and 1998)
- Human-ignited wildfire is almost 5 times more likely to occur in a roaded area than in a roadless area (USDA 2000, Table 3-19).

There are 375,000 miles of roads in our national forests.



Photo: USDA Forest Service, Coconino National Forest

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**Attachment 2: Using Road Density as a Metric for Ecological Health in National Forests:
What Roads and Routes should be Included?
Summary of Scientific Information
Last Updated, November 22, 2012**

I. Density analysis should include closed roads, non-system roads administered by other jurisdictions (private, county, state), temporary roads and motorized trails.

Typically, the Forest Service has calculated road density by looking only at open system road density. From an ecological standpoint, this approach may be flawed since it leaves out of the density calculations a significant percent of the total motorized routes on the landscape. For instance, the motorized route system in the entire National Forest System measures well over 549,000 miles.¹ By our calculation, a density analysis limited to open system roads would consider less than 260,000 miles of road, which accounts for less than half of the entire motorized transportation system estimated to exist on our national forests.² These additional roads and motorized trails impact fish, wildlife, and water quality, just as open system roads do. In this section, we provide justification for why a road density analysis used for the purposes of assessing ecological health and the effects of proposed alternatives in a planning document should include closed system roads, non-system roads administered by other jurisdictions, temporary roads, and motorized trails.

Impacts of closed roads

It is crucial to distinguish the density of roads physically present on the landscape, whether closed to vehicle use or not, from “open-road density” (Pacific Rivers Council, 2010). An open-road density of 1.5 mi/mi² has been established as a standard in some national forests as protective of some terrestrial wildlife species. However, many areas with an open road density of 1.5 mi/mi² have a much higher inventoried or extant hydrologically effective road density, which may be several-fold as high with significant aquatic impacts. This higher density occurs because many road “closures” block vehicle access, but do nothing to mitigate the hydrologic alterations that the road causes. The problem is

¹ The National Forest System has about 372,000 miles of system roads. The forest service also has an estimated 47,000 miles of motorized trails. As of 1998, there were approximately 130,000 miles of non-system roads in our forests. Non-system roads include public roads such as state, county, and local jurisdiction and private roads. (USFS, 1998) The Forest Service does not track temporary roads but is reasonable to assume that there are likely several thousand miles located on National Forest System lands.

² About 30% of system roads, or 116,108 miles, are in Maintenance Level 1 status, meaning they are closed to all motorized use. (372,000 miles of NFS roads - 116,108 miles of ML 1 roads = 255,892). This number is likely conservative given that thousands of more miles of system roads are closed to public motorized use but categorized in other Maintenance Levels.

further compounded in many places by the existence of “ghost” roads that are not captured in agency inventories, but that are nevertheless physically present and causing hydrologic alteration (Pacific Watershed Associates, 2005).

Closing a road to public motorized use can mitigate the impacts on water, wildlife, and soils only if proper closure and storage technique is followed. Flow diversions, sediment runoff, and illegal incursions will continue unabated if necessary measures are not taken. The Forest Service’s National Best Management Practices for non-point source pollution recommends the following management techniques for minimizing the aquatic impacts from closed system roads: eliminate flow diversion onto the road surface, reshape the channel and streambanks at the crossing-site to pass expected flows without scouring or ponding, maintain continuation of channel dimensions and longitudinal profile through the crossing site, and remove culverts, fill material, and other structures that present a risk of failure or diversion. Despite good intentions, it is unlikely given our current fiscal situation and past history that the Forest Service is able to apply best management practices to all stored roads,³ and that these roads continue to have impacts. This reality argues for assuming that roads closed to the public continue to have some level of impact on water quality, and therefore, should be included in road density calculations.

As noted above, many species benefit when roads are closed to public use. However, the fact remains that closed system roads are often breached resulting in impacts to wildlife. Research shows that a significant portion of off-road vehicle (ORV) users violates rules even when they know what they are (Lewis, M.S., and R. Paige, 2006; Frueh, LM, 2001; Fischer, A.L., et. al, 2002; USFWS, 2007.). For instance, the Rio Grande National Forest’s Roads Analysis Report notes that a common travel management violation occurs when people drive around road closures on Level 1 roads (USDA Forest Service, 1994). Similarly, in a recent legal decision from the Utah District Court , *Sierra Club v. USFS*, Case No. 1:09-cv-131 CW (D. Utah March 7, 2012), the court found that, as part of analyzing alternatives in a proposed travel management plan, the Forest Service failed to take a hard look at the impact of continued illegal use. In part, the court based its decision on the Forest Service’s acknowledgement that illegal motorized use is a significant problem and that the mere presence of roads is likely to result in illegal use.

In addition to the disturbance to wildlife from ORVs, incursions and the accompanying human access can also result in illegal hunting and trapping of animals. The Tongass National Forest refers to this in its EIS to amend the Land and Resources Management Plan. Specifically, the Forest Service notes in the EIS that Alexander Archipelego wolf mortality due to legal and illegal hunting and trapping is related not only to roads open to motorized access, but to all roads, and that *total road densities* of 0.7-1.0 mi/mi² or less may be necessary (USDA Forest Service, 2008).

As described below, a number of scientific studies have found that ORV use on roads and trails can have serious impacts on water, soil and wildlife resources. It should be expected that ORV use will continue to

³ The Forest Service generally reports that it can maintain 20-30% of its open road system to standard.

some degree to occur illegally on closed routes and that this use will affect forest resources. Given this, roads closed to the general public should be considered in the density analysis.

Impacts of non-system roads administered by other jurisdictions (private, county, state)

As of 1998, there were approximately 130,000 miles of non-system roads in national forests (USDA Forest Service, 1998). These roads contribute to the environmental impacts of the transportation system on forest resources, just as forest system roads do. Because the purpose of a road density analysis is to measure the impacts of roads at a landscape level, the Forest Service should include all roads, including non-system, when measuring impacts on water and wildlife. An all-inclusive analysis will provide a more accurate representation of the environmental impacts of the road network within the analysis area.

Impacts of temporary roads

Temporary roads are not considered system roads. Most often they are constructed in conjunction with timber sales. Temporary roads have the same types environmental impacts as system roads, although at times the impacts can be worse if the road persists on the landscape because they are not built to last.

It is important to note that although they are termed temporary roads, their impacts are not temporary. According to Forest Service Manual (FSM) 7703.1, the agency is required to "Reestablish vegetative cover on any unnecessary roadway or area disturbed by road construction on National Forest System lands within 10 years after the termination of the activity that required its use and construction." Regardless of the FSM 10-year rule, temporary roads can remain for much longer. For example, timber sales typically last 3-5 years or more. If a temporary road is built in the first year of a six year timber sale, its intended use does not end until the sale is complete. The timber contract often requires the purchaser to close and obliterate the road a few years after the Forest Service completes revegetation work. The temporary road, therefore, could remain open 8-9 years before the ten year clock starts ticking per the FSM. Therefore, temporary roads can legally remain on the ground for up to 20 years or more, yet they are constructed with less environmental safeguards than modern system roads.

Impacts of motorized trails

Scientific research and agency publications generally do not decipher between the impacts from motorized trails and roads, often collapsing the assessment of impacts from unmanaged ORV use with those of the designated system of roads and trails. The following section summarizes potential impacts resulting from roads and motorized trails and the ORV use that occurs on them.

Aquatic Resources

While driving on roads has long been identified as a major contributor to stream sedimentation (for review, see Gucinski, 2001), recent studies have identified ORV routes as a significant cause of stream sedimentation as well (Sack and da Luz, 2004; Chin et al.; 2004, Ayala et al.; 2005, Welsh et al.; 2006). It has been demonstrated that sediment loss increases with increased ORV traffic (Foltz, 2006). A study by

Sack and da Luz (2004) found that ORV use resulted in a loss of more than 200 pounds of soil off of every 100 feet of trail each year. Another study (Welsh et al., 2006) found that ORV trails produced five times more sediment than unpaved roads. Chin et al. (2004) found that watersheds with ORV use as opposed to those without exhibited higher percentages of channel sands and fines, lower depths, and lower volume – all characteristics of degraded stream habitat.

*Soil Resources*⁴

Ouren, et al. (2007), in an extensive literature review, suggests ORV use causes soil compaction and accelerated erosion rates, and may cause compaction with very few passes. Weighing several hundred pounds, ORVs can compress and compact soil (Nakata et al., 1976; Snyder et al., 1976; Vollmer et al., 1976; Wilshire and Nakata, 1976), reducing its ability to absorb and retain water (Dregne, 1983), and decreasing soil fertility by harming the microscopic organisms that would otherwise break down the soil and produce nutrients important for plant growth (Wilshire et al., 1977). An increase in compaction decreases soil permeability, resulting in increased flow of water across the ground and reduced absorption of water into the soil. This increase in surface flow concentrates water and increases erosion of soils (Wilshire, 1980; Webb, 1983; Misak et al., 2002).

Erosion of soil is accelerated in ORV-use areas directly by the vehicles, and indirectly by increased runoff of precipitation and the creation of conditions favorable to wind erosion (Wilshire, 1980). Knobby and cup-shaped protrusions from ORV tires that aid the vehicles in traversing steep slopes are responsible for major direct erosional losses of soil. As the tire protrusions dig into the soil, forces far exceeding the strength of the soil are exerted to allow the vehicles to climb slopes. The result is that the soil and small plants are thrown downslope in a “rooster tail” behind the vehicle. This is known as mechanical erosion, which on steep slopes (about 15° or more) with soft soils may erode as much as 40 tons/mi (Wilshire, 1992). The rates of erosion measured on ORV trails on moderate slopes exceed natural rates by factors of 10 to 20 (Iverson et al., 1981; Hinckley et al., 1983), whereas use on steep slopes has commonly removed the entire soil mantle exposing bedrock. Measured erosional losses in high use ORV areas range from 1.4-242 lbs/ft² (Wilshire et al., 1978) and 102-614 lbs/ft² (Webb et al., 1978). A more recent study by Sack and da Luz (2003) found that ORV use resulted in a loss of more than 200 lbs of soil off of every 100 feet of trail each year.

Furthermore, the destruction of cryptobiotic soils by ORVs can reduce nitrogen fixation by cyanobacteria, and set the nitrogen economy of nitrogen-limited arid ecosystems back decades. Even small reductions in crust can lead to diminished productivity and health of the associated plant community, with cascading effects on plant consumers (Davidson et al., 1996). In general, the deleterious effects of ORV use on cryptobiotic crusts is not easily repaired or regenerated. The recovery time for the lichen component of crusts has been estimated at about 45 years (Belnap, 1993). After this time the crusts may appear to have regenerated to the untrained eye. However, careful observation will reveal that the 45 year-old crusts will not have recovered their moss component, which will take an additional 200 years to fully come back (Belnap and Gillette, 1997).

⁴ For a full review see Switalski, T. A. and A. Jones (2012).

*Wildlife Resources*⁵

Studies have shown a variety of possible wildlife disturbance vectors from ORVs. While these impacts are difficult to measure, repeated harassment of wildlife can result in increased energy expenditure and reduced reproduction. Noise and disturbance from ORVs can result in a range of impacts including increased stress (Nash et al., 1970; Millspaugh et al., 2001), loss of hearing (Brattstrom and Bondello, 1979), altered movement patterns (e.g., Wisdom et al. 2004; Preisler et al. 2006), avoidance of high-use areas or routes (Janis and Clark 2002; Wisdom 2007), and disrupted nesting activities (e.g., Strauss 1990).

Wisdom et al. (2004) found that elk moved when ORVs passed within 2,000 yards but tolerated hikers within 500 ft. Wisdom (2007) reported preliminary results suggesting that ORVs are causing a shift in the spatial distribution of elk that could increase energy expenditures and decrease foraging opportunities for the herd. Elk have been found to readily avoid and be displaced from roaded areas (Irwin and Peek, 1979; Hershey and Legee, 1982; Millspaugh, 1995). Additional concomitant effects can occur, such as major declines in survival of elk calves due to repeated displacement of elk during the calving season (Phillips, 1998). Alternatively, closing or decommissioning roads has been found to decrease elk disturbance (Millspaugh et al., 2000; Rowland et al., 2005).

Disruption of breeding and nesting birds is particularly well-documented. Several species are sensitive to human disturbance with the potential disruption of courtship activities, over-exposure of eggs or young birds to weather, and premature fledging of juveniles (Hamann et al., 1999). Repeated disturbance can eventually lead to nest abandonment. These short-term disturbances can lead to long-term bird community changes (Anderson et al., 1990). However when road densities decrease, there is an observable benefit. For example, on the Loa Ranger District of the Fishlake National Forest in southern Utah, successful goshawk nests occur in areas where the localized road density is at or below 2-3 mi/mi² (USDA, 2005).

Examples of Forest Service planning documents that use total motorized route density or a variant

Below, we offer examples of where total motorized route density or a variant has been used by the Forest Service in planning documents.

- The Mt. Taylor RD of the Cibola NF analyzed open and closed system roads and motorized trails together in a single motorized *route* density analysis. Cibola NF: Mt. Taylor RD Environmental Assessment for Travel Management Planning, Ch.3, p 55.
http://prdp2fs.ess.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5282504.pdf.
- The Grizzly Bear Record of Decision (ROD) for the Forest Plan Amendments for Motorized Access

⁵ For a full review see: Switalski, T. A. and A. Jones (2012).

Management within the Selkirk and Cabinet-Yaak Grizzly Bear Recovery Zones (Kootenai, Lolo, and Idaho Panhandle National Forests) assigned route densities for the designated recovery zones. One of the three densities was for Total Motorized Route Density (TMRD) which includes open roads, restricted roads, roads not meeting all reclaimed criteria, and open motorized trails. The agency's decision to use TMRD was based on the Endangered Species Act's requirement to use best available science, and monitoring showed that both open and closed roads and motorized trails were impacting grizzly. Grizzly Bear Plan Amendment ROD. Online at cache.ecosystem-management.org/48536_FSPLT1_009720.pdf.

- The Chequamegon-Nicolet National Forest set forest-wide goals in its forest plan for both open road density and total road density to improve water quality and wildlife habitat.

I decided to continue reducing the amount of total roads and the amount of open road to resolve conflict with quieter forms of recreation, impacts on streams, and effects on some wildlife species. ROD, p 13.

Chequamegon-Nicolet National Forest Land and Resource Management Plan Record of Decision. Online at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5117609.pdf.

- The Tongass National Forest's EIS to amend the forest plan notes that Alexander Archipelago wolf mortality due to legal and illegal hunting and trapping is related not only to roads open to motorized access, but to all roads, and that *total road densities* of 0.7-1.0 mi/mi² or less may be necessary.

Another concern in some areas is the potentially unsustainable level of hunting and trapping of wolves, when both legal and illegal harvest is considered. The 1997 Forest Plan EIS acknowledged that open road access contributes to excessive mortality by facilitating access for hunters and trappers. Landscapes with open-road densities of 0.7 to 1.0 mile of road per square mile were identified as places where human-induced mortality may pose risks to wolf conservation. The amended Forest Plan requires participation in cooperative interagency monitoring and analysis to identify areas where wolf mortality is excessive, determine whether the mortality is unsustainable, and identify the probable causes of the excessive mortality.

More recent information indicates that wolf mortality is related not only to roads open to motorized access, but to all roads, because hunters and trappers use all roads to access wolf habitat, by vehicle or on foot. Consequently, this decision amends the pertinent standard and guideline contained in Alternative 6 as displayed in the Final EIS in areas where road access and associated human caused mortality has been determined to be the significant contributing factor to unsustainable wolf mortality. The standard and guideline has been modified to ensure that a range of options to reduce mortality risk will be considered in these areas, and to specify that total road densities of 0.7 to 1.0 mile per square mile or less may be necessary. ROD, p 24.

Tongass National Forest Amendment to the Land and Resource Management Plan Record of Decision and Final EIS. January 2008. http://tongass-fpadjust.net/Documents/Record_of_Decision.pdf

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ATTACHMENT B



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Forest Service
Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-844

August 2011



Adapting to Climate Change at Olympic National Forest and Olympic National Park



The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the national forests and national grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

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Cover

Butterfly photo by Betsy Howell, Forest Service (Olympic NF).
River photo by Jessica Halofsky (University of Washington).
Fish photo courtesy of the National Park Service (Olympic NP).
Forest photo courtesy of the U.S. Forest Service (Olympic NF).

Adapting to Climate Change at Olympic National Forest and Olympic National Park

**Jessica E. Halofsky, David L. Peterson,
Kathy A. O'Halloran, and Catherine Hawkins Hoffman
Editors**

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Abstract

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Climate change presents a major challenge to natural resource managers both because of the magnitude of potential effects of climate change on ecosystem structure, processes, and function, and because of the uncertainty associated with those potential ecological effects. Concrete ways to adapt to climate change are needed to help natural resource managers take the first steps to incorporate climate change into management and take advantage of opportunities to counteract the negative effects of climate change. We began a climate change adaptation case study at Olympic National Forest (ONF) in partnership with Olympic National Park (ONP) to determine how to adapt management of federal lands on the Olympic Peninsula, Washington, to climate change. The case study began in the summer of 2008 and continued for 1½ years. The case study process involved science-based sensitivity assessments, review of management activities and constraints, and adaptation workshops in each of four focus areas (hydrology and roads, fish, vegetation, and wildlife). The process produced adaptation options for ONF and ONP, and illustrated the utility of place-based vulnerability assessment and science-management workshops in adapting to climate change. The case study process provides an example for other national forests, national parks, and natural resource agencies of how federal land management units can collaborate in the initial stages of climate change adaptation. Many of the ideas generated through this process can potentially be applied in other locations and in other agencies.

Keywords: Adaptation, climate change, fish habitat management, hydrology, road management, science-management partnerships, vegetation management, wildlife habitat management.

Summary

In this report, we describe results of the Olympic Climate Change Case Study, a science-management collaboration initiated to develop climate change adaptation strategies and actions for Olympic National Forest (ONF) and Olympic National Park (ONP). The case study was one of three parallel climate change adaptation case studies on national forests and adjacent national parks in the Western United States as a part of a larger effort, the WestWide Climate Initiative. This initiative was created by scientists of the U.S. Forest Service to address the urgent need to communicate climate change information to land managers and work with them to develop adaptation options.

For the Olympic Climate Change Case Study, we conducted a vulnerability assessment to facilitate development of adaptation strategies and actions for ONF and ONP. The first step in the vulnerability assessment process involved a review of available climate model projections to determine likely levels of exposure to climate change (degree of deviation in temperature and precipitation) on the Olympic Peninsula (chapter 3). In the next step, we reviewed relevant literature on effects of climate change and available projections to identify likely climate change sensitivities in each of four focus areas on the Olympic Peninsula, including hydrology and roads (chapter 4), fish (chapter 5), vegetation (chapter 6), and wildlife (chapter 7). We worked with regional scientists and specialists to interpret available information and apply it more directly to Olympic Peninsula ecosystems. Finally, we reviewed current management activities at ONF and ONP and identified management constraints to evaluate some aspects of institutional capacity to implement adaptive actions. Review of current management activities was done by focus area and is described in the chapter for each focus area.

The vulnerability assessment process set the stage for development of adaptation options at the forest and park through science-management workshops (also described in the chapter for each focus area). The workshop format gave managers an open forum to brainstorm, express initial thoughts and ideas, and vet those ideas among peers. Direct engagement of scientists and managers in the workshop format fostered development of science-based adaptation strategies. During workshop discussions, managers identified general priority actions for adaptation, as well as priorities for species protection, habitat protection, and monitoring.

Although interagency partnerships exist elsewhere to address specific natural resource issues, the Olympic Climate Change Case Study is an unprecedented example of U.S. Forest Service and National Park Service jointly planning for climate change adaptation. The case study process produced specific and tangible ways for ONF and ONP to incorporate climate change adaptation strategies into management. A key finding of the assessment was that the current general management at both ONF and ONP, with restoration as a primary goal, is consistent with managing for resilience to prepare ecosystems for a changing climate. However, the effort highlighted some potential issues related to climate change that challenge current precepts and management guidelines and helped to identify new potential actions and actions that could be increased and reprioritized.

Climate change adaptation requires systematic monitoring and evaluation to detect changes and determine the success of adaptive management activities. Staying abreast of available information on potential climate change effects is essential to determine additional ways to incorporate climate change adaptation into management. Although further effort will be required, the case study described in this report was an essential first step for ONF, ONP, and their stakeholders in preparing for climate change on the Olympic Peninsula.

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Chapter 1: Introduction

Jessica E. Halofsky, David L. Peterson, Kathy A. O'Halloran, and Catherine Hawkins Hoffman¹

There is strong and growing scientific evidence for human-induced global climate change (Pachauri and Reisinger 2007). Global ecological effects triggered by warming in the late part of the 20th century include earlier snowmelt and decreased spatial extent of snow and ice (Barnett et al. 2008, Hamlet et al. 2005, Mote et al. 2005, Pachauri and Reisinger 2007), shifts in species distributions (Parmesan 2006, Parmesan and Yohe 2003, Mote et al. 2005, Root et al. 2003), and rising sea levels (Parry et al. 2007). Despite current and future greenhouse gas mitigation efforts, changes in the climate system will continue owing to already elevated concentrations of carbon dioxide in the Earth's atmosphere (Watson and the Core Writing Team 2001). Thus, climate change adaptation, or "the adjustment in ecological, social, or economic systems in response to climate stimuli and their effects" (Pachauri and Reisinger 2007), will be critical in reducing unwanted effects of climate change on both ecosystems and society.

Climate change presents a major challenge to natural resource managers because of the magnitude of potential effects of climate change on ecosystem structure, process, and function, and because of the uncertainty associated with potential ecological effects. Although general guidelines exist (e.g., Julius et al. 2008, Millar et al. 2007) to proactively incorporate climate change into planning, decisions, and activities, managers require concrete and place-based methods to adapt to climate change.

Scientists and managers must work together to develop and implement strategies that facilitate adaptation to climate change. Resource managers have the skills and local knowledge to incorporate climate change into management. However, there is an overwhelming amount of climate change information to absorb, a steep learning curve with

climate change science, and little time for learning owing to managers' many responsibilities. Given the relative infancy and experimental nature of climate change adaptation strategies, resource managers generally lack specific guidance and directives regarding how to incorporate climate change into program planning and implementation. Scientists have technical knowledge on climate change but often a poor understanding of management and regulatory, policy, and collaborative social processes for resource planning and decisionmaking. Although these two groups of specialists share complementary sets of skills and knowledge, a lack of formal relationships, and differences in work culture, timeframes, and communication styles limit science-management interactions on climate change issues.

In this report, we describe results of the Olympic Climate Change Case Study, a science-management collaboration initiated as part of a larger effort called the WestWide Climate Initiative (USDA Forest Service 2007). Scientists of the U.S. Forest Service created the WestWide Climate Initiative to address the urgent need to provide climate change information and adaptation tools to land managers in the Western United States. As a part of this initiative, parallel case studies were conducted to develop climate change tools and adaptation options at Olympic National Forest (ONF) and Olympic National Park (ONP) (Washington); Tahoe National Forest, Inyo National Forest, and Devils Postpile National Monument (California); and Shoshone National Forest (Wyoming).

The Olympic Climate Change Case Study occurred in two phases. The first phase involved education for managers at ONF on climate change science and potential effects of climate change, and an initial effort to develop

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adaptation strategies (Littell et al. 2011). The second phase, described here, focused on further development of strategies and actions for climate change adaptation. The case study began in the summer of 2008 and continued for 1½ years. The ONP joined with ONF in the second phase of the case study because of the proximity of the park and forest, similarities in management goals, and the importance of collaboration between neighbors in preparing for climate change. Although interagency partnerships exist elsewhere to address specific natural resource issues, this collaborative effort is unprecedented in development of climate change adaptation strategies and actions for a large landscape.

The second phase of the Olympic Climate Change Case Study developed adaptation strategies and actions in four focus areas identified by ONF and ONP managers as being most important: hydrology and roads, fish, vegetation, and wildlife. To develop adaptation actions for each focus area, we conducted a vulnerability assessment, or an assessment of the degree to which geophysical, biological, and socioeconomic systems are susceptible to, and unable to cope with, unwanted impacts of climate change (Parry et al. 2007). **Vulnerability** is a function of system exposure, its sensitivity, and its adaptive capacity (Gallopín 2006, Parry et al. 2007). In a climate change context, **exposure** can be thought of as the degree, duration, or extent of deviation in climate to which a system is exposed. **Sensitivity** is the degree to which a system is affected, either positively or negatively and directly or indirectly, by climate-related stimuli (Parry et al. 2007). **Adaptive capacity** is the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (Parry et al. 2007).

To determine likely levels of exposure to climate change on the Olympic Peninsula, we reviewed global climate model projections included in the University of Washington Climate Impacts Group Washington State Assessment (Mote and Salathé 2010) (see chapter 3 for further detail). Then, to assess other aspects of climate change vulnerability and develop adaptation options, for each focus area, we used a three-part process that involved:

- An assessment of climate change sensitivity through a topical literature review and review of available climate change impact model output, incorporating information directly applicable to the Olympic Peninsula whenever possible. Sometimes, scientists summarized best-available information in presentations to managers, and scientists and managers worked together to interpret and apply it to Olympic Peninsula ecosystems.
- An assessment of the capacity of ONF and ONP to adapt to climate change through review of current management practices and potential regulatory and institutional constraints.
- Development of adaptation strategies through science-management workshops. The results of the vulnerability assessment provided the starting point for facilitated science-management dialog on possible adaptation strategies in each focus area. The workshop format provided opportunities to transfer information and facilitate discussions between managers and scientists.

In all steps of the case study process, scientists and managers worked together to gather and refine information to identify climate change vulnerabilities and develop adaptation options for ONF and ONP. For consistency across focus areas, two scientists from the Forest Service Pacific Northwest Research Station and the natural resource staff supervisors from ONF and ONP participated in and guided the entire process. Participants in each focus area included forest and park staff specialists, including silviculturists, forest geneticists, botanists, wildlife biologists, engineers, fish biologists, and hydrologists. For each focus area, scientists from the University of Washington Climate Impacts Group and Forest Service scientists provided presentations and participated in discussions of adaptation options. Both the hydrology and roads, and vegetation workshops were limited to forest and park specialists and scientists with specialized knowledge in the focus area because of the need for progress within a specific timeframe, and for continuity and commitment to the process over many months, in addition to the complicated scheduling, logistics, and orchestration of a large-group planning process. However, the wildlife workshops included specialists from other natural

resource organizations, including the Washington Department of Natural Resources, the U.S. Geological Survey, and U.S. Fish and Wildlife Service, to take advantage of their specialized knowledge of wildlife on the peninsula and interest in climate change. A science-focused fish workshop included over 100 participants from a variety of state and federal natural resource agencies, watershed organizations, and tribes. The fish workshop was opened to a broader audience because fish (particularly salmonids) are one of the widest ranging, multijurisdictional organisms inhabiting the peninsula. A critical next step will be to work with these and other partners in climate change adaptation on the peninsula.

During workshop discussions, ONF and ONP identified general priority actions for adaptation, as well as priorities for species protection, habitat protection, and monitoring. In developing these adaptation strategies, the goal was to identify no-regrets strategies and actions that are likely to produce favorable outcomes, are compatible with current management objectives, and are adaptable through time. For the purposes of the workshops, it was assumed that there will be no changes in policy mandates (e.g., land allocation designations, Endangered Species Act ([ESA 1973]) listings, or directives in the Northwest Forest Plan) over the next 5 years. These objectives and constraints yielded realistic and tangible adaptation strategies and actions for ONF and ONP.

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Chapter 2: Olympic National Forest and Olympic National Park: Biogeographic Setting, Cultural History, and Policy Context

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The Olympic Peninsula

Located in the northwestern portion of Washington state, USA, the Olympic Peninsula comprises an area of 16 800 km² (fig. 2.1). Bounding the peninsula is the Pacific Ocean to the west, the Strait of Juan de Fuca to the north, and Puget Sound and Hood Canal to the east. Elevation on the peninsula ranges from sea level to 2427 m at Mount Olympus, the highest peak of the Olympic Mountains, which dominate the central portion of the peninsula. The steep and dissected topography in the central portion of the peninsula results in temperature and precipitation gradients and varied climatic conditions (Peterson et al. 1997). A wet and humid maritime climate characterizes the western, coastal side of the peninsula, which receives 300 to 500 cm of precipitation per year depending on location, while the crest of the Olympic Mountains receives >600 cm of precipitation per year, making it the wettest location in the coterminous United States (Peterson et al. 1997). In contrast, the northeastern portion of the peninsula is characterized by a drier, more continental climate owing to the rainshadow effect of the Olympic Mountains (and prevailing winds from the southwest during the winter). Rainfall in the northeastern portion of the peninsula is as low as 50 cm per year at lower elevations (Henderson et al. 1989). Most precipitation falls between October and March, and winter precipitation falls mainly as rain below 300 m, as rain and snow between 300 m and 750 m, and as snow above 750 m. Snow at higher elevations persists through the early part of summer.

Varied climatic conditions on the peninsula result in diverse ecological communities. Vegetation assemblages

on the peninsula include temperate rain forests, mixed-conifer forests, prairies, alpine tundra, subalpine parklands, wetlands, rivers, streams, and mountain lakes. There are 1,480 native vascular plant species (Buckingham et al. 1995) on the peninsula, including eight endemic species. Several endemic animal species also inhabit the peninsula, including the Olympic marmot, the Olympic pocket gopher, and the Olympic torrent salamander (See Common and Scientific names).

Land ownership on the peninsula is a mix of federal, state, tribal, and private lands (fig. 2.1). Olympic National Park (ONP) occupies the core of the peninsula and includes much of the higher elevation portion. Olympic National Forest (ONF) surrounds the park. The forest and park cover about one-third of the peninsula.

Cultural History of the Olympic Peninsula

The Olympic Peninsula has a rich cultural history involving extensive interaction between native peoples and their environment. Prior to what European Americans call the historic period (less than 200 years before present), there were about 10,000 people living on the Olympic Peninsula, the ancestors of the tribes here today: the Elwha Klallam, Jamestown S'Klallam, Port Gamble S'Klallam, Quinault, Hoh, Quileute, Makah, Queets, and Skokomish (Wray 2002). The tribes of the Olympic Peninsula maintain close ties to all of their ancestral lands and share concern for resource protection. They are an integral part of the ecosystem, as their traditional practices included land management, such as maintaining prairies by burning them to increase edible and medicinal plant populations.

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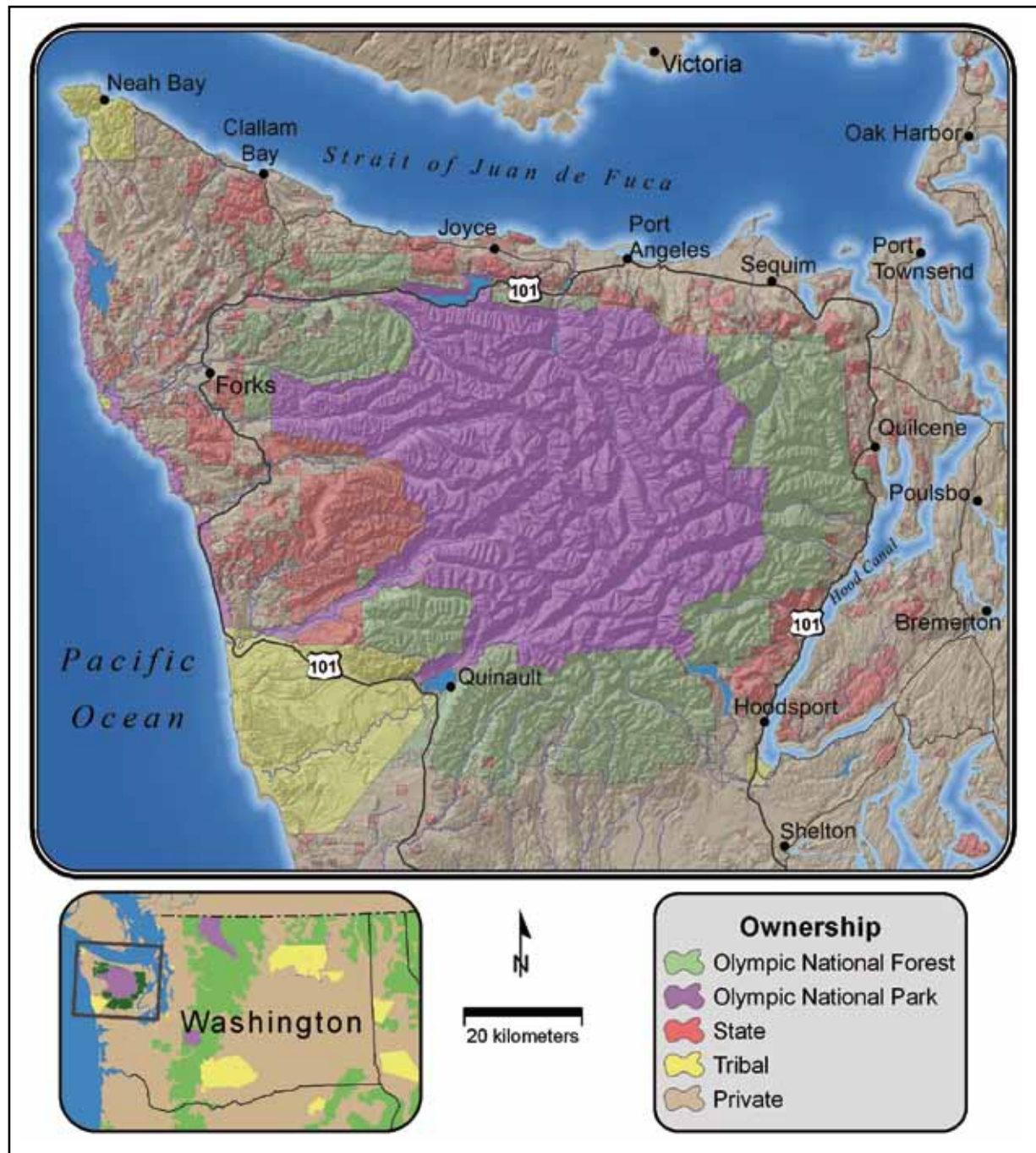


Figure 2.1—Location of and land ownership on the Olympic Peninsula.

In 1854, Governor Issac Stevens, who was also Superintendent of Indian Affairs in Washington Territory, began treaty negotiations to unite the numerous bands of Indians into tribes and to extinguish title to their lands

for settlement by U.S. citizens. The treaties established formal relationships between the tribes as sovereigns and the United States and established the Quinalt, Skokomish, and Makah reservations. The Quileute and Hoh reservations were established by Executive order and the three

Klallam reservations by Congress. Tribal reservation lands on the peninsula comprise over 89 000 ha, ranging from the Quinault Reservation, encompassing 86 000 ha, to the Jamestown S’Klallam Reservation, with only 2 ha.

The peninsula treaties that ceded the land now within ONP include the Treaty of Point No Point 1855 (Skokomish and Klallam), Treaty of Neah Bay 1855 (Makah), and Treaty of Olympia 1856 (Quinault, Quileute, and Hoh). The treaties specify that the tribes have the right to fish at “usual and accustomed grounds and stations... in common with all citizens... together with the privilege of hunting and gathering roots and berries on open and unclaimed lands.” In 1974, Federal District Court Judge George Boldt found that the tribes were guaranteed an equal share or half of the sustainable harvest of anadromous fish in *U.S. v. Washington*. He also found that the treaties were “not a grant of rights to the Indians, but a grant of rights from them, and a reservation of those not granted” [*United States v. State of Washington* 384 F. Supp. 312 (1974):323]. In other words, these were not rights given to them, but rights they always had—from time immemorial.

The relationship between the first people and the Olympic Peninsula is recounted in origin legends and mythic events that explain both the creation of the landscape and peoples’ relationship to it. These legends depict a strong reliance upon waterways, forests, and valleys for the acquisition of vital resources, and detailed descriptions of travel into the mountains for pleasure, social interchange such as marriage, and spiritual pursuits [Wray 2002].

Trails were used where canoes could not go, following the river drainages to the open meadows and mountain ridgelines. Trails crossed the mountains between the Hoh and the Elwha Rivers and from the Quileute to the Pysht and the Hoko (Gibbs 1877). Other trails led from Hood Canal to Grays Harbor, and crossed the Olympics from the Skokomish and Dosewallips River drainages to the Quinault. Many of the trail routes are the same routes used today by hikers in the park and forest.

The remains of stone tool manufacture, or lithics, have been documented in the Olympic Mountains and surrounding foothills by archeologists. These tools were used for hunting, butchering, and plant processing. In 1993, portions

of a woven cedar basket—part of a pack basket used as a backpack—were found in the alpine reaches of ONP. This discovery provides additional evidence of high-country habitation. The basket has been radiocarbon dated to be about 2,880 years old.

Maritime archeological village sites on the Pacific coast, Strait of Juan de Fuca, and Hood Canal had economies that included intertidal gathering, fishing, sealing, and whaling, dating back thousands of years. Animal remains, along with stone and wood artifacts, indicate the presence of an “Early Maritime” culture on the Olympic Peninsula about 3,000 years ago (Bergland 1983). This culture relied on salmon and shellfish, which had likely increased in abundance in response to stabilization of sea level and increased precipitation during that time period (Henderson et al. 1989).

Native peoples of the Olympic Peninsula used native plant materials extensively (Gunther 1945, Norton 1979, as cited in Henderson et al. 1989). Western redcedar was used for a variety of purposes, including cedar plank houses, canoes, fishing tools, cradles, paddles, and arrowshafts (Henderson et al. 1989). The bark of western redcedar was also used to make clothing, baskets, mats, and eating utensils, among other objects (Gunther 1945). Other plants, such as camas, bracken fern, salmonberry, salal, and huckleberries, provided important food sources (Henderson et al. 1989). Prairies were regularly burned to maintain and cultivate camas and other food plants (Norton 1979).

Native plants were also used for medicine and other purposes. For example, stinging nettle was used for medicine and rope (Henderson et al. 1989). Cattail and beargrass were used in basketry. Sitka spruce roots were also used for nets and cordage, and spruce pitch, limbs, bark, and wood were also used (Henderson et al. 1989).

Olympic National Forest

Created in 1907, ONF encompasses an area of 256 440 ha, 15 percent of which is federally designated wilderness. The mission of the Forest Service, and thus ONF, is “to sustain the health, diversity, and productivity of the Nation’s forest and grasslands to meet the needs of present and future generations” (USDA FS 2007). Timber production and

fresh water were historically the most valued ecosystem services provided by ONF. Timber harvest activities began on ONF in the 1920s. Until the 1990s, timber management generally consisted of clearcutting, broadcast burning, and tree replanting. These management practices resulted in the conversion of over one-third of ONF into relatively young even-aged forests. In addition, over 3500 km of forest roads built for timber harvest remain on the forest road network.

The 1994 Northwest Forest Plan (NWFP) (USDA and USDI 1994) and a change in Forest Service agency management policy led to a movement toward ecosystem management at ONF. Ecosystem management from a Forest Service perspective has four main components including protecting ecosystems, restoring deteriorated ecosystems, providing multiple-use benefits for people within the capabilities of ecosystems, and ensuring organizational effectiveness. The NWFP also mandates management for ecological priorities, mainly the protection, enhancement, and acceleration of late-successional forest conditions. At ONF, a major land allocation under the NWFP is late-successional reserve (LSR), the goal of which is to maintain late-successional and old-growth forest ecosystems. The LSRs are designed primarily to serve as habitat for late-successional and old-growth-related species, including the northern spotted owl. Olympic National Forest is focused on:

- Managing for native biodiversity and promoting the development of late-successional forests
- Restoring and protecting aquatic ecosystems from the impacts of an aging road infrastructure
- Managing for individual threatened and endangered species as defined by the Endangered Species Act (ESA) (ESA 1973) and related policies

Because of this focus on ecological restoration, forest personnel consider ONF to be a “restoration forest.”

Besides the ESA, other federal statutes guide current management activities at ONF, including the National Forest Management Act (NFMA) (NFMA 1976) and the National Environmental Policy Act (NEPA) (NEPA 1969). The NFMA imposes directives on national forest planning and activities. The NEPA requires all federal government agencies to conduct environmental analyses and prepare environmental documents (environmental assessments or

environmental impact statements [EIS]) that assess and disclose the environmental impacts of proposed actions.

The ONF land and resource management plan (LRMP) (as amended by the NWFP; USDA FS 1990) guides management activities at ONF and is revised every 10 years. A key component of the LRMP is the aquatic conservation strategy (ACS), which includes eight objectives for maintaining and restoring watershed processes and functions. To be consistent with the LRMP and the ACS, all management activities at ONF must maintain or help restore watershed conditions.

The ONF also has a forest strategic plan that integrates aquatics, wildlife, silviculture, and fire, helping to identify priority areas for management activities such as habitat restoration, road decommissioning, forest thinning, and fuel reduction treatments. Factors such as habitat improvement potential (specifically for threatened and endangered species and important charismatic species such as Roosevelt elk), economic viability of activities, and existing priorities and land allocation restrictions determine priority actions.

The ONF and the Forest Service in general are just beginning to address climate change and adaptation to climate change. In October 2008, the Forest Service issued the *Forest Service Strategic Framework for Responding to Climate Change* (USDA FS 2008), which identified climate change adaptation as a key goal for the agency and recommended integrating climate change considerations into agency-wide policies and program guidance. The agency also issued national guidance on how climate change can be incorporated in LMRP revision and analyses of projects. Further guidance for adaptation on national forests is in development at this writing.

Olympic National Park

Created in 1938, ONP covers 373 384 ha on the Olympic Peninsula. The park includes both the central, mountainous portion of the Olympic Peninsula, as well as a strip more than 110 km long on the Pacific coast. In 1988, the U.S. Congress designated over 95 percent of the park as a wilderness area. Much of the park is in relatively pristine condition, although effects of past human activities are evident and persistent in some areas.

The foundation for National Park Service (NPS) policies governing the management at ONP is the 1916 Organic Act, which established an NPS with the purpose to “conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations” (NPS 1916). The fundamental purpose of the NPS is to conserve park resources and values and to provide for enjoyment of parks while avoiding or minimizing adverse impacts. Management within parks focuses on preserving physical and biological processes and preserving the “natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems” (NPS 2006).

The mandate of the NPS requires that parks both conserve natural resources and provide for public enjoyment, although the Redwoods Act (1978) clarified that protecting resources takes precedence over providing for the enjoyment of the public. Nevertheless, this dual mandate entails careful management to avoid conflicts between the two goals. Several other statutes such as the NPS General Authorities Act (NPS 1970), Clean Air Act (1970), ESA (1973), NEPA (1969), Wilderness Act (1964), and Wild and Scenic Rivers Act (1968) constitute additional directives for park management. Management policies of the NPS (2006) provide a stewardship framework and broad guidance to park managers. Individual parks develop long-term management plans and other implementation plans that describe specific management objectives.

The ONP General Management Plan (NPS 2008) established a vision for managing ONP for the next 15 to 20 years and aims to protect natural and cultural resources while improving visitor experiences. The plan designated management zones within the park and established desired resource conditions. The plan also established fundamental objectives including maintaining access to existing developed areas, trails, campgrounds, and facilities; seeking additional partnerships to help provide better visitor access and enjoyment and protection of sensitive resources; making boundary adjustments through purchases or land exchanges to incorporate sensitive resource areas within the park (e.g., fish habitat, wetlands); and providing continued

protection of wilderness resources and cultural resources within wilderness. The public participated in the development of this plan.

Other park plans guide management practices, including the ONP backcountry management plan, the fire management plan, and the wilderness management plan (to be developed beginning fall 2010). Besides regulations found in the Code of Federal Regulations (36CFR part 7.28), the ONP superintendent’s compendium establishes regulations that are specific to ONP.

Like ONF, ONP is subject to NEPA. As part of NEPA analyses, park managers evaluate management actions within the park to determine their potential effect on ONP resources, select the action that will meet park management needs with the least impacts, and ensure that no activities will result in impairment. Depending on the nature of the activity, compliance may be relatively informal or may require an EIS under NEPA.

Similar to the Forest Service, the NPS is just beginning to address climate change in agency policy and directives. The U.S. Department of the Interior (DOI) issued Secretarial Order No. 3226 directing bureaus, including the NPS, to “provide leadership by developing timely responses to emerging climate change issues.” The secretarial order requires agencies in the DOI to consider potential impacts of climate change in planning, setting priorities for research, and making decisions affecting resources. The order also calls on DOI agencies to review existing programs and policies to identify potential climate change impacts on areas of responsibility and recommend actions in response to potential impacts.

At the agency level, NPS management policies (NPS 2006) refer to potential effects of climate change on resources and call for parks to gather and maintain climate data for reference and to educate visitors about climate change. Future management directives may consider climate change responses across all aspects of park planning and operations. The NPS Pacific West Region, which includes ONP, is developing mitigation strategies in response to a regional directive that calls on all parks in the region to aim to become carbon neutral. Park planning specialists are developing guidance to include climate

change in general management plans and other planning documents, as well as draft adaptation concepts for local park units in the Pacific West Region.

Similarities in Management Between Olympic National Forest and Olympic National Park

Although differences in policy exist for management at ONF and ONP, similarities in management objectives exist. Crosscutting statutes such as the ESA (1973), NEPA (1969), Clean Air Act (1970), and Clean Water Act (1977) apply to all management activities for both entities. They also have similar policy goals for preservation of biodiversity and native gene pools. Both ONF and ONP practice ecosystem management focused on maintaining ecosystem process and function and use restoration as a tool to maintain process and function. Policies applied to the wilderness areas of the forest and park are very similar. In addition, recreation and benefit to society are key functions of both ONP and ONF. These similarities in management objectives provide a consistent context for how the forest and park adapt to climate change.

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Chapter 3: Future Climate on the Olympic Peninsula: Forest-Relevant Climate Scenarios

Jeremy S. Littell¹

Introduction

Adaptation to climate change in forest ecosystems requires a robust estimate (or, in the case of substantial uncertainty, multiple estimates) of future climate to use in planning and scenario development. In this section, I borrow heavily from the Washington Climate Change Impacts Assessment (WACCIA) by the University of Washington Climate Impacts Group (Littell et al. 2010), the chapter on future Pacific Northwest Climate (Mote and Salathé 2010), the chapter on regional dynamic climate modeling (Salathé et al. 2010), and the chapter on future hydrologic regimes (Elsner et al. 2010). I first describe emissions scenarios used to constrain the climate models used in this study, then summarize findings on regional climate in the Pacific Northwest and some of the subregional consequences of those climate changes for variables more closely related to forest ecosystems (see box 3.1 for summary).

Emissions Scenarios: A1B (Moderate) and B1 (Low)

To develop plausible estimates of the future climate of the Pacific Northwest, physically based global climate models (GCMs) that incorporate key elements of the climate system (e.g., ocean, atmosphere, cryosphere [snow and ice], and land surface) must be used to project future conditions based on known climate dynamics and changes in the climate forcing factors. The primary forcings likely to affect changes in climate the most in the 21st century are future emissions of greenhouse gases (which increase the heat-trapping capability of the atmosphere, causing warming) and sulfate aerosols (which reflect sunlight and also promote cloud formation, causing local cooling).

Under the direction of the Intergovernmental Panel on Climate Change (IPCC), over 40 emissions scenarios have been published in the Special Report on Emissions Scenarios (SRES) (Nakićenović and Swart 2000). These scenarios

Box 3.1—Summary of projected climate change effects in the Pacific Northwest and on the Olympic Peninsula.

- The Washington Climate Change Impacts Assessment, conducted by the University of Washington Climate Impacts Group, provided detailed information on potential climate changes in the Pacific Northwest and on the Olympic Peninsula
- Climate models project increases in annual average temperature of +0.6 °C to +1.9 °C by the 2020s; +0.9 °C to +2.9 °C by the 2040s; and +1.6 °C to +5.4 °C by the 2080s for the Pacific Northwest.
- Warming is expected to occur during all seasons, with most models projecting the largest temperature increases in summer.
- Projected changes in annual precipitation in the Pacific Northwest differ considerably between models, but averaged over all models are small (+1 to +2 percent).
- Ensemble means of models for precipitation suggest wetter winters (+3.3 percent in the 2040s, +7.6 percent in the 2080s) and drier summers (-8.5 percent in the 2040s, -12.8 percent in the 2080s).
- Summer potential evapotranspiration (one component of water balance and closely related to fuel moisture and tree stress) is expected to increase by 5 to 18 mm by the 2040s, with much of the largest increases in lower elevation forests in the northeastern portion of the peninsula.
- Winter precipitation on the Olympic Peninsula is likely to increase by 4.5 to 5 percent, on average and depending on location.
- In addition to increased precipitation quantity, regional climate models show significant increases in the intensity of winter precipitation in the western portion of the Olympic Peninsula.

have widely varying assumptions about future socioeconomic changes and the resulting changes in greenhouse gas (including carbon dioxide) and aerosol emissions, and represent one constraint on future climate uncertainty. Three

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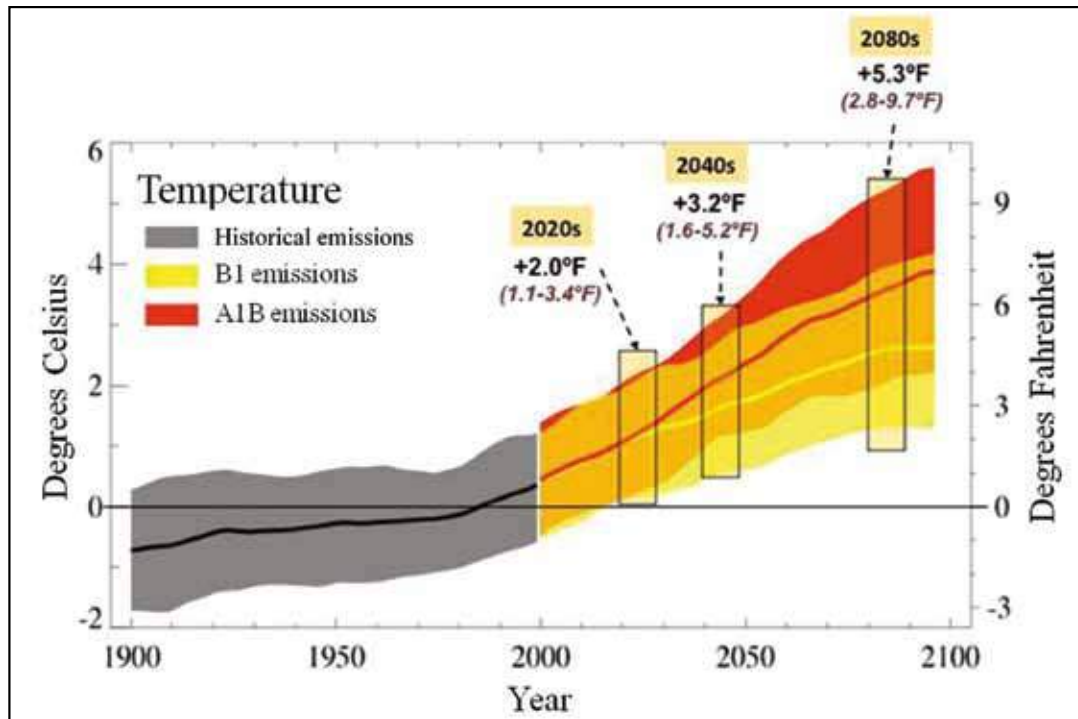


Figure 3.1—Simulated temperature change for the 20th- and 21st-century global climate model simulations for the Pacific Northwest region. The black curve is the weighted average of all models during the 20th century. The colored curves are the weighted average of all models in that emissions scenario (“low” or B1, and “moderate” or A1B) for the 21st century. The colored areas indicate the range (5th to 95th percentile) for each year in the 21st century. All changes are relative to 1970–99 averages.

of these SRES scenarios were commonly chosen for forcing GCMs used in the IPCC Fourth Assessment Report: B1, A1B, and A2. The climate forcing of all scenarios is similar until the 2020s because of a long lifetime of coal-fired electric powerplants and of the major greenhouse gases. Of these three scenarios, A2 produces the highest emissions by the end of the century, but before mid-century, none of the scenarios is consistently the highest. Because more modeling groups use A1B than A2, and because the focus for this study was on mid-century change, A1B was used as the higher emissions scenario and B1 as the low emissions scenario for analysis of 21st-century Pacific Northwest climate. Though B1 is the lowest of the IPCC illustrative scenarios, it still produces changes in climate that many scientists call “dangerous” (Schellnhuber et al. 2006). At the high end, scenario A1FI results in even higher climate forcing by 2100 than A1B. Mid-2000s global emissions of carbon dioxide exceeded even the A1FI scenario (Raupach et al. 2007).

Whether these exceedingly high emissions will continue into the future is uncertain, but in any case, the projections described here are potentially conservative.

Pacific Northwest Future Regional Climate

Mote and Salathé (2010) used 20 different climate models to explore the consequences of two different greenhouse gas emissions scenarios for the Pacific Northwest. All of the models indicate that the future climate will be warmer than the past (fig. 3.1) and, together, they suggest that Pacific Northwest warming rates will be greater in the 21st century than those observed in the 20th century. All changes below are relative to the period 1970–1999, and all are regionally averaged changes that apply to the Pacific Northwest. Climate models project increases in annual average temperature of +1.1 °C, range +0.6 °C to +1.9 °C by the 2020s; +1.8 °C, range +0.9 °C to +2.9 °C by the 2040s; and +3.0 °C, range +1.6 °C to +5.4 °C by the 2080s. Climate models are

able to match the observed 20th-century warming (0.8 °C since 1920, or +0.1 °C per decade for 1920 to 2000) in the Northwest, and project a warming rate of roughly +0.3 °C per decade in the 21st century. Projected changes in annual precipitation (fig. 3.2) differ considerably between models, but averaged over all models are small (+1 to +2 percent).

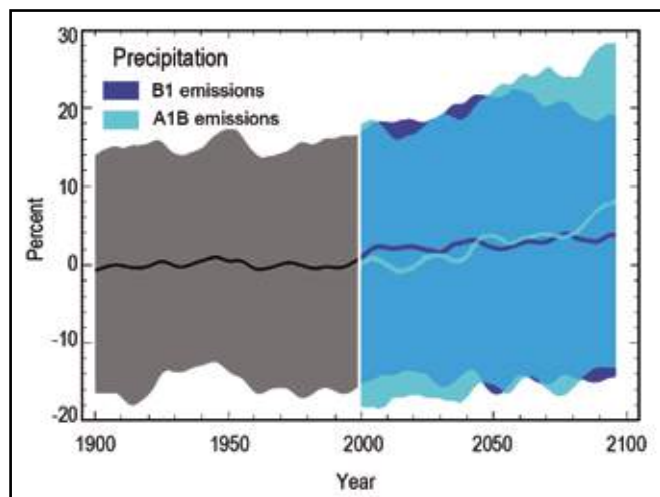


Figure 3.2—Simulated precipitation change for the 20th- and 21st-century global climate model simulations for the Pacific Northwest region. The black curve is the weighted average of all models during the 20th century. The colored curves are the weighted average of all models in that emissions scenario (“low” or B1, and “moderate” or A1B) for the 21st century. The colored areas indicate the range (5th to 95th percentile) for each year in the 21st century. All changes are relative to 1970–99 averages.

Seasonal changes in climate are arguably more important for projecting the impacts of climate change on forests. Warming is expected to occur during all seasons, with most models projecting the largest temperature increases in summer (fig. 3.3). Seasonal changes in precipitation early in the 21st century may not be separable from historical conditions given the large natural variations between wetter and drier years. Some GCMs suggest large seasonal changes (fig. 3.4), but the ensemble means point toward wetter winters (+3.3 percent in the 2040s, +7.6 percent in the 2080s, averaged over all A1B and B1 scenarios) and drier summers (–8.5 percent in the 2040s, –12.8 percent in the 2080s, averaged over all A1B and B1 scenarios).

Regional climate modeling (weather models forced with GCMs in the future, Salathé et al. 2010) points out areas and seasons that get drier even as the region gets wetter. The

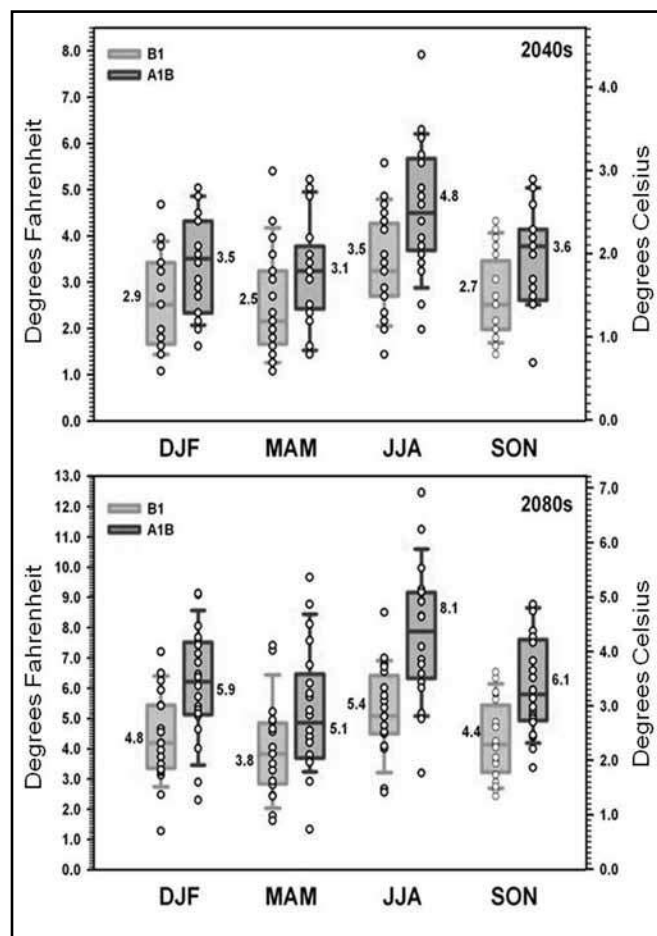


Figure 3.3—Range (lowest to highest) of projected changes in temperature for each season (DJF [December, January, and February] = winter, etc.), relative to the 1970–99 mean, for the Pacific Northwest region. In each pair of box-and-whiskers, the left one is for emission scenario B1 and the right is scenario A1B; circles are individual model values. Box-and-whiskers plots indicate 10th and 90th percentiles (whiskers), 25th and 75th percentiles (box ends), and median (solid middle bar) for each season and scenario. Not all values are visible due to symbol overlap. Printed values are the weighted reliability ensemble average of all global climate models for the season and scenario.

models with the most warming also produce the most summer drying. Regional climate models project some changes that are similar across global models, namely increases in extreme high precipitation in western Washington (including the southwestern Olympics) and reductions in Cascade Range snowpack. Regional climate models project a larger increase in extreme daily heat and precipitation events in some locations than the GCM ensemble suggests, the former being true of the southwestern Olympic Peninsula (Salathé et al. 2010). Regional climate models also suggest

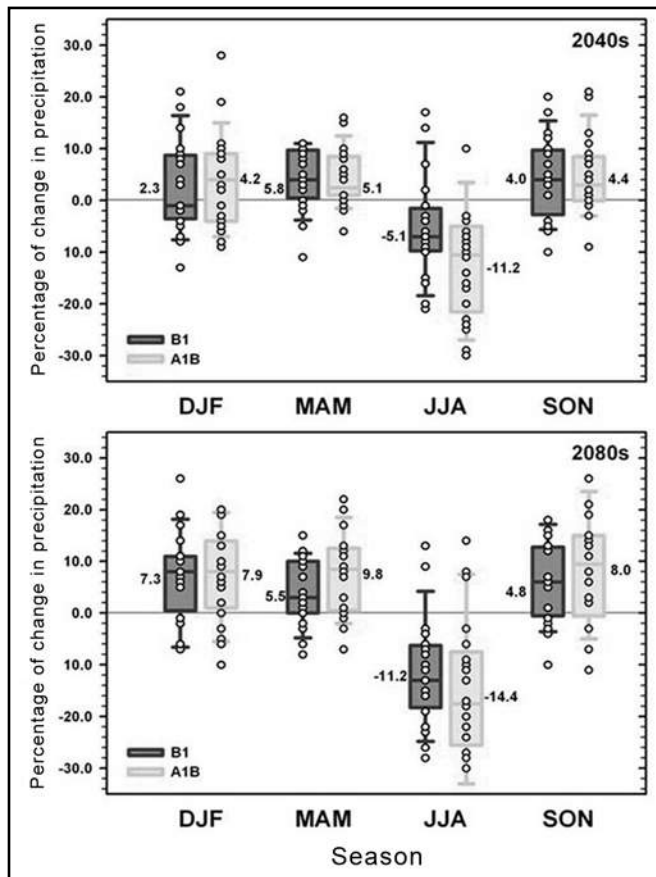


Figure 3.4—Range (lowest to highest) of projected changes in precipitation for each season (DJF [December, January, and February] = winter, MAM [March, April, and May] = spring, JJA [June, July, and August] = summer, SON [September, October, and November] = fall), relative to the 1970–99 mean, for the Pacific Northwest region. In each pair of box-and-whiskers, the left one is for emission scenario B1 and the right is scenario A1B; circles are individual model values. Box-and-whiskers plots indicate 10th and 90th percentiles (whiskers), 25th and 75th percentiles (box ends), and median (solid middle bar) for each season and scenario. Not all values are visible due to symbol overlap. The height of the bars indicates actual water precipitation, but the percentages are calculated with respect to a reference value for that season, so that -11 percent in JJA is much less than -11 percent in DJF. The reference values for the extremes are that model's 20th-century mean for that season (or annual mean), and for the Reliability Ensemble Average, the reference is the all-model 20th-century value. Some models project increases and some project decreases for a season, although the vast majority project decreases for summer and increases for winter by the 2080s.

that some *local* changes in temperature and precipitation may be quite different than average *regional* changes projected by the global models. For example, the two global models examined suggest winter precipitation will increase

in many parts of the Pacific Northwest, but potentially decrease in the Cascade Range. Future research is required to understand if this trend is consistent across many global models.

These comparisons between global and regional models are not yet developed to the point that they are a strong basis for decisionmaking; additional models would be needed to characterize the likely seasonal trends expected in the future. Currently, their chief use is as a research tool to better understand where the inferences derived from global models are likely to hold up best, which process may influence rates of change differently within a region, and which changes might be expected to exacerbate extreme events (e.g., prolonged droughts or high-intensity storms). On the Olympic Peninsula, for example, it is possible that decreases in snowpack in spring will lead to higher rates of warming in spring than the regional average owing to the loss of the snow albedo feedback, an effect that the GCMs would not likely capture.

Climatic Downscaling: Winter Precipitation and Water Deficit

The GCMs produce output at relatively coarse scales (100 km or greater) and do not yet operate at scales that provide future climate estimates useful for subregional planning. However, downscaled future climate projections at more local scales are based on the relationship between finer scale historical observations and the GCM during the same historical period. The best way to constrain uncertainty in future regional climate associated with the high number of potential GCM futures is to use the fidelity of each model to the 20th century observed record to gage its usefulness for regional projection (Mote and Salathé 2010). In the WACCIA comparison of GCMs (Mote and Salathé 2010), models were weighted according to their fidelity to construct an ensemble average or an average of all models that gives more weight to models that did well in predicting past climate in the region. However, another approach to this problem (Hamlet et al. 2010, Overland and Wang 2007) is to constrain the average to models that best estimate observed climate (i.e., models that have the smallest bias in temperature and precipitation and that simulate the

most realistic annual cycle in these parameters). Hamlet et al. (2010) evaluated a pool of 20 GCMs run for the A1B scenario in IPCC Fourth Assessment Report (Solomon et al. 2007) and selected 10 models, eliminating models that do a poor job of estimating climate change already known to have occurred. In this section on deficit, the average (ensemble) is composed of this subset of the available GCMs: UKMO-HadCM3, CNRM-CM3, ECHAM5/MPI-OM ECHO-G, PCM, CGCM3.1(T47), CCSM3, IPSL-CM4, MIROC3.2(medres), and UKMO-HadGEM.

Elsner et al. (2010) described methods and results for future climatic downscaling and incorporation into hydrologic modeling by using the Variable Infiltration Capacity (VIC) hydrologic model. Littell et al. (2010) showed that Washington forest ecosystem processes such as tree growth and fire are directly associated with potential evapotranspiration, actual evapotranspiration, and their difference (water balance deficit [DEF]), particularly in summer. The DEF is effectively the difference between water demand by the atmosphere and water supply in the soil profile; when demand exceeds supply, there is deficit. These variables are derived from temperature, precipitation, and other physical variables in VIC. Future changes in June to August (JJA) water balance deficit on the Olympic Peninsula (2040s, scenario A1B) are greatest in the northeast, east, and southeast, with increases (effectively drier) of 0.4 in (10 mm) to 2.4 in (60 mm) depending on location, likely because of increased evapotranspiration associated with increased temperature (fig. 3.5). Some of the highest elevations suggest decreases in deficit of similar magnitude, likely owing to increased snowmelt.

Winter (December to February [DJF]) precipitation on the Olympic Peninsula is likely to increase (fig. 3.6) by about 4.5 to 5 percent, on average and depending on location. Precipitation increases suggested by the GCM ensemble should be considered as general estimates of future trends, because the GCMs do not have sufficient topographic detail to describe fine-scale differences in future precipitation. However, Salathé et al. (2010) presented results from regional climate models (weather models forced with GCMs) that show significant increases in the intensity of winter precipitation in the western

portion of the Olympic Peninsula. Although there is some uncertainty in this projection because relatively few climate models were used, these results suggest that portions of the Olympic Peninsula will receive not only more precipitation, but that it will come in the form of more intense storms.

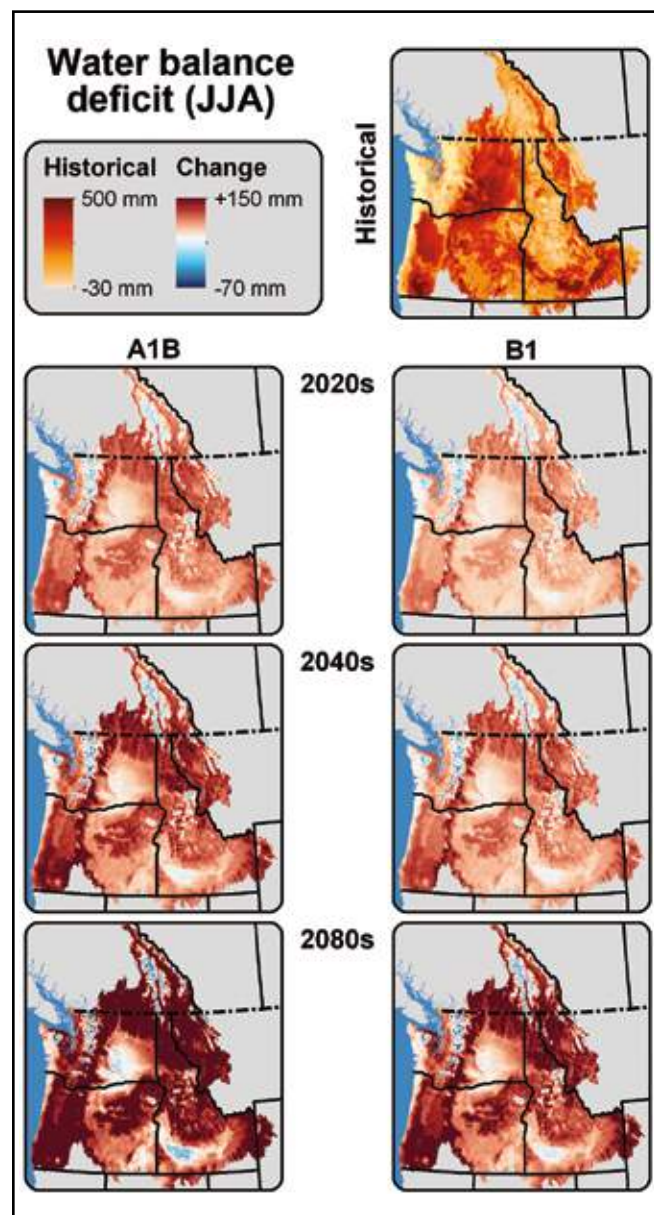


Figure 3.5—Historical June to August (JJA) water balance deficit in the Pacific Northwest and projected changes from historical for the 2020s, 2040s, and 2080s (A1B and B1 emissions scenarios). Deficit increases in most of the drier parts of the Columbia River basin, but on the Olympic Peninsula, most increases are confined to the north, northeast, and southeast.

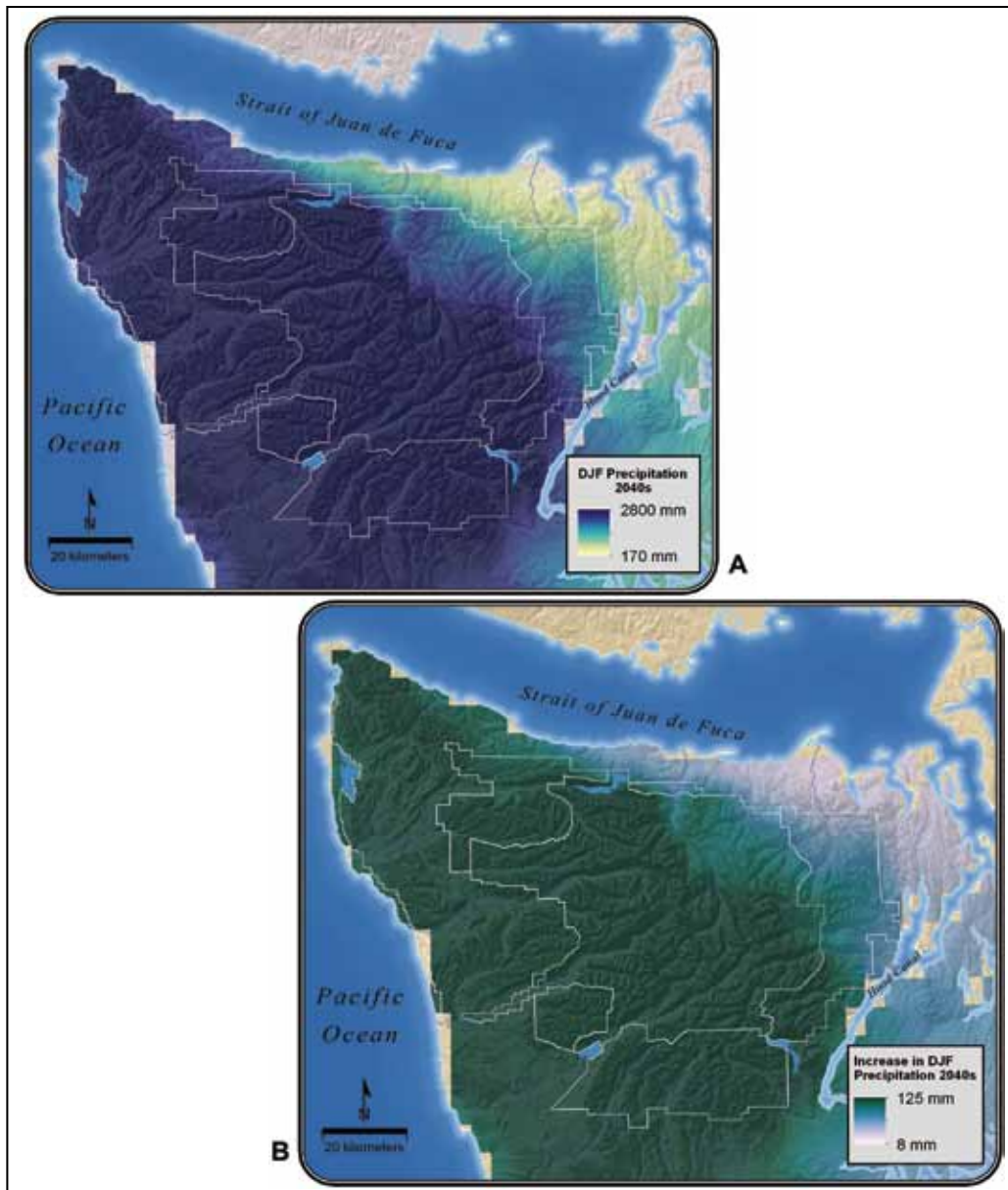


Figure 3.6—(A) Future (2040s) December to February (DJF) precipitation and (B) change from 1916 to 2006 precipitation for the Olympic peninsula based on statistically down-scaled Global Climate Model (GCM) information for 10 GCM models. Olympic National Park and Olympic National Forest are outlined in white. The largest increases in precipitation are in the southwestern Olympic Peninsula.

Summer (June to August [JJA]) potential evapotranspiration (one component of water balance and closely related to fuel moisture and tree stress) is expected to increase by 5 to 18 mm by the 2040s (fig. 3.7), with most of the largest increases in lower elevation forests in the northeastern portion of the peninsula.

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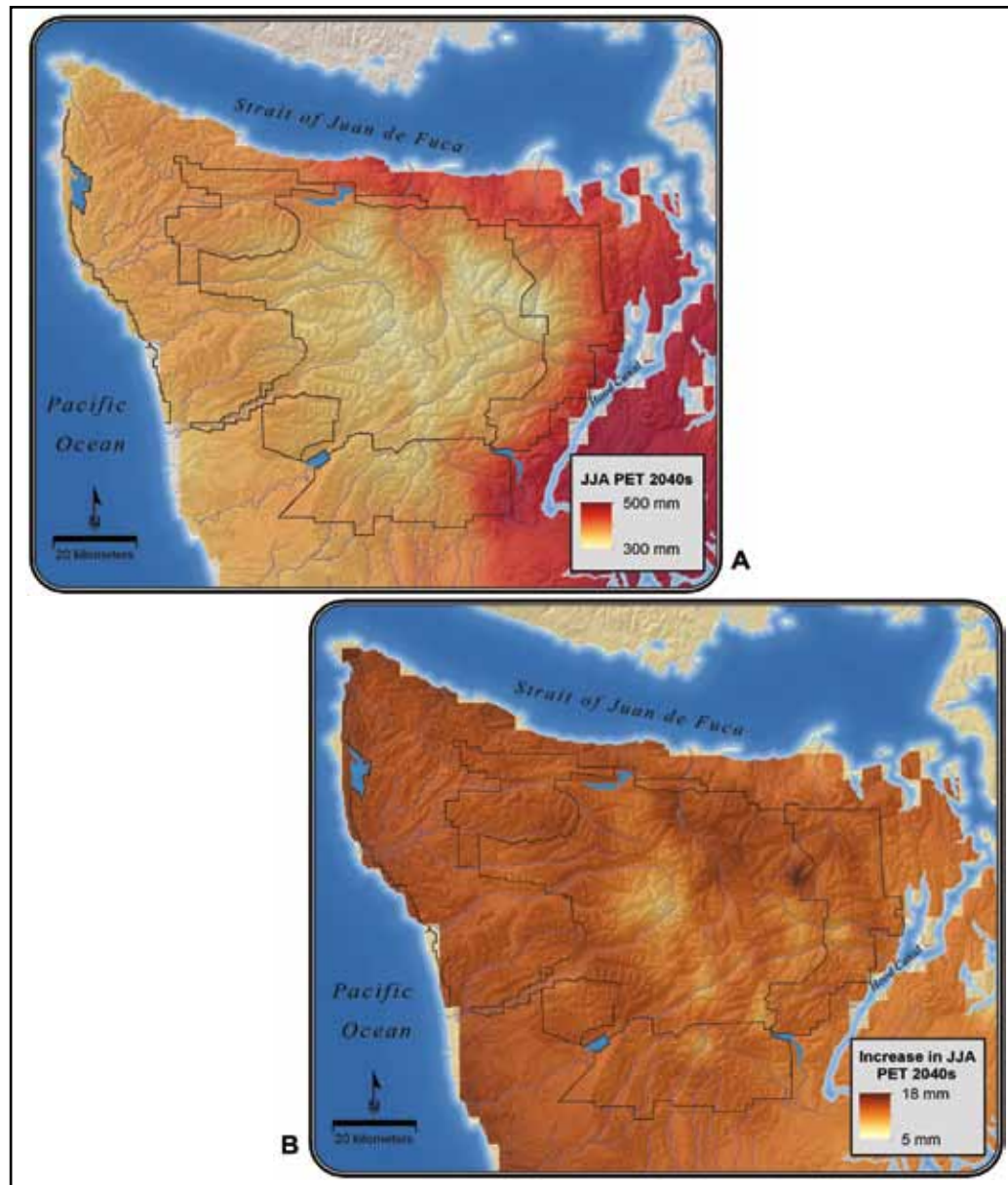


Figure 3.7— (A) Future (2040s) June to August (JJA) potential evapotranspiration (PET) and (B) change from 1916 to 2006 June to August baseline PET for the Olympic Peninsula based on downscaled climate projections and Variable Infiltration Capacity hydrologic modeling (Elsner et al. 2010). Olympic National Park and Olympic National Forest are outlined in black. Increased PET is related to decreased soil moisture and increased drought stress. The largest increases in PET are in the northeastern Olympic Peninsula.

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Chapter 4: Climate Change, Hydrology, and Road Management at Olympic National Forest and Olympic National Park

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Potential Effects of Climate Change on Hydrology on the Olympic Peninsula

Temperature, Snowpack, and Timing of Streamflow

Across the Western United States, increasing temperatures over the last 50 years have led to more precipitation falling as rain rather than snow, earlier snowmelt (Hamlet et al. 2007, Stewart et al. 2005), and reduced spring snowpack (Barnett et al. 2008, Hamlet et al. 2005, Mote 2003, Mote et al. 2005). Further reductions in snowpack and shifts in timing of snowmelt are expected with increasing temperatures in the 21st century. April 1 snow water equivalent (a measure of water in snowpack) is projected to decrease by an average of 27 to 29 percent across Washington state by the 2020s, 37 to 44 percent by the 2040s, and 53 to 65 percent by the 2080s (Elsner et al. 2010) (fig. 4.1). The greatest reductions in snowpack are expected for lower elevations (<1000 m) because of warmer midwinter temperatures at these elevations (Elsner et al. 2010, Hamlet et al. 2005).

Changes in snowpack are particularly important for the mountainous regions of the Western United States, including the Pacific Northwest, because snowmelt provides about 70 percent of annual streamflow in these regions (Mote et al. 2008). Warming temperatures affect the timing of snowmelt and associated seasonal streamflow. Both increased winter rain (as opposed to snow) and shifts to earlier spring snowmelt result in higher winter and spring streamflows and lower summer streamflows in snowmelt-dominated and transient (rain/snow mixed) watersheds (Elsner et al. 2010, Stewart et al. 2005). Snowmelt-dominant watersheds

store most winter precipitation in snowpack. This snowpack melts in the spring and early summer, resulting in peak

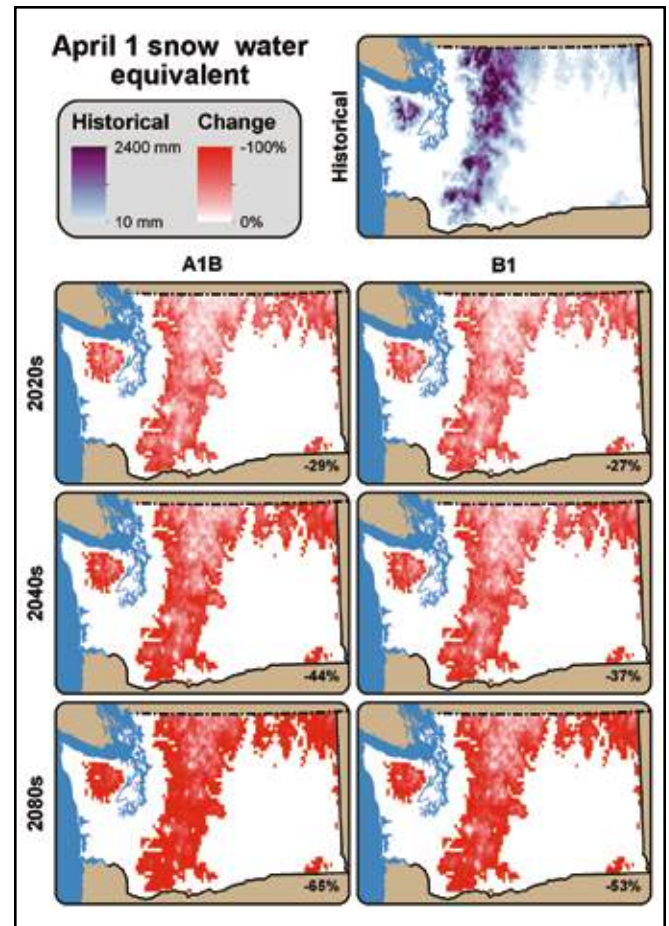


Figure 4.1—Summary of projected changes in April 1 snow water equivalent (SWE), an indication of snow amount, compared to historical for the 2020s, 2040s, and 2080s (A1B and B1 emissions scenarios) by the Variable Infiltration Capacity model. Percentage change values represent spatially averaged April 1 SWE across Washington state (Elsner et al. 2010).

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streamflow in the late spring or early summer and lower streamflow during the winter months (Elsner et al. 2010). Transient watersheds are primarily at mid elevations and receive some snow and some rain. Of the snow that these watersheds receive, some melts in the winter months, and some is stored in the winter months and melts with warming temperatures in the spring (Elsner et al. 2010). Thus, streams and rivers draining transient watersheds often have one streamflow peak in fall or early winter owing to runoff generated by precipitation falling as rain, and another peak in late spring when the snowpack accumulated in midwinter melts (Elsner et al. 2010). Projections for Washington state show that by the 2080s, there will be widespread transformation of transient watersheds to rain-dominant behavior, with essentially no snowmelt-dominant watersheds remaining in Washington by the end of the 21st century (Elsner et al. 2010). In response to these changes in natural storage processes, seasonal streamflow timing will shift significantly in both snowmelt-dominant and transient watersheds,

resulting in increased winter and decreased spring and summer streamflows.

Examples of projected shifts in timing of streamflow for river systems on the Olympic Peninsula are shown in figures 4.2 through 4.7. Some river systems on the peninsula, such as the Satsop River (not shown), are rain-dominant watersheds. Warming temperatures will not likely have a significant impact on timing of streamflow in rain-dominant watersheds. Several Olympic Peninsula river systems, such as the Queets, Skokomish, Quinault, and Hoh River basins (figs. 4.2 through 4.5), receive most precipitation as rain but also some as snow at higher elevations, and thus warming will likely have moderate impact on the timing of streamflow in these watersheds. Other river systems, such as the Elwha and Dungeness Rivers, are in transient watersheds. Increasing temperatures in the 21st century will likely lead to significant increases in the winter and early spring peak streamflows and significant decreases in the summer low flows in these transient watersheds (figs.

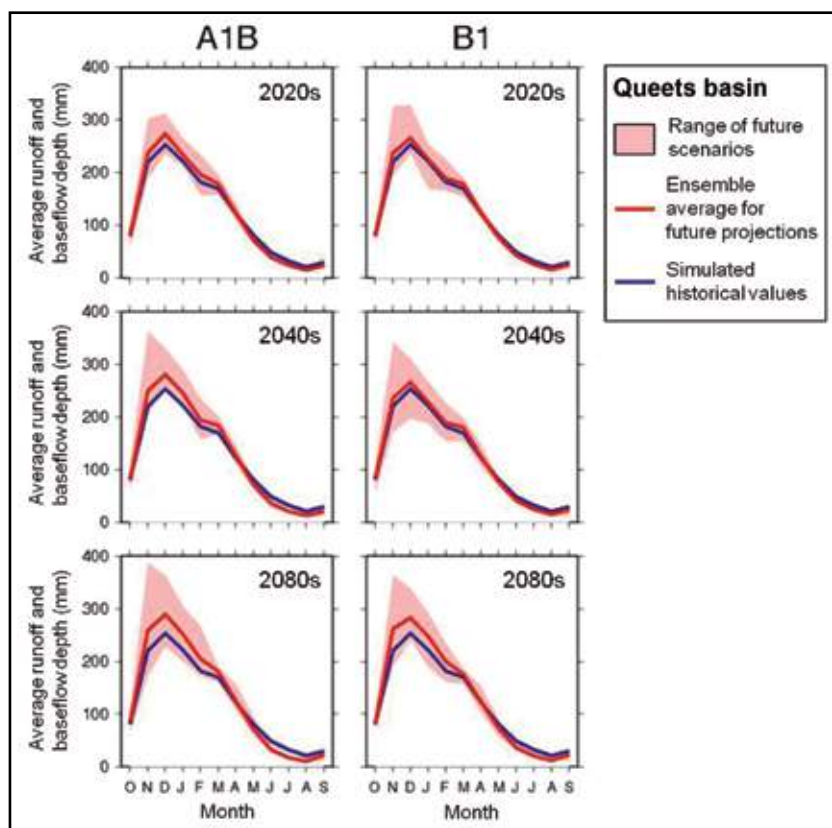


Figure 4.2—Simulated combined monthly average total runoff and baseflow over the entire Queets basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the dark red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.

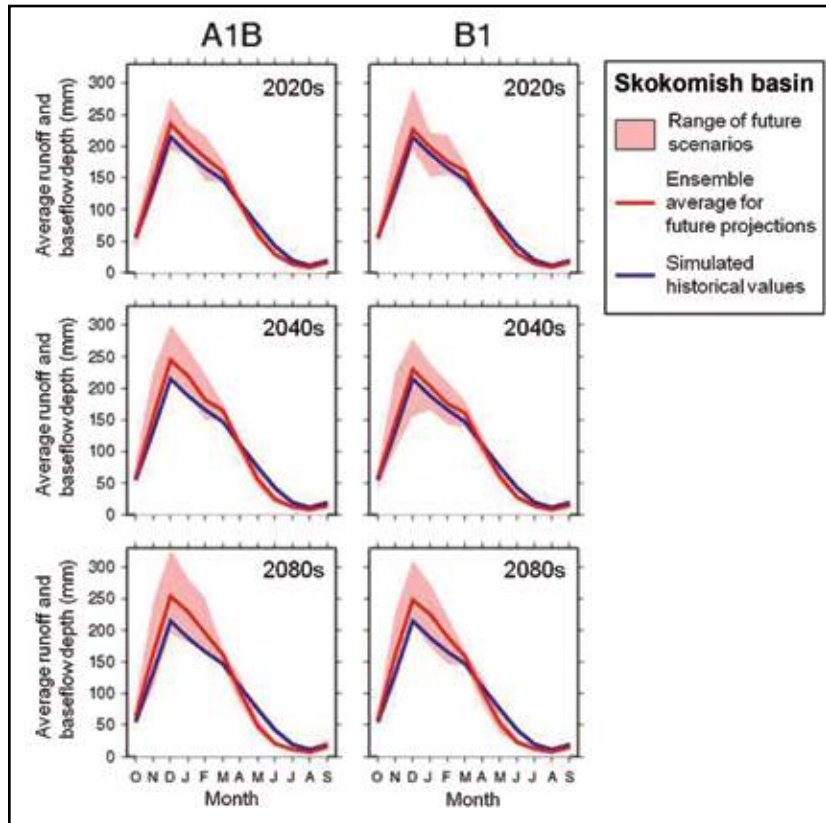
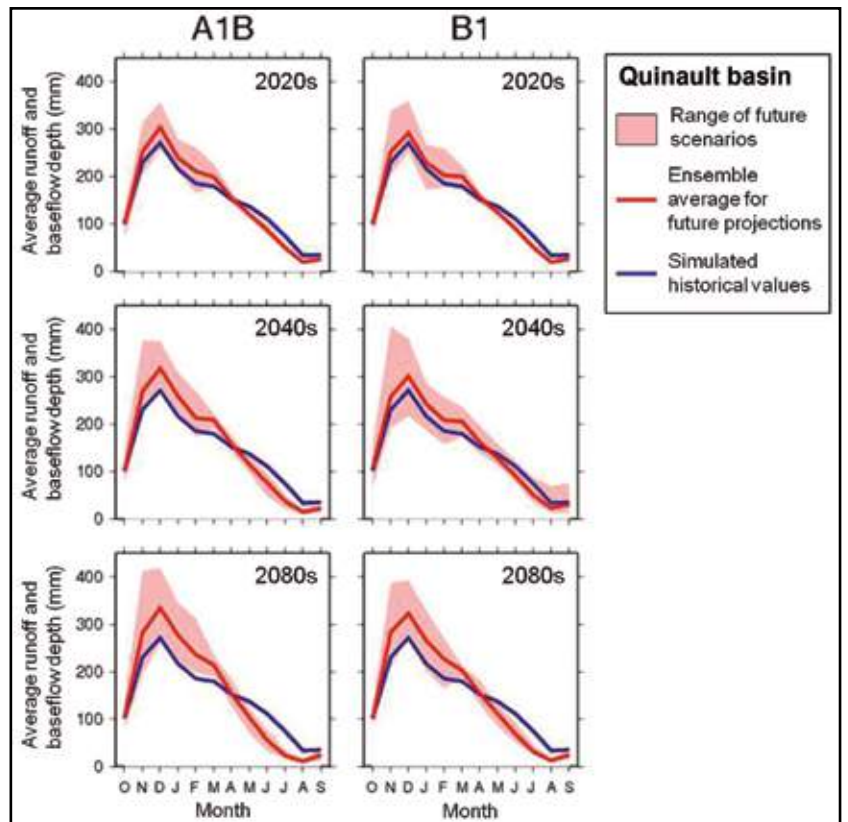


Figure 4.3—Simulated combined monthly average total runoff and baseflow over the entire Skokomish basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.

Figure 4.4—Simulated combined monthly average total runoff and baseflow over the entire Quinault basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.



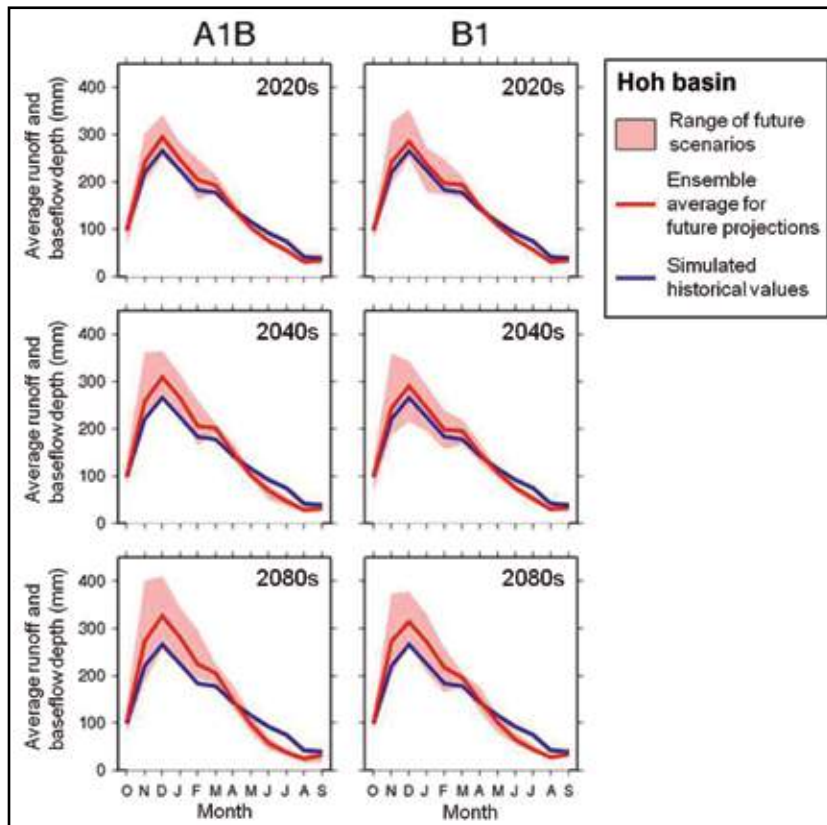
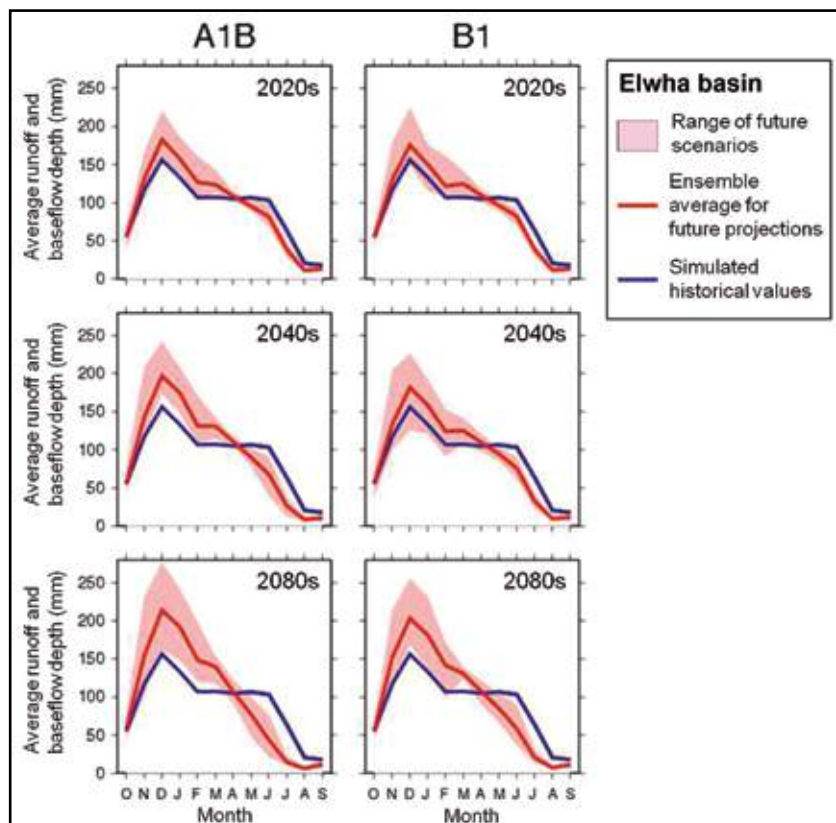


Figure 4.5—Simulated combined monthly average total runoff and baseflow over the entire Hoh basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.

Figure 4.6—Simulated combined monthly average total runoff and baseflow over the entire Elwha basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.



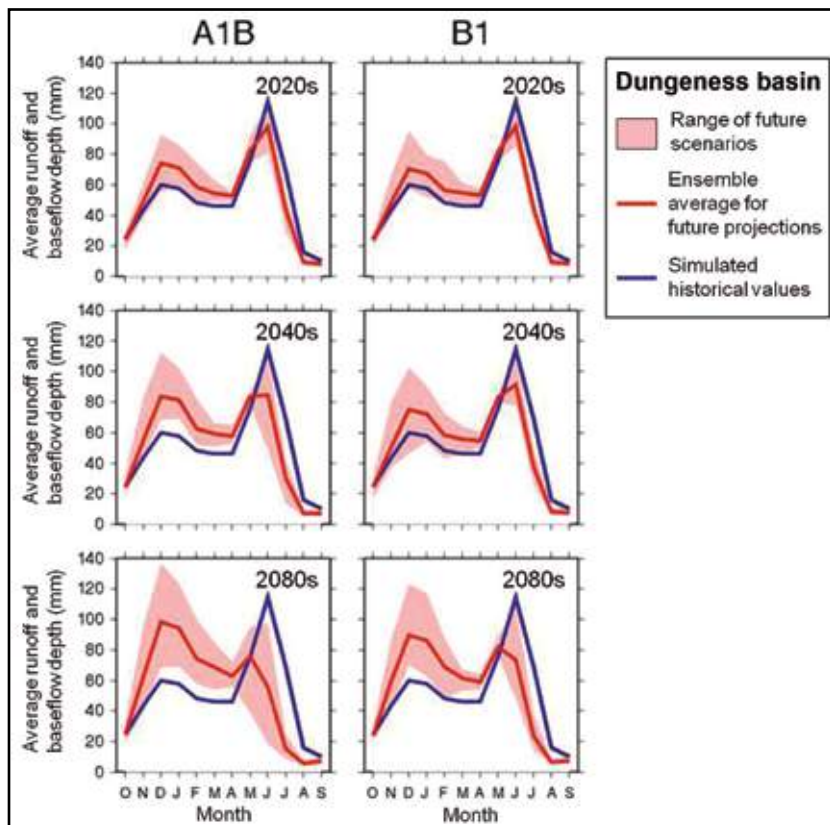


Figure 4.7—Simulated combined monthly average total runoff and baseflow over the entire Dungeness basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. Blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and dark red lines show the ensemble average for the future projections. See <http://www.hydro.washington.edu/2860> for a detailed description of the methods used to generate these outputs.

4.6 and 4.7). Decreased summer flow will likely be most evident in the headwaters of watersheds, where flows will likely become increasingly ephemeral or cease altogether in the summer months (fig. 4.8). However, such effects are sometimes strongly linked to changes in groundwater in the basin, which are not included in the projections discussed above (Tague et al. 2008). Locations where deep groundwater may mediate streamflow responses on the Olympic Peninsula could potentially be identified through interpretation of a geological map and locating areas where intense fracturing has occurred. However, groundwater effects are unlikely to be a major influence on hydrologic changes as they are in regions with porous and young volcanic soils, such as central Oregon.

Precipitation, Storm Intensity, and Flooding

Changes in precipitation have a direct influence on streamflow and the frequency and magnitude of flooding events. Model projections for precipitation in the 21st century are much more uncertain than those for temperature. Elsner et

al. (2010) analyzed precipitation projections of 20 global climate models and two future carbon dioxide scenarios for the Pacific Northwest, and they found that annual projected precipitation changes range from -9 to +12 percent for the 2020s, -11 to +12 percent for the 2040s, and -10 to +20 percent for the 2080s (Elsner et al. 2010, Mote and Salathé 2010). Projections of seasonal precipitation changes, however, show increases in winter precipitation and decreases in summer precipitation (Elsner et al. 2010, Mote and Salathé 2010). Projections of cool season precipitation (combining both A1B and B1 emission scenarios) range from +2.3 to +3.3 percent for the 2020s, +3.9 to +5.4 percent for the 2040s, and +6.4 to +9.6 percent for the 2080s (Elsner et al. 2010). These increases in cool season precipitation are projected to lead to overall increases in annual runoff across Washington (0 to 2 percent by the 2020s, 2 to 3 percent by the 2040s, and 4 to 6 percent by the 2080s), although the effects differ for individual watersheds (Elsner et al. 2010).

Besides potential increases in winter precipitation, precipitation intensity is projected to increase in some parts of Washington, including the west slopes of the Olympic



Figure 4.8—Projected increases in 20-year floods on the Olympic Peninsula. Numbers indicate the ratio of projected 20-year flood statistics for the 2040s to 20th-century flood statistics at select locations under the A1B carbon dioxide emission scenario. Higher numbers, and larger and darker red dots, indicate higher projected increases in 20-year flood frequency. Olympic National Park and Olympic National Forest are outlined in dark gray. (Adapted from Mantua et al. 2010.)

Peninsula, in the 21st century (Salathé et al. 2010). Increases in winter precipitation, increases in precipitation intensity, and changes in timing of peak streamflow in transient watersheds will contribute to increased flood risk in some of Washington's rivers. Flooding magnitude and frequency are projected to increase most in December and January and in historically transient watersheds in Washington (Mantua et al. 2010). Rain-dominant watersheds will likely see small increases in flood frequency, whereas many snowmelt-dominant watersheds will likely see decreases in flooding owing to decreases in snowpack and corresponding decreases in snowmelt-driven peak flows in the spring (Mantua et al. 2010). On the Olympic Peninsula, increases in flood frequency are projected for many river systems (fig. 4.8), with greater increases in flood frequency projected in historically transient watersheds such as the Elwha. At the opposite extreme, earlier snowmelt and timing of runoff

is projected to lead to decreased low flows in the summer in many Olympic Peninsula watersheds (fig. 4.9). As noted above, effects of groundwater on summer streamflows may mitigate these impacts in some watersheds.

Effects of Changing Hydrology on Physical Watershed Processes

Projected hydrologic effects of climate change, including more precipitation falling as rain rather than snow, decreased snowpack, earlier snowmelt, increased winter precipitation and runoff, increased storm intensity, increased winter and spring streamflows, reduced summer streamflows, increased flood frequency and magnitude, and elevation shifts in transition (rain on snow) zones, will likely affect physical watershed processes (table 4.1). Increased precipitation and storm intensity, higher snowlines (increasing effective basin area), and loss of snow

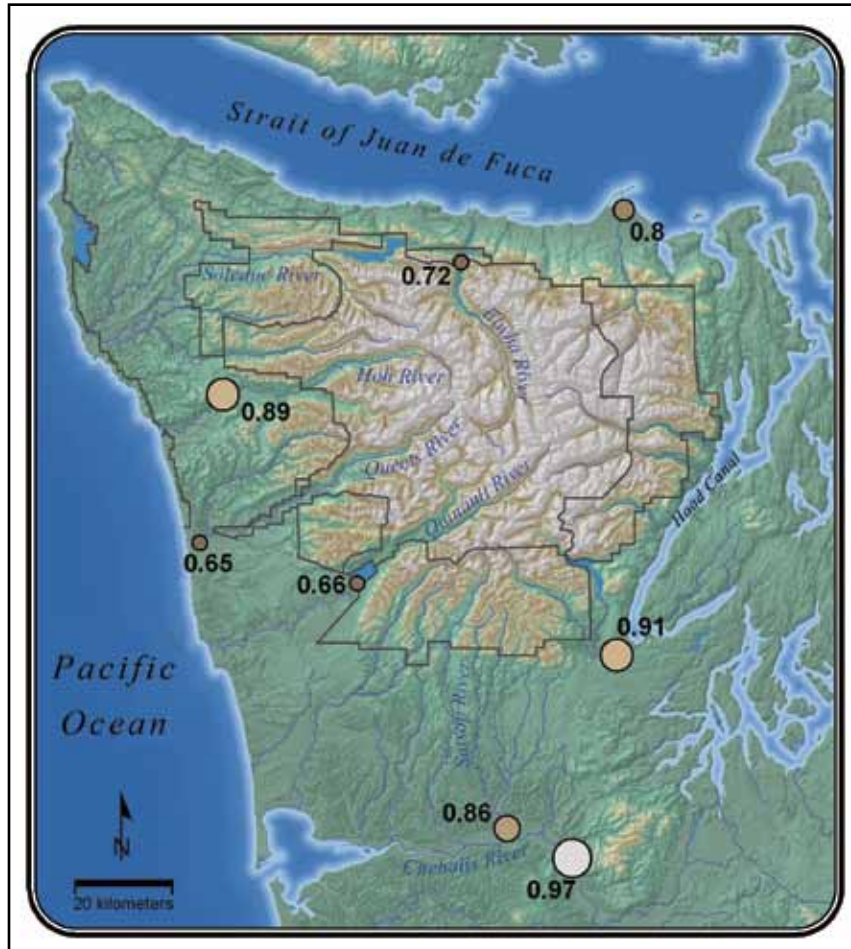


Figure 4.9—Projected decreases in low streamflows on the Olympic Peninsula. Numbers indicate the ratio of projected 20-year low streamflow statistics for the 2040s to 20th-century low flow statistics under the A1B carbon dioxide emission scenario. Lower numbers, and smaller and darker red dots, indicate higher projected decreases in low flow. Olympic National Park and Olympic National Forest are outlined in dark gray. (Adapted from Mantua et al. 2010.)

cover are expected to lead to increased rate and volume of water delivery to channels, increased mass wasting and debris flows, and increased sediment and wood delivery to streams (Benda and Dunne 1997). Increased winter and spring flow volume in streams will lead to increased flood-plain inundation, increased channel migration, and increased channel erosion and scour. Other climate-related stressors, such as fire and tree mortality (see chapter 6), could also exacerbate these hydrologic effects of climate change on physical watershed processes.

Road Management at Olympic National Forest and Olympic National Park

The following section provides information on road management at Olympic National Forest (ONF) and Olympic National Park (ONP) including (1) the context in which ONF and ONP manage roads, (2) the guidance and constraints

on road management at ONF and ONP, and (3) the primary issues around and activities currently conducted in road management at ONF and ONP. This information, coupled with the likely impacts of climate change on hydrology on the Olympic Peninsula (described above), provides a basis on which to develop climate change adaptation options for road management at ONF and ONP.

Road Management at Olympic National Forest

Olympic National Forest has 3500 km of roads. Most of these roads were built between 1950 and 1980, primarily for logging purposes, by using practices that are not consistent with today's standards. The high number of roads, heavy rainfall, steep slopes, frequent storm damage, and high recreational demand for well-maintained forest roads all lead to high road maintenance costs at ONF. However, funding allocated for road maintenance, upgrading, and decommissioning at ONF is limited.

Table 4.1—Projected climate change effects and adaptation options in the context of road management at Olympic National Forest (ONF) and Olympic National Park (ONP)

Program	Project	Projected climate change effects ^a	Projected effects on physical watershed processes	Current and expected sensitivities	Adaptation management options and strategies	Barriers and information needed
Road maintenance ^b	Planning	2, 6–10	- Increased flow volume - Increased mass wasting and avalanches - Increased sediment delivery - Increased flood-plain inundation - Increased channel migration	- Culvert capacity - Water diversion - Fill-slope failures - Stream-adjacent road failure	Prioritize road treatment by watershed risk and road risk (the roads with the most sensitivities and that are most connected to streams)	- National Highway Safety Act fund requirements (ONF) - Maintenance funding limitations - Need assessments to refine links to physical process and response
	Implementation	1, 5–9	- Increased flow volume - Increased mass wasting/debris flows - Increased sediment delivery to culvert inlets and ditches - Increased rate and volume of water delivery to channels - Increased transport of wood in channels	- Culvert capacity - Culvert plugging - Water diversion - Fill-slope failures - Extension of channel network (development of first-order channels)	- Increased maintenance (preparation and response), including: Culvert cleaning - Armoring outlets and ditches - Installing water bars and drivable dips	- National Highway Safety Act fund requirements (ONF) - Maintenance funding limitations - Physical barriers to road access in winter
Road operations	Planning	2, 5–10	- Increased flow volume - Increased mass wasting and avalanches - Increased sediment delivery - Increased flood-plain inundation - Increased channel migration	- Culvert capacity - Water diversion - Fill-slope failures - Stream-adjacent road failure - Encroachment from stream-adjacent road segments	- Prioritize road treatment by watershed risk and road risk (the roads with the most sensitivities and that are most connected to streams) - Assess possibilities to design more sustainable road types for the future	- National Highway Safety Act fund requirements (ONF) - Road funding limitations - Need assessments to refine links to physical process and response - Need feasibility studies for mass transit options (ONP)

Table 4.1—Projected climate change effects and adaptation options in the context of road management at Olympic National Forest (ONF) and Olympic National Park (ONP) (continued)

Program	Project	Projected climate change effects ^a	Projected effects on physical watershed processes	Current and expected sensitivities	Adaptation management options and strategies	Barriers and information needed
	Design: Water crossing Fish passage	2, 5–10	• Increased flow volume • Increased sediment and wood transport • Increased channel migration	• Culvert capacity • Foundation scour • Lateral channel adjustments	• Design more resilient structures (design resilient bridges and larger structures, and incorporate channel geomorphic attributes in structure design)	• Need method to calculate Q_{100} (historical or recent data?) or an alternative
	Design: Bank protection	7–10	• Increased flow volume • Increased erosion and scour • Increased channel migration • Increased mass wasting and avalanches	• Stream-adjacent road failure • Cut-bank failures on montane and subalpine roads	• Relocate road segment, decommission road segment, or accept higher maintenance costs (ONF) • In a scenario-planning context, analyze roads and road segments (ONP) • Install retaining walls or other cut-bank stabilization (ONP)	• Revisit access and travel management plan and develop better resolution in identifying sensitive stream-adjacent roads • Need geomorphic analyses of other (park) rivers bordered by roads (ONP) • No funding source for proactive, sustainable bank protection • Emergency Relief for Federally Owned Roads funding policies limit or preclude sustainable road restoration options
	Design: New construction	7–10	• Potential increase in capture and concentration of water • Potential decrease in slope stability	• Increased potential for ditch or culvert plugging and diversion • Increased potential for erosion and scour at pipe outlets	• Decrease reliance on drainage structures • Increase frequency of drainage discharge points • Increase redundancy or backup features • Limit consequence of failure • Adjust alignment, roll with topography	• May have to adjust thinking regarding design life and therefore life cycle costs in alternative comparisons

30 **Table 4.1—Projected climate change effects and adaptation options in the context of road management at Olympic National Forest (ONF) and Olympic National Park (ONP) (continued)**

Program	Project	Projected climate change effects ^a	Projected effects on physical watershed processes	Current and expected sensitivities	Adaptation management options and strategies	Barriers and information needed
Road operations	Design Reconstruction Drainage upgrades Stabilization Storm-proofing	7–10	- Increased flow volume - Increased rate and volume of water delivery to channels - Increased sediment and wood transport - Increased mass wasting/debris flows - Increased sediment delivery to culvert inlets and ditches	- Culvert capacity - Culvert plugging; water diversion - Fill-slope failures - Extension of channel network (development of first-order channels)	- Implement more conservative design elements (more intensive treatments such as larger diameter culverts, closer spacing between ditch relief culverts and waterbars) - Increase maintenance frequency of drainage features	- Revisit access and travel management plan and develop better resolution for identifying road vulnerability (consider rain-on-snow and increased storm intensity) (ONF) - Region 6 is currently developing a road storm-damage risk reduction guide (ONF)
	Design: Decommissioning (ONF)	7–10	- Increased runoff - Increased flow volume; increased channel migration - Increased sediment transport - Increased mass wasting and debris flows	Increased erosion with sediment delivery to channels	Implement more conservative design elements (bigger channels, more drainage, more outslipping, increased armoring of outlets)	
	Implementation	1, 5–9	- Increased flood-plain inundation - Increased flow volume - Increased mass wasting/debris flows - Increased sediment delivery to culvert inlets and ditches	- Increasing number of projects needed to reduce resource risk and road failures - Limited funding - Changes in project work periods	- Continue efforts to improve, stabilize, and reduce existing road system - Focus road improvements in priority areas	- National Highway Safety Act requirements (ONF) - Funding limitations - Physical barriers to road access owing to storm damage

Table 4.1—Projected climate change effects and adaptation options in the context of road management at Olympic National Forest (ONF) and Olympic National Park (ONP) (continued)

Program	Project	Projected climate change effects ^a	Projected effects on physical watershed processes	Current and expected sensitivities	Adaptation management options and strategies	Barriers and information needed
			• Increased rate and volume of water delivery to channels • Increased wood transport		• Seek out additional funding to implement improvements	
^a Projected climate change effects relevant to road management:						
		(1) Increased winter air temperatures/fluctuation above and below freezing		(8) Increased storm intensity		
		(2) More precipitation falling as rain rather than snow		(9) Increased flood frequency and magnitude in some types of watersheds		
		(3) Decreased snowpack		(10) Elevation shifts in transition (rain-on-snow) zones		
		(4) Earlier snowmelt				
		(5) Increased winter and spring streamflows in some types of watersheds				
		(6) Decreased summer streamflows in some types of watersheds				
		(7) Increased winter precipitation and runoff				
^b Road maintenance activities ensure that existing roads function correctly (defined by policy).						

To help prioritize road management activities at ONF, a road management strategy (RMS) was developed in 2000 that assessed the risks that individual road segments posed to various resources, especially aquatic resources, against the need for access that the road provided. The RMS was developed at least partly in response to the aquatic restoration mandate of the Northwest Forest Plan (USDA and USDI 1994). The RMS is used for setting priorities for road maintenance, upgrading, and decommissioning (see box 4.1 for specific activities in these categories) and considers five factors, each of which incorporates particular indicators. These five factors include aquatic risk, access needs, wildlife concerns, high-value watersheds, and silvicultural opportunities (box 4.2). In general, roads that present high risk to aquatic systems, are needed for access (by the public or for activities such as restoration thinning), impact threatened or endangered species, and are located in high-value watersheds are prioritized for maintenance, stabilization, and upgrading. Roads that meet the above criteria but are not necessary for access are prioritized for decommissioning (e.g., fig. 4.10).

In addition to being guided by the RMS, road management at ONF is guided by the access and travel management (ATM) plan, which is a strategic management tool that describes the proposed future road system. The ATM was updated by forest managers in 2003. By using RMS information as a starting point, managers conducted a road-by-road evaluation on about 3300 km of road, during which RMS data were supplemented by the site-specific knowledge of interdisciplinary ONF District ATM teams to generate draft proposals for the long-term management of forest roads. Public and tribal involvement was also a critical component of the ATM plan update. The updated ATM plan proposes substantial reductions in road mileage throughout many watersheds at ONF owing to declining road maintenance funding, reduced need for access, and high risk to aquatic habitat. Nearly one-third of the forest's roads are proposed for decommissioning.

Road Management at Olympic National Park

There are more than 225 km of paved and unpaved visitor use roads at Olympic National Park (ONP). There are no

Box 4.1—Common road management activities at Olympic National Forest (ONF) and Olympic National Park (ONP). Many of these activities will likely be influenced, in frequency or nature, by climate change.

Road maintenance activities—

- Culvert cleaning, replacement, and installation
- Grading
- Slide removal
- Erosion control
- Brushing
- Hazard and downed tree removal (developed areas only at ONP)
- Pavement repair
- Bridge maintenance
- Gate installation and maintenance
- Painting
- Shoulder maintenance
- Ditch cleaning and drainage maintenance
- Water bar and dip installation

Storm-proofing and road drainage upgrading activities—

- Correcting stream-diversion potentials at stream crossings
- Removing unstable fill (ONF)
- Rerouting road drainage to stable areas
- Adding new culverts
- Installing proper-sized culverts
- Lowering fills (ONF)
- Hardening stream crossings (ONF)
- Lowering inlets
- Out-sloping
- Installing waterbars (ONF)

Road decommissioning activities (ONF)—

- Removing culverts
- Ripping or decompacting road surfaces
- Out-sloping
- Removing unstable fills
- Removing bridges or converting road bridges to trail bridges
- Constructing waterbars
- Seeding/planting
- Installing erosion-control measures
- Placing travel barriers

cross-park roads; however, roads do penetrate the park's perimeter and front-country areas, often along major river drainages. Roads and other infrastructure located within flood plains of the Olympic Peninsula have a high risk of being damaged during storm events. Coastal rivers located in the temperate rain forest exhibit a broad range of flows. For example, the summer low flow in the Queets River for the 2007 water year was about 10 m³/s, while the peak flow for the year was 1190 m³/s, or two orders of magnitude higher (USGS 2008). The record flow for the Queets River is 4080 m³/s, which approximates the mean annual flow of the Columbia River (USGS 2008).

The ONP General Management Plan (GMP) (NPS 2008) calls for all existing roads to be maintained in a sustainable manner and for improving mass-transit opportunities. Objectives and desired conditions described in the plan relevant to the road system include the following:

- Park managers will use the most current and feasible engineering methods and techniques that minimize adverse effects on natural river processes to protect park roads and facilities located in flood plains.
- Park managers will inventory flood-prone areas near facilities and roads, and develop a program to proactively protect or relocate these facilities by using the most current techniques that minimize adverse effects on aquatic and riparian habitats and fluvial processes.
- Park managers will work with area partners, including tribes, federal, state, and county agencies, and others, to develop restoration plans for at-risk river systems, and for incorporating current technologies, over time, to restore or improve flood-plain and riparian functions altered in the past by bank-hardening techniques.

If park facilities are damaged or destroyed by a hazardous natural event, park managers will thoroughly evaluate options for relocation or replacement by new construction at a different location. If a decision is made to relocate or replace a severely damaged or destroyed facility, it will be placed, if practicable, in an area believed to be free from natural hazards.

The GMP specifically calls for road management plans to be developed in cooperation with federal, state,

Box 4.2—Critical factors and associated indicators considered in road work prioritization under the Olympic National Forest road management strategy.

Aquatic risk:

Geologic hazard—This factor identifies those roads located within potentially unstable terrain or within areas with high sensitivity to erosion. In this context, it is used as an aquatic habitat and water quality risk factor. It evaluates the terrain that the road is located on, not the terrain above the road. It is intended to be a reflection of the potential to initiate erosion or mass wasting from roads themselves rather than the potential for impacts to roads from processes initiated upslope.

Proximity (delivery) to fish habitat—This factor uses a combination of sediment delivery efficiency and physical distance from the fish-bearing portions of the stream network. It provides an estimate of how direct any road effects would be on fish and fish habitat.

Stream crossing density—The stream crossing density factor determines the relative hazard associated with stream crossing(s) within the road segment, defined as the frequency.

Riparian zone/stream proximity—The riparian zone factor determines the relative degree of connectivity between the road system and the stream system. This factor considers the portion of the road segment within the riparian zone or near a stream. Riparian zones are defined as a 100-m buffer width, which spans both sides of the channel, as measured from the center of the channel.

Upslope hazard—The upslope hazard factor identifies those roads located downslope of steep converging topography or terrain designated to have a high potential for landslides. These hazard elements may initiate new hill slope failures or increase the magnitude of initial mass wasting events. This factor differs from the geologic hazard factor in that the road itself may not be on the terrain that is considered hazardous, and the problems or disturbances affecting the road or the aquatic system may not be initiated from the road itself.

Access:

Private access—This factor identifies roads that provide access to non-National Forest System lands or special use permit sites.

Public access—This factor identifies roads that provide access to national forest-developed recreation sites.

Administrative access—This factor identifies roads that provide access to administrative sites (facilities, rock sources, and communication sites).

Wildlife:

Threatened and endangered species—The wildlife factor identifies roads that lie within or intersect a 0.40-km radius of a known northern spotted owl activity center, a marbled murrelet occupied site, or a bald eagle activity center.

High-value watersheds:

These factors are used to determine whether the road segment lies within or is within areas contributing to:

- Northwest Forest Plan key watersheds
- Municipal watersheds
- Clean Water Act 303(d) listed water bodies
- Habitat for listed fish stocks

Silvicultural:

Terrestrial habitat development (commercial thinning)—This factor considers whether the road provides access to stands with potential for terrestrial habitat development through commercial thinning.

Terrestrial habitat development (precommercial thinning)—This factor considers whether the road provides access to stands with potential for terrestrial habitat development through precommercial thinning.



Figure 4.10—A decommissioned road at Olympic National Forest. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

and tribal partners for at-risk roads near rivers and within the flood plains of the Hoh, Queets, and Quinault Rivers. These plans may include geomorphic investigations (such as that prepared for a section of the Quinault River) (see Bountry et al. 2005), restoration, feasibility studies, and as appropriate, recommendations for road relocations and potential wilderness boundary changes that may be needed as rivers respond to changing hydrology associated with climate change. The plan includes development of a North Shore Road/Finley Creek management plan (Quinault) to address the hydrologic and geomorphic issues associated with maintaining year-round vehicle access in this unstable environment, and to return Finley Creek to a more naturally functioning and stable condition. Finally, related to rising sea levels associated with climate change, the GMP calls for a risk-assessment study for Highway 101 along the coastal portion of the park to be conducted in cooperation with the Washington State Department of Transportation. This study will identify at-risk portions of the highway and determine suitable areas for reroutes or road relocations.

Specific road management goals for ONP, including considerations for potential effects of climate change, include:

- Hurricane Ridge—Road access to Hurricane Ridge will continue to be provided year round, and alternative

methods of transportation (transit) will be provided if studies indicate it is feasible. The unpaved road to Obstruction Point will be maintained seasonally.

- Staircase—The Staircase road will be maintained by using methods that minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008).
- Elwha—Road access will be retained to the Boulder Creek and Whiskey Bend trailheads; methods will minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008).
- Sol Duc—Seasonal road access will be provided by using methods that minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008).
- Mora—The last 0.8 km of road will be retained unless lost to a catastrophic event and reconstruction is infeasible because of topography. This section of the road lies within a tsunami zone in an area of very high sensitivity to future sea level rise. Access to the Rialto Beach area will be by trail should this section of road be lost (Pendleton et al. 2004).
- Hoh—Year-round road access will be provided by using methods that minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008). In the event of a flood with associated road loss or damage, if road relocation away from river meander areas is feasible, wilderness boundary changes that result in no net loss of ONP wilderness acreage will be sought as necessary (NPS 2008). Alternative methods of transportation (transit) would be provided if studies indicate it is feasible.
- Kalaloch—The ONP will work with the Washington Department of Transportation to determine options to relocate all or portions of Highway 101 outside the active coastal erosion zone as needed to maintain access, and for the protection of the coastal portion of the park. Kalaloch is also in an area of very high sensitivity to future sea level rise (Pendleton et al. 2004).
- Queets—Vehicular access will be retained, but the road or portions of the road may be moved or closed as needed in response to river meandering and changing

conditions, by using methods that minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008). The ONP will develop a plan to address long-term access options, and existing facilities may be removed or relocated in response to changing river and road conditions.

- Quinault—The loop drive will be retained and will provide access to the North Fork and Graves Creek areas. ONP will seek options to redesign or relocate the Finley Creek bridge, including moving and possibly redesigning the North Shore Road. The North Fork and Graves Creek roads will be retained; relocations may be necessary because of river movement and river restoration goals. Year-round road access would be retained by using methods that minimize adverse effects on river processes and aquatic and riparian habitats to the extent possible (NPS 2008). If road relocation away from river meander areas is feasible, wilderness boundary changes that result in no net loss of ONP wilderness acreage would be sought as necessary.
- Dosewallips—Road access will be provided by using methods that minimize adverse effects on river processes, aquatic and riparian habitats, and old-growth forests, to the extent possible.
- Deer Park—No change is expected for Deer Park Road; the road will remain unpaved and opened seasonally as weather conditions permit.

Climate Change Adaptation Strategies and Action Items for Road Management at Olympic National Forest and Olympic National Park

Process Used to Develop Adaptation Strategies for Road Management

In January 2009, ONF and ONP natural resources and engineering staff, and scientists from the Forest Service Pacific Northwest Research Station (PNW) and University of Washington Climate Impacts Group (CIG) convened to discuss adapting road management activities to climate change and related hydrologic changes on the Olympic Peninsula. Objectives of the workshop were to (1) learn about the latest climate and hydrology model projections, and (2)

use an interactive dialogue between scientists and managers to explore options to incorporate climate change information into road management at ONF and ONP. The workshop began with a presentation from Alan Hamlet on climate and hydrologic model projections, and a presentation from ONF engineer William Shelmerdine on current road management at ONF. A facilitated discussion on potential adaptation strategies for road management at ONF and ONP followed. Table 4.2 and the “General Adaptation Strategies for Road Management” section below describe key points from the discussion.

Building on the January workshop, ONF natural resources and engineering staff and PNW scientists further examined the ideas brought forth in the workshop and developed a strategy to use climate change information in road management at ONF, in particular, and to further inform road management activities at ONP. Participants concluded that climate change predictions could affect all aspects of road management, including (1) planning and prioritization, (2) operations and maintenance, and (3) design. A discussion of adaptation strategies developed for each of these areas is below, after a description of more general adaptation strategies for road management in the forest and park. See box 4.3 for a summary of projected climate change effects on hydrology on the peninsula and related adaptation strategies for road management at ONF and ONP.

General Adaptation Strategies for Road Management

The goal of road management at ONF and ONP is to provide a safe and economical transportation system to meet the access needs of various users while minimizing potential adverse impacts to other resources. Recent road management actions at ONF have focused on reducing potential risk to aquatic resources by removing unstable roads, relocating roads and infrastructure out of valley bottom areas, and at both ONF and ONP, correcting culvert fish passage barriers (fig. 4.11), and increasing the size and number of drainage structures, or replacing culverts with bridges where appropriate. Anticipated climate change effects tend to validate the current road management

efforts. In many ways, climate change will not necessitate large modifications of road management at ONF and ONP because the majority of current practices are focused on increasing the resilience of infrastructure and ecosystems. However, potential climate change effects underscore the need to increase activity and be proactive in priority areas to avoid impacts associated with infrastructure failure.

To deal with the uncertainty associated with climate change, strategic planning and efforts to increase flexibility in road management policies will be critical. Strategic approaches to resource allocation and utilizing no-regrets strategies will likely reduce vulnerability to future climate change and also help to better meet current objectives. Increasing flexibility in forest road management policies will allow management actions to shift more rapidly in response to new information on climatic changes and ecosystem response.

Managers will likely need to evaluate the density, location, design, and maintenance intensity of roads and related structures in the context of climate change to avoid escalating road maintenance costs associated with impacts discussed above. For example, roads in valley bottoms are particularly susceptible to flood damage, and moving these roads to other locations, when possible, may be desirable. Roads within or downslope of transient snow zones or snow-dominated areas will likely be subjected to increased flood damage because of more precipitation in the form of rain and increased storm intensity. These roads may require more intense treatments or more frequent maintenance. Also, current methods to size culverts and guidelines to determine design life may no longer be appropriate under changing climate.

The concept of Q_{100} (the peak flow anticipated in a 100-year flood event) is a key factor currently used for road

Box 4.3—Summary of projected climate change effects on hydrology on the Olympic Peninsula and related adaptation strategies for road management at Olympic National Forest and Olympic National Park.

- Reductions in snowpack and shifts in timing of snowmelt and streamflow are expected across the Western United States with increasing temperatures in the 21st century.
- Shifts in timing of streamflow, mainly increased winter and early spring peak flows and lower summer low flows, are expected for many Olympic Peninsula rivers, particularly for those in transient (mixed rain and snow) basins, such as the Elwha and Dungeness Rivers.
- Increases in cool season precipitation are projected to lead to overall increases in annual runoff across Washington state.
- Increases in precipitation intensity are also expected for the west slope of the Olympic Peninsula.
- Increases in winter precipitation, increases in precipitation intensity, and changes in timing of peak streamflow will contribute to increased flood risk in some of the Olympic Peninsula's rivers, particularly in December and January and in historically transient watersheds.
- Potential climate change effects underscore the need to increase activity and be proactive in priority areas to avoid impacts associated with increased infrastructure failure.
- Managers will likely need to evaluate the density, location, design, and maintenance intensity of roads and related structures in the context of climate change to avoid escalating road maintenance costs associated with impacts discussed above. For example, roads in valley bottoms are particularly susceptible to flood damage, and moving these roads to other locations, when possible, may be desirable to reduce maintenance costs and impacts on aquatic systems.
- Roads within, or downslope of, transition or snow-dominated areas will likely be subjected to increased flood damage because of more precipitation in the form of rain and increased storm intensity. Identifying these roads may be useful as they will likely require more intense treatments or more frequent maintenance.
- Also, current methods to size culverts and guidelines to determine design life may no longer be appropriate under changing climate. There are several alternatives, including using only the last 30 years of record (as opposed to the entire period of record), or using physically based model simulations to determine design discharge.

Table 4.2—Methods to incorporate climate change into road management at Olympic National Forest and Olympic National Park

Adaptation principle	Example adaptation strategies and actions
Be strategic and flexible	• Use selectivity in allocating resources. • Identify no-regrets strategies that do not require an accurate design standard but meet multiple criteria (e.g., for fish and streamflow). For example, with culvert design, bigger culverts could be put in every location to accommodate higher flows and fish passage, thus avoiding the development of new engineering design standards every decade. A standard design that works most of the time does not require constant updating and the large cost associated with the updating process. • Work under a new climate change paradigm in road management that is less prescriptive and more flexible. • Develop strategies and actions that are adaptable over time. • Focus on management actions that are robust to multiple future scenarios. • Broaden options and consider which option is more prudent for time and cost: new design, relocation, or increased maintenance. • Conduct management experiments on national forests to learn valuable lessons and contribute to the broader interest of all land and resource managing agencies. • Consider potential alterations to desired future conditions and alternative management pathways to achieve those conditions.
Reexamine road locations and entire design	• Rethink the design-life guidelines (usually <50 years) for roads and other structures. • Redo culvert size analysis based on peak flow data from only the last 30 years (as opposed to the period of record) or by using a physically based hydrology model (such as Variable Infiltration Capacity). • Consider whether existing roads are in the right locations (e.g., valley bottom roads). • Consider sediment problems in glacier-fed rivers that can make some valley bottom roads at risk or unsafe (such as in Mount Rainier National Park, or potentially the Hoh and Quinault valleys). • Consider future repair and maintenance needs in evaluating relocation options.
Use information selectively	• Use empirical data first and models second in analysis and planning. Assess sensitivities and trends in failures over the last 30 years and determine whether the sensitivities/failures were due to increased precipitation intensity or snowpack. Use the causes and consequences of past failures to determine where future failures will be and where actions should be focused. Consider new information and model predictions for the future only after that analysis. • Use expert knowledge when reliable quantitative data are not available. For example, instead of quantitative calculations of expected peak flow based on historical data, look at actual channel size on the ground and base culvert size on expert judgment.
Manage risk	• Expect that there will be some road failures. For example, failure can be expected in debris-prone areas. Without proactive action to manage risk, the anticipated failure rate will increase in response to climate change. • Conduct more up-front analysis and have plans in place to protect the most at-risk resources. • Use "What if it fails?" scenarios to address risk and uncertainty in evaluating road management alternatives. Failures that will result in the most severe impacts are the ones to be avoided
Increase communication and foster partnerships	• Foster science-management partnerships. • Engage scientists in communicating new science for management. • Communicate with the Federal Highway Administration about projected climate change effects and associated needs to widen programmatic capability and resources to respond.

management and stream crossing design. Calculation of this metric may need to shift under a changing climate. For example, instead of quantitative calculations of expected peak flow based on historical data, culvert size could be based on a qualitative ground-based assessment within an expert systems framework. Alternatively, physically based hydrologic models that incorporate changes in climate could provide quantitative estimates of changes in Q_{100} or other factors affecting design decisions. Assessing changing sensitivities and trends over the last 30 years (and their relationship to projected 21st century impacts) may also give a more accurate picture of future sensitivities and trends than the entire period of record. Looking for evidence of precession of peak flows or of the temporal centroid of the hydrograph, and determining the rate at which any change is occurring, may be useful to managers in determining how rapidly hydrologic effects of climate change are being realized. Observed trends may also provide important information needed to augment and validate model predictions (further discussion below).

Regardless of forward-thinking design or restoration methods used for roads, uncertainties associated with rainfall, steep slopes, and the transport of water, sediment, and wood in stream channels make some level of road failure inevitable. Climate change will exacerbate these uncertainties and associated risks. However, several strategies can minimize risk and failure. For example, inventorying and analyzing high-risk areas, such as debris-prone sites, can support development of plans to prevent or manage issues in these areas. In addition, “what if it fails?” scenario analyses can identify likely failures that will result in the most adverse consequences. This information can help to target sensitive areas in strategic planning to emphasize specific actions to avoid these impacts (e.g., specifying more robust design criteria for these areas).

Communication and partnerships are needed for adapting road management to climate change on the peninsula. Topography constrains potential road-access options; roads can affect important resource values such as fish and riparian resources; and forest management, recreation, tourism, and residential access are essential. The present case study



Figure 4.11—Fish passage culvert at Olympic National Forest. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

serves as an example of the utility of science-management partnerships that facilitate communication and help to address challenges and barriers to climate change adaptation.

Adaptation Strategies for Road Management Planning and Prioritization at Olympic National Forest

The RMS at ONF is a tool to evaluate the use or need for all of the roads in the transportation system against the potential risks the roads pose to other resources. Identified through analysis with RMS criteria, priority roads for decommissioning are those determined to be of low use volume or need, and high environmental impact. A major category in evaluating road risk is risk to aquatic resources. The RMS applies five rating factors to assess aquatic risk: (1) geologic hazard, (2) proximity (delivery) to fish habitat, (3) stream crossing density, (4) riparian zone proximity, and (5) upslope hazard. Climate change will likely influence all of these aquatic risk factors. The ONF engineering and natural resources staff identified three of the aquatic risk factors to focus discussion of adaptive strategies for road management planning and prioritization: proximity (delivery) to fish habitat, riparian zone proximity, and upslope hazard.

The upslope hazard factor developed in the RMS incorporates geologic hazard and delivery conditions within the hill slope immediately upslope of the road segment being evaluated. It identifies roads located downslope of either steep converging topography or terrain designated as having a high potential for landslides. These hazard elements may initiate new hill slope failures or increase the magnitude of initial mass wasting events. To incorporate climate change predictions, ONF proposes to modify the upslope hazard factor to consider the amount of area upslope that is in the transient snow zone or rain-on-snow (ROS) zone. With increasing temperatures, there will be shifts in the location and extent of ROS zones. High rates of water delivery to soils in ROS zones can be associated with mass wasting of hill slopes, and thus hill slopes with increasing area of ROS are potentially more susceptible to slope failure (Swanson and Dyrness 1975, Swanson et al. 1998, Wemple et al. 2001), which will affect use and maintenance of the adjacent road.

Scientists and engineers can predict future locations of ROS zones by using a model that accounts for factors such as climate, snow cover, and elevation. The ONF proposes to model the area within the ROS zone in hill slope areas above and connected to road segments, and evaluate road segments for ROS under current conditions and future projected conditions (e.g., 2040). Assessment of current and future hazard evaluations will flag areas with a higher hazard rating under projected future conditions as priorities for maintenance, upgrading, or decommissioning. This comparative evaluation will support recommendations for increased frequency and intensity of road treatments for some roads, as well as recommendations to decommission other road segments rather than continue efforts to maintain them.

Riparian area and stream proximity are also used to evaluate the risks that roads present to aquatic systems under the 2000 RMS. Managers consider stream-adjacent or riparian area roads to be risky owing to their often direct and deleterious effects on aquatic habitats. Stream-adjacent roads also have high potential for frequent damage from floods and stream channel changes, resulting in higher maintenance costs. To incorporate climate change predic-

tions, ONF proposes to modify the riparian area/stream proximity factor in the RMS by manually validating the locations of stream-adjacent roads and degree of connectivity of these roads to streams. Olympic National Forest engineers will assess roads under current and future projected conditions, and assign a higher (riparian zone proximity) hazard rating to those that are determined to be within a projected flood hazard corridor (in a potential area of inundation or channel migration zone, or in a geotechnical setback buffer). Highest priorities for maintenance, upgrading, or decommissioning will focus on roads with higher hazard ratings under future projected conditions (e.g., roads at higher risk owing to increased flood risk).

Adaptation Strategies for Road Operations and Maintenance at Olympic National Forest and Olympic National Park

Assessing current road maintenance and operations tasks conducted at ONF and ONP in the context of climate change can inform managers of necessary changes. For example, climate change will likely influence watershed processes, resulting in increased flow volume, increased mass wasting and debris flows, increased sediment delivery to culvert inlets and ditches, increased rate and volume of water delivery to stream channels, and increased transport of wood. These changes will likely increase the incidences of culvert capacity being exceeded, fill slope failures, and development of first-order channels that can affect roads and related structures (e.g., fig. 4.12). A response to these potential changes could involve prioritizing maintenance preparation and response, including increased frequency of culvert cleaning, installing more and larger culverts where appropriate, and installing water bars and drivable dips. Table 4.1 lists potential climate change effects and affected watershed processes and sensitivities associated with major road maintenance and operations tasks, along with potential strategies to address climate change issues.

Adaptation Strategies for Road Design

Anticipating the effects from changes in watershed processes also informs the design of roads and related structures. Design of water crossing structures in the context

of climate change, specifically culvert design, is an area of particular interest to both the forest and the park because of the increased potential for higher fall and winter flow volumes to exceed culvert capacity. Stream simulation is a method used to design culverts on fish-bearing streams that applies attributes of streams (geometry and geomorphology) to size and select water crossing structures. This method leads to designs that are relatively resilient to a range of conditions. Consequently, no changes to this method are proposed at this time.

Culverts on non-fish-bearing streams are designed principally by analyzing predicted runoff and flow capacity. Standard methods applied at ONF and elsewhere include sizing culverts for the predicted 100-year flood and associated debris ($Q_{100} + \text{debris}$). The Northwest Forest Plan aquatic conservation strategy (ACS) established this standard in 1994. The standard requires that an understanding of watershed process and channel functions be incorporated in culvert design, and thus, culverts designed by using this standard are considerably more resilient than those designed under pre-ACS standards. However, there is a question as to whether the methods used to predict Q_{100} should be altered according to expected hydrologic effects of climate change.

Engineers currently use the period of record to predict the Q_{100} . However, flood magnitude will likely increase in the transient snow zone with warming temperatures. Predictions based on the period of record may be even less accurate for predicting large flows if future precipitation or runoff patterns change. In many Olympic Peninsula streams, the largest flows on record at gauged sites are clustered in the later part of the record (i.e., the last 20 years). For example, at the Duckabush River gauge, the five largest flows in the 70-year record occurred in the past 12 years. Deriving the same predictive equations based on the late, early, or entire record gives entirely different predictions of Q_{100} .

There are several possible ways to modify the current method used for prediction of design discharge (Q_{100} flow). Suggested alternatives include calculations based on the later part of the record, such as the past 30 years. Alternatively, the Variable Infiltration Capacity (VIC) hydrologic model can provide future runoff estimates under different

scenarios of climate change, which could be used to supplement information from the period of record. The VIC model uses a physically based simulation of runoff processes combined with a unit hydrograph approach that would provide a more physically based analysis than the current Q_{100} calculation method. The VIC model has predictive capabilities related to temperature and snowpack changes, which the current method does not. In considering climate change, ONF proposes to conduct an analysis of both the current method and the proposed VIC-based method and compare results, selecting the most appropriate option based on hazard and consequence for a particular site.

These analyses would not address several potential issues with culvert design based on predictions of Q_{100} . Predictions of Q_{100} have been and likely will continue to be associated with much uncertainty, regardless of the method used for prediction. Predictions of Q_{100} also do not address sediment and wood, which are most frequently the cause of culvert failures (not excessive water) (Furniss et al. 1998). Thus, continued and potentially increased focus on geomorphic culvert design on non-fish-bearing streams will be important with climate change. Besides an increase in magnitude, the frequency of moderate floods will likely increase with climate change; five 20-year flood events may in fact cause more damage to road infrastructure than one 100-year flood event. As noted above, increased focus on design of resilient structures will help avoid adverse effects of climate change on road systems.

Challenges and Opportunities in Climate Change Adaptation in Road Management

There are many potential challenges in the implementation of adaptation strategies and actions in road management on the Olympic Peninsula (table 4.2). For example, the National Highway Safety Act sets specific requirements for heavily used roads, arterials and collectors (maintenance level 3 and above), and most appropriated road operations and maintenance funds focus on these higher standard roads. Valley bottom and stream-adjacent roads are well represented, but other roads are not. In general, lower standard roads at the head of the transportation and drainage network have higher hazards when it comes to slope and runoff processes, but



Figure 4.12—Ditch scour along an Olympic National Forest road. Changes in hydrology and physical watershed processes with climate change will likely increase the incidences of culvert capacity being exceeded, fill slope failures, and development of first-order channels that can affect roads and related structures. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

funding generally does not target operations and maintenance on these lower standard and higher hazard roads.

Another potential policy challenge is the Federal Highway Administration Emergency Relief for Federally Owned Roads (ERFO) Program. This program is the principal source for storm damage repair funds. However, at present, use of these funds is generally limited to in-kind replacement (although there have been some recent exceptions). For example, if storm damage occurs owing to culvert failure, ERFO funds will cover replacement of the same size culvert but not a larger one that could accommodate higher flows and be more resilient to future floods. Such policies limit the ability to design replacement structures that accommodate changing conditions with climate change or other factors. Further collaboration with the Federal Highway Administration may help to alleviate these limitations.

Budgets and the need for economic efficiency present further challenges in climate change adaptation in road management. Competing with the need to implement resilient designs is the objective to be economically efficient. Although long-term costs may be reduced by implementing more resilient designs for a changing climate, costs at the time of construction will likely be higher than current designs (especially in the case of in-kind replacement

guidelines discussed above). Thus, strategic planning and prioritization efforts to identify areas where more robust designs would be most advantageous will make the best use of limited financial resources for climate change adaptation.

Acknowledgments

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Chapter 5: Climate Change, Fish, and Fish Habitat Management at Olympic National Forest and Olympic National Park

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Potential Climate Change Effects on Hydrology, Summer Stream Temperatures, and Fish on the Olympic Peninsula

Climate plays a crucial role in aquatic ecology, but the relative importance of climatic factors is quite different for different species, and even different populations of the same species. For example, key limiting factors for freshwater salmon productivity include thermal and hydrologic regimes that depend on species, their life history, watershed characteristics, and to a great extent, stock-specific adaptations to local environmental factors (e.g., Beechie et al. 2008, Crozier and Zabel 2006, Farrell et al. 2008, Richter and Kolmes 2005). Those stocks that typically spend extended rearing periods in freshwater (steelhead, stream-type chinook salmon, sockeye salmon, and coho salmon) are likely to have a greater sensitivity to freshwater habitat changes than those that migrate to sea at an earlier age (ocean-type chinook salmon, pink salmon, and chum salmon). Because they spend almost all of their life cycle in freshwater, resident rainbow trout, cutthroat trout, and bull trout are also likely to be sensitive to freshwater habitat changes. Effects of changes in marine conditions with climate change could interact with effects of changes in freshwater conditions to further affect fish populations that spend part of their life cycle in the marine environment.

Mantua et al. (2010) reported on a few direct, well-understood mechanisms whereby more easily predicted physical properties of the freshwater habitat for salmon directly influence salmon reproductive success (or overall fitness) at certain stages of their life cycle. Those physical properties are warm season stream temperature and the volume and time distribution of streamflow. They did not,

however, assess the impacts of climate change on cold season water temperatures and related impacts on salmon, and this choice directed their focus on negative, rather than positive, impacts of climate change on the freshwater habitat for Washington's salmon.

We describe in a report by Mantua et al. (2010) qualitatively assessed the potential effects of climate change on the reproductive success for salmon in Washington's watersheds by combining salmon sensitivities described in the scientific literature with future scenarios for changes in the statistics of stream temperature and streamflows. Climate also influences estuarine and marine habitat for salmon. See reviews of climate effects on marine habitat for Pacific Northwest salmon in ISAB (2007), Loggerwell et al. (2003), and Percy (1992).

Summertime Stream Temperature Projections

Maximum weekly water temperatures in Washington are typically observed from late July through late August, similar to the period of climatologically warmest air temperatures. Figure 5.1 shows downscaled historical averages for August surface air temperatures and simulated annual maximum weekly water temperatures (T_w) for the 1970–99 (1980s) period (left panel) and for a multimodel ensemble average under A1B greenhouse gas emissions for 2030–2049 (2040s) (right panel). Although air temperatures are not the only influence on water temperatures, air temperature can provide an accurate indicator of water temperature in many cases (Mohseni et al. 1998; see Mantua et al. [2010] for detailed modeling methods). Under historical conditions, August mean surface air temperatures on the Olympic Peninsula are below 17 °C everywhere except a narrow corridor in the lowlands along Hood Canal. Two of

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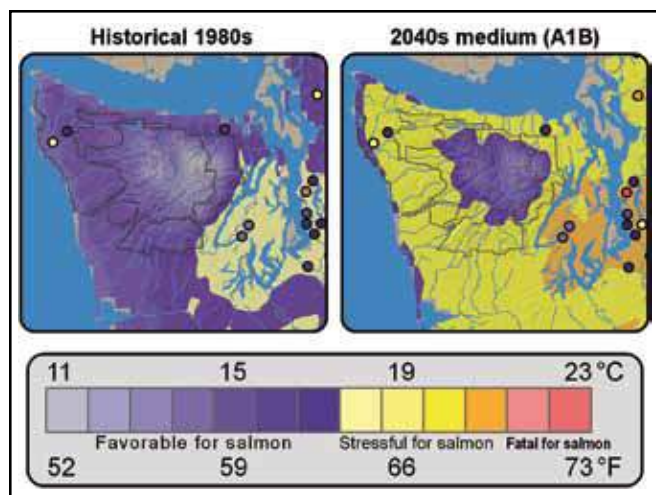


Figure 5.1—August mean surface air temperature and maximum stream temperature for the Olympic Peninsula. Color shading shows mean surface air temperatures for August, and shaded circles show the simulated mean of the annual maximum for weekly water temperatures for select locations. Historical air temperature and simulated water temperature for the 1980s (1970–99) are in the left panel, while a future scenario derived from a multimodel average under A1B medium level emissions is shown in the right panel. Olympic National Park and Olympic National Forest are outlined in dark gray. (Adapted from Mantua et al. 2010.)

the three water temperature sites on the Olympic Peninsula have $T_w < 17^\circ\text{C}$, while one has T_w approximately 20°C . For the 2040s scenario, the encroachment of summertime air temperatures with $T_a > 20^\circ\text{C}$ becomes the norm for western Washington's lowlands, and for this period only, the higher elevations of the Cascades and Olympics have temperatures like those characteristic of the western Washington lowlands in the 1980s.

For A1B emissions scenarios in the 2020s, annual maximum T_w at most stations on the Olympic Peninsula is projected to rise less than 1°C , but by the 2080s, several stations on the Olympic Peninsula warm by 1 to 2°C (not shown). Water temperatures projected under the A1B emissions scenarios become progressively warmer than those projected under the B1 emissions, and by the 2080s the differences are approximately 1°C (projected summertime air temperatures under A1B emissions are, on average, 1.8°C warmer than those under B1 emissions for the 2080s).

Increases in stream temperature with climate change are likely to differ across landscapes. Locations that currently experience high summer air temperatures are likely

to have the largest increases in water temperature (ISAB 2007). A study by Daly et al. (2009) suggests that complex patterns of temperature change may occur in locations with complex terrain; locations with cold air drainage and pooling will likely experience the lowest temperature increases, whereas exposed hill slope and ridge top locations will likely experience the highest temperature increases. In the John Day River basin in northeastern Oregon, Torgersen et al. (1999) found water temperatures to be warmest in downstream (low-elevation) stream reaches and in locations where the cooling effects of subsurface flow are less apparent. These and locations with channel conditions prone to heating (wide, shallow, lack of riparian vegetation) (Crozier and Zabel 2006) are likely to experience further warming with climate change. Changes in water temperature will also differ with hydrologic changes. Decreases in summer low flows will make streams more susceptible to increased air temperature, and earlier snowmelt will result in warming beginning earlier in the year in basins affected by snowmelt (ISAB 2007).

Climate Change Effects on Snowpack and Streamflow

Figure 5.2 classifies runoff in Washington's watersheds (at the level 4 hydrologic unit code) for historic and future periods as either snowmelt dominant, transient, or rain dominant based on their basin-averaged ratio of simulated April 1st snowpack to their October to March total precipitation (Elsner et al. 2010). Rain-dominant basins (where the ratio is < 0.1) are the most common type on the Olympic Peninsula (for the 1980s). There is one transient basin (mixed rain and snow basin where the ratio lies between 0.1 and 0.4) in the northeastern portion of the Olympic Peninsula, and there are no snowmelt basins (where this ratio > 0.4 for the 1980s). As projected climate warms, the historically transient basin on the Olympic Peninsula is projected to become rain dominant by the 2040s under the A1B emissions scenario, and by the 2080s under the B1 emissions scenarios.

The recently completed *Hydrologic Climate Change Scenarios for the Pacific Northwest Columbia River Basin and Coastal Drainages* project (project homepage <http://>

www.hydro.washington.edu/2860) includes future snowpack and streamflow scenarios from 10 global climate models under two greenhouse gas emission scenarios for the 21st century. A sample of hydrologic model output for select watersheds on the Olympic Peninsula is provided in figures 4.2 to 4.7 in chapter 4. The magnitude and frequency of flooding are predicted to increase for watersheds on the Olympic Peninsula, most dramatically in the months of December and January, and most dramatically for the coldest basins that in the late 20th century typically collected significant amounts of snow in their upper reaches. Hydrologic models indicate that warming trends will substantially reduce seasonal snowpack on the Olympic Peninsula (Elsner et al. 2010), thereby decreasing the risk of springtime snowmelt-driven floods.

The shifts in flood risk in each basin tend to monotonically increase or decrease through time. In other words, the increases or decreases in flooding magnitude of each basin generally become larger, with the same sign from the 2020s to the 2080s, with the greatest impacts occurring at the end of the 21st century. Emissions scenarios also play a strong role in the rate of change in flooding magnitudes, with the changes for A1B emissions in the 2040s being similar to those for the B1 emissions in the 2080s.

Reductions in the magnitude of summer low flows are projected to be widespread for the Olympic Peninsula's rain-dominant and transient runoff river basins (not shown). Future estimates of the annual average low flow magnitude (7Q10, which is the 7-day average low flow magnitude with a 10-year return interval) are projected to perhaps increase by a few percentage points or decline by up to 50 percent, with most climate model scenarios leading to declines by the 2080s under both the A1B and B1 emissions scenarios. As indicated by the simulated runoff graphs shown in figures 4.2 through 4.7, the duration of the summer low flow period is also projected to increase significantly in all but the most rain-dominant watersheds, which include the Skokomish, Queets, and Hoh watersheds.

Projected Effects of Altered Hydrology on Olympic Peninsula Salmon, Steelhead, and Bull Trout

Waples et al. (2008) noted that existing salmon popula-

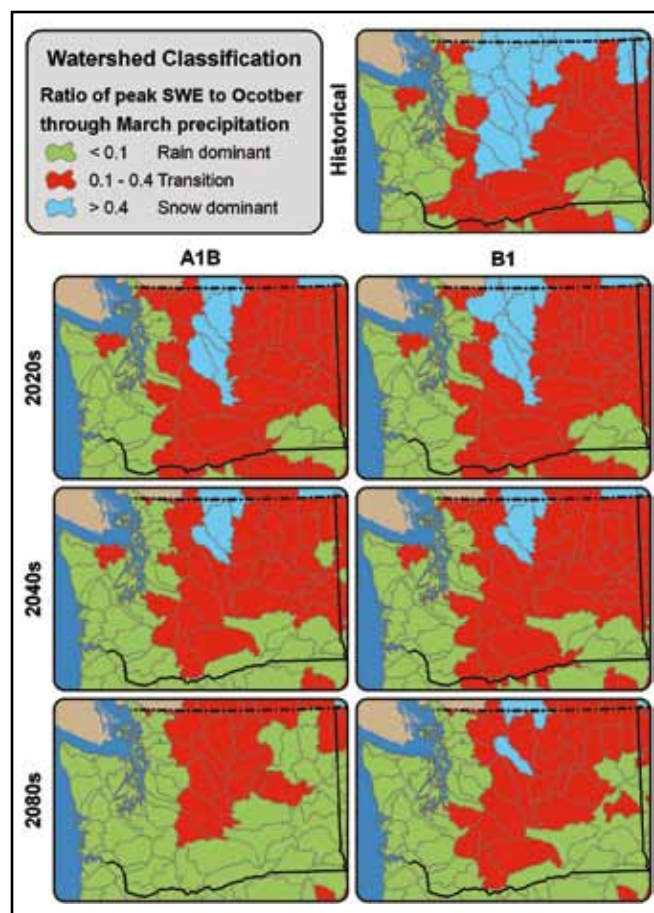


Figure 5.2—Watershed classification in Washington state for simulated runoff in the historic period (1970–99) and future periods (2020s, 2040s, and 2080s). Simulations that use A1B emissions are in the lower three rows of the left column, and those that use B1 emissions scenarios are in the lower three rows of the right column. [SWE = snow water equivalent.] (Adapted from Elsner et al. 2010.)

tions should have the capacity for responding to habitat changes that fall within the bounds of historical disturbance regimes, specifically episodic disturbances that most often impact relatively small habitat patches relative to the spatial extent of evolutionarily significant population groups that are typically influenced by regional physiographic features. It remains an open question whether present-day salmonid fish populations on the Olympic Peninsula can adapt (either through phenological, phenotypic, or evolutionary responses) at rates required to deal with the combination of anthropogenic climate change and other habitat and ecosystem changes that will come in the next century (Crozier et al. 2008).

Our assessment of future stream temperature, stream-flow changes, and limiting factors indicates widespread declines in the quality and quantity of freshwater habitat for many Olympic Peninsula salmon, steelhead, bull trout, and resident fish populations, unless they are able to quickly adapt to changing habitat conditions. Increases in stream temperature alone point to significant increases in thermal stress (fig. 5.1) for Washington's salmonid fish populations having a stream-type life history that puts them in freshwater during summer for spawning migrations, spawning, rearing, or seaward smolt migrations. Temperature impacts on adult spawning migrations are projected to be most severe for stocks having summertime migrations. These include summer-run coho salmon in the Sol Duc watershed, and summer run chum salmon in several Hood Canal streams. Increased stream temperatures pose risks to the quality and quantity of favorable rearing habitat for stream-type chinook and coho salmon and steelhead (summer and winter run) because these stocks spend at least one summer (and for steelhead typically two summers) rearing in freshwater.

Increased stream temperatures on the Olympic Peninsula will also affect bull trout. This species, which is listed as threatened under the federal Endangered Species Act (ESA) (ESA 1973), is highly sensitive to stream temperature, generally requiring stream temperatures below 15 °C (USFWS 2004). There are six core areas of spawning bull trout on the peninsula (USFWS 2004). Unlike other areas of their range, bull trout on the peninsula are found only within the anadromous portion of watersheds, below anadromous migration barriers. Increased stream temperatures and reduced summer streamflows could particularly affect bull trout by reducing the quantity and quality of rearing habitat.

In addition to increased stream temperatures, reductions in the volume of summer/fall low flows in transient and rain-dominated basins might also affect summer-run steelhead migration and reduce the availability of spawning habitat for bull trout and salmon populations that spawn early in the fall (e.g., Healey 1991). Predicted increases in the intensity and frequency of winter flooding will likely negatively impact the egg-to-fry survival rates (table 5.1) for

pink, chum, sockeye, chinook, and coho salmon and bull trout owing to an increased intensity and frequency of redd and egg scouring. However, the effects of scour will differ, in part, by channel type and location in the stream network. Confined streams that are high in the network will likely be most susceptible to scour, which will likely impact the steelhead and bull trout that inhabit them. Lower gradient streams in unconfined settings, such as those typically inhabited by chinook, will likely be least vulnerable to scour. In addition, the impact of increasing winter flooding will likely differ across species or populations because redd depth is a function of fish size (deeper redds will be less vulnerable to scouring and the deposition of fine sediments).

Parr-to-smolt survival rates may be reduced for coho and stream-type chinook salmon and steelhead with climate change because increases in peak flows can reduce the availability of slow-water habitats and cause increases in the displacement of rearing juveniles downstream of preferred habitats (table 5.1). However, the effects of increased peak flows will depend on the particular geomorphic setting and on whether the fry will have emerged before or at the time of the high flows. The effects of increased peak flows will be more pronounced in constrained reaches (i.e., narrow valleys and higher gradient streams), which are used by steelhead and bull trout for spawning, than in unconstrained reaches (i.e., wide valleys and lower gradient streams), which are used by coho and chinook. In the latter, the fish may be able to move to off-channel areas that would not be available at normal flows. Displacement could be a problem in the former situation. Displacement could be exacerbated if fish emerge earlier because of elevated winter water temperatures. The effects of high flows may be minimal for some fish, such as winter steelhead that spawn after peak flow events. However, for some species, reductions in springtime snowmelt may negatively impact the success of smolt migrations from snowmelt-dominant streams where seaward migration timing has evolved to match the timing of peak snowmelt flows.

Summer chum salmon stocks in Hood Canal are listed as threatened under the ESA. These populations have a unique life history that makes them especially vulnerable to the impacts of climate change. Adults return to spawn in

Table 5.1—Salmon life cycle stages and climate change effects that will likely impact each salmon life cycle stage

Salmon life cycle stage	Climate change effects that will likely impact salmon life cycle stage
Eggs in stream gravel; hatch in 1 to 3 months	Increased winter flooding and mean flows; warmer water
Alevins in stream gravel; 1 to 5 months	Increased winter flooding and mean flows; warmer water
Fry emerge in spring or summer	Increased winter flooding and mean flows; warmer water
Juvenile fish in freshwater; a few days to 4 years depending on species and locality	Warmer water and lower streamflows in summer; increased winter flooding in transient basins
Smolt migration to ocean; usually in spring and early summer	Warmer water and lower streamflows in summer; increased winter flooding in transient basins
Fish in ocean; 1 to 4 years	Sea level rise; altered river discharge
Migration to spawning grounds; timing depends on species and race	Warmer water and lower streamflow
Fish spawning in freshwater stream	Warmer water and lower streamflow

small shallow streams in late summer, and eggs incubate in the fall and early winter before fry migrate to sea in late winter. The predicted climate change effects for the low-elevation Hood Canal streams used by summer chum include multiple negative impacts stemming from warmer water temperatures and reduced streamflow in summer.

It is possible that climate-induced warming in winter and spring will lead to earlier and perhaps longer growing seasons, increased aquatic food web productivity, and more rapid juvenile salmon growth and development rates that benefit parts of the freshwater life cycle of the Olympic Peninsula's salmon and steelhead (Schindler and Rogers 2009). This could potentially increase the full life cycle productivity for salmon populations if the positive impacts outweigh the negative impacts described above. For example, in watersheds that are currently minimally affected by snowmelt (rain-dominant basins), the changes in the timing of streamflow with climate change will likely be minimal. Thus, without substantial increases in winter flooding and reductions in summer low flows, increased winter stream temperatures could have a net positive impact on salmon in these watershed types, depending on the magnitude of late-spring through fall stream temperature changes.

Potential benefits of warmer stream temperatures for coho salmon were shown in studies of clearcut logging impacts in the Carnation Creek watershed of Vancouver Island, British Columbia (Holtby 1988). Logging in this

watershed led to stream warming of 0.7 °C in December and over 3 °C in August, which in turn contributed to positive growth responses in juvenile coho salmon, accelerations in the freshwater component of coho salmon life histories, and increases in overwinter survival rates for rearing juveniles. However, these changes in freshwater development appear to have been offset by reduced marine survival rates associated with earlier smolt migrations to the ocean (because of warmer spring stream temperatures) that may have been mismatched to the optimal timing for ocean prey availability and predator avoidance. Holtby (1988) estimated that warmer stream temperatures increased the full life cycle coho production in this system by about 9 percent. Modeling from the same study system suggested that effects of warmer stream temperatures as a result of logging may be greater on chum than coho salmon (Holtby and Scrivener 1989).

Because of the earlier timing of snowmelt and increased evaporation, some of the Olympic Peninsula's river basins (including the Elwha and Dungeness) are projected to experience reduced streamflow in summer and early fall that results in an extended period of summer low flows, and many basins are also projected to have substantially lower base flows. In combination with increased summertime stream temperatures, reduced summertime flow is likely to limit rearing habitat for salmon with stream-type

life histories (wherein juveniles rear in freshwater for 1 or more years) and increase mortality rates during spawning migrations for summer-run adults (table 5.1).

Fish Habitat Management at Olympic National Forest and Olympic National Park

This section provides information on the biogeographic context, guiding policies and legislation, and primary activities in fish habitat management at Olympic National Forest (ONF) and Olympic National Park (ONP), including (1) the context in which ONF and ONP manage fish habitat, (2) the guidance and constraints on fish habitat management at ONF and ONP, and (3) the primary issues around and activities currently conducted in fish habitat management at ONF and ONP. This information, coupled with the likely impacts of climate change on fish on the Olympic Peninsula, provides a basis on which to develop climate change adaptation options for fish habitat management at ONF and ONP.

Biogeographic Context

The ONF contains portions of 17 major drainages on the Olympic Peninsula and manages about 560 km of anadromous fish streams and another 685 km of streams that provide habitat for resident fish populations. At least 40 small alpine lakes and two reservoirs exist on the forest.

The streams, rivers, and lakes at ONF provide habitat for seven anadromous fish species including chinook, coho, chum, and pink salmon; steelhead trout; sea-run cutthroat trout; and bull trout. Resident salmonids include cutthroat trout and rainbow trout. Four of the fish stocks on the forest are listed as threatened under the ESA: Puget Sound chinook, Puget Sound steelhead, Hood Canal summer chum, and bull trout.

Rainfall, geology, and management legacies present some challenges for fish habitat management at ONF. Some parts of the Olympic Peninsula receive more than 5 m of rain per year. Long, steep slopes, underlying geology, and heavy rainfall result in unstable ground on some parts of ONF. The ONF also has an extensive legacy of timber harvest. About 50 percent of the suitable land base was harvested between the 1960s and the mid 1990s. Over 3500 km of forest roads initially built for timber harvest remain

on the forest road network. Unstable slopes combined with an extensive road network can result in sedimentation and aquatic habitat degradation.

The ONP contains over 5600 km of rivers and streams that support 70 unique salmonid stocks as well as numerous nonsalmonid species. The park also includes two large natural lakes and over 300 smaller alpine lakes and lower elevation ponds. In addition to the federally listed fish stocks at ONF, ONP also has the Lake Ozette sockeye fish stock, which is listed as threatened under the ESA.

There are 225 km of roads located in the park, along with many visitor facilities (visitors' centers, campgrounds, and way points). With the exception of the Hurricane Ridge Road and Deer Park Roads that access alpine areas, the park's road system and many visitor facilities occur within the flood plains of the park's major river systems (Elwha, Sol Duc, Hoh, Queets, Quinault, and North Fork Skokomish); segments of these roads lie immediately adjacent to the rivers. Maintenance and repair activities associated with these road systems constitute (historically) a major impact to fish and aquatic communities.

Guiding Policies and Legislation

The ONF Land and Resource Management Plan (LRMP) (USFS 1990) as amended by the 1994 Northwest Forest Plan (USDA and USDI 1994) guides current management activities at ONF. A key component of the plan is the Aquatic Conservation Strategy (ACS), which includes nine objectives for maintaining and restoring watershed processes and functions. To be consistent with the LRMP and the ACS, all management activities at ONF must maintain or help restore watershed conditions. In line with these broader mandates, the goal of fish habitat management at ONF is to maintain or restore watershed processes and functions and provide diverse, resilient fish habitats capable of supporting populations of native fishes over the long term.

At ONP, fish habitat management programs and decisions are guided by the National Park Service Management Policies (NPS 2006), as well as the ONP General Management Plan (GMP) (NPS 2008), the ONP Backcountry Management Plan (NPS 1980), and the ONP Superintendent's Compendium. The park's planning and compliance process

guides preservation of fish habitat within ONP by prescribing measures to prevent or minimize the impact of all park management activities. Usually, particularly within wilderness areas, limiting the construction of new facilities within flood plains avoids impacts to fish habitat. The park's GMP (NPS 2008) calls for potential relocation of existing roads, campgrounds, or other visitor facilities out of flood plains as feasible, or when a road or facility cannot be relocated, directs that measures to protect and maintain the facility must be designed to minimize the effect on fish habitat to the extent possible. The ONP recently evaluated a variety of road and facility hazards within the park, and will evaluate protection measures designed to be more environmentally sensitive than traditional engineered designs.

Primary Fish Habitat Management Issues and Activities

Olympic National Forest—

The primary management issues for fish and fish habitat at ONF include:

Sedimentation from forest roads

Road-related landslides can cause sedimentation in streams (Fredriksen 1970, Harr and Nichols 1993) and influence fish habitat (Harr and Nichols 1993). Road-related sedimentation is a major issue impacting fish habitat at ONF. In response, ONF decommissions unneeded roads, and removes sidecast material and improves drainage on the remaining roads.

In 2000, the forest completed a Road Management Strategy (RMS). This geographic information system based analysis evaluated the risk each road segment presented to fish habitat and water quality based on its location, geomorphic factors, distance to stream channels, and number of stream crossings. About 34 percent of the roads on the forest are rated as “high” or “very high” risk to aquatic resources.

In 2003, the forest used the new aquatic risk information, coupled with an assessment of the access needs and anticipated future funding levels, to revise the Access and Travel Management (ATM) Plan. The plan proposes decommissioning of over 1270 km of forest roads, or about one-third of the road system. The ATM and aquatic risk information helps to prioritize road treatment locations as

funding becomes available. In previous actions and following the new ATM plan, ONF decommissioned about 700 km of road since 1990.

Fish passage and culverts

Currently, 77 culverts block fish passage on the forest including five anadromous sites blocking a total of 13 km of anadromous fish habitat, 16 high-priority resident sites blocking more than 1.6 km of resident fish habitat each, 14 moderate-priority resident sites blocking between 0.8 and 1.6 km of resident fish habitat each, and 42 low-priority resident sites that block less than 0.8 km of resident fish habitat each. Since 2002, forest managers completed 18 fish passage barrier correction projects, restoring access to 39 km of fish habitat. Anadromous barriers are the top priority for correction. Biologists prioritize resident barriers based on the amount of fish habitat that would be reconnected.

Instream large wood

Past stream clearing and splash damming activities at ONF removed large wood from many stream channels. Placing large wood in key stream reaches restores watershed processes and functions and improves fish habitat by providing structure, creating cover, scouring pools, and trapping spawning gravels. The forest completed numerous small-scale large-wood placement projects in the past and is planning an extensive logjam construction project on the South Fork Skokomish River in 2010. Increasing landslides with climate change (see chapter 4) could also potentially increase upslope sources of wood to streams.

Riparian vegetation

Logging activities in the past removed conifers from many streambanks at ONF. Conifers regenerated in some riparian areas, but many riparian corridors have few conifers to provide large wood to streams. In these areas, reestablishment of conifers will help to provide a long-term source of large wood in channels. However, these projects require long commitments over time, are costly, and are consequently not a high priority for forest managers.

Nutrient supplementation

Marine-derived nutrients carried back into anadromous streams by returning adult salmon carcasses are a key

element in the productivity of many streams (Helfield and Naiman 2001, Naiman et al. 2002). Extirpation of salmon stocks and extremely low escapements of anadromous fish have likely reduced potential productivity in forest streams. Supplementing nutrient supplies, either by distributing salmon carcasses or adding slow-release fertilizers, has the potential to increase the numbers and condition of juvenile salmon, steelhead, and bull trout in forest streams. Although carcass supplementation has not yet been demonstrated to improve salmonid productivity or riparian vegetation growth on the Olympic Peninsula, Cederholm et al. (1989) showed that carcasses are utilized by a large number of wildlife species. The forest has been distributing surplus chum salmon carcasses throughout the upper South Fork Skokomish watershed. The Pacific Salmon Coalition distributes salmon carcasses throughout the Quileute system.

Invasive species

Some exotic species such as Japanese knotweed are considered invasive owing to their potential to outcompete native vegetation. Invasive infestations in riparian areas reduce future sources of large wood by outcompeting tree species and change the terrestrial food inputs into streams. Removal and control of priority invasive weed species helps to maintain riparian function. There are also public education efforts for aquatic invasive species. However, ONF has not identified aquatic species on the forest that warrant intensive control or monitoring efforts.

Olympic National Park—

At ONP, fish habitat management activities fall into three general categories: (1) habitat preservation, (2) habitat restoration, and (3) management planning. Within the past 5 years, the park has conducted several restoration projects, including removal or replacement of numerous undersized culverts that were partial or complete barriers to fish migration. A significant habitat restoration project is the upcoming removal of two dams from the Elwha River. However, with the exception of the Elwha project, habitat restoration within ONP is opportunistic as opposed to strategic, and has no sustained funding source. Park biologists work to rectify this through numerous activities,

including participation in various salmon recovery forums, interagency planning for watershed water use strategies, cooperation with the National Oceanic and Atmospheric Administration National Marine Fisheries Service and local tribes to develop and implement ESA recovery plans, and development of a prioritized list of culverts targeted for replacement.

It will be critical for ONP to consider climate change in the future management of fish habitat. Whether management activities involve protection, restoration, or unknown and undecided manipulative actions, the changing climate will dictate measures needed to preserve “unimpaired” the fisheries resources of the park. Although today’s conditions will change, through careful consideration and evaluation of the effects of climate change on the aquatic environment, adaptation strategies may help to sustain processes that shape and maintain viable aquatic ecosystems.

Climate Change Adaptation in Fish and Fish Habitat Management at Olympic National Forest and Olympic National Park

Process Used in Development of Adaptation Strategies for Fish Management

To develop adaptation strategies and action items for fish management on federal lands on the Olympic Peninsula, scientists, managers, and other stakeholders collaborated and shared information and perspectives at two workshops. In November 2009, a workshop on “Climate Change Impacts on Olympic Peninsula Salmon” provided scientific information to a broad audience of stakeholders regarding vulnerabilities of aquatic habitats and salmonids on the Olympic Peninsula under a changing climate. Twelve scientists spoke on a variety of topics, including scenarios for the Olympic Peninsula’s climate and landscape in the 21st century, climate change effects on freshwater aquatic ecosystems, climate change effects on coastal marine systems, and planning for climate change (presentations are available online at: http://www.fs.fed.us/ccrc/video/olympic_climate_change.shtml). Panel discussions followed the presentations in each topic area, and the workshop concluded with an open discussion focused on key vulnerabilities and adaptation strategies for aquatic ecosystems on the peninsula. The

nearly 100 participants included representatives from ONF, ONP, and a variety of state and federal natural resource agencies, watershed organizations, and tribes.

A subsequent, smaller workshop focused on developing adaptation strategies and action items for fish management at ONF and ONP. Participants in this second workshop included ONF and ONP natural resources staff and scientists from the Forest Service Pacific Northwest Research Station (PNW) and the University of Washington Climate Impacts Group. Objectives of the workshop were to (1) use the latest scientific information on climate change and effects on fish to identify adaptation actions for fish management that should be taken by ONF and ONP in the short term (over 1 to 5 years), (2) identify priorities and priority areas (e.g., key watersheds, stream reaches, and species) for climate change adaptation on the forest and park, and (3) identify policy issues and regulatory barriers to climate change adaptation in fisheries and fish habitat management. The workshop began with a presentation from Nathan Mantua on key aquatic vulnerabilities with climate change on the Olympic Peninsula. Fish biologists Patrick Crain (ONP) and Robert Metzger (ONF) provided presentations on fish habitat management at ONP and ONF, respectively. Gordon Reeves (PNW) also gave a presentation on the potential utility of the NetMap tool (Benda et al. 2009; <http://www.netmaptools.org>) in adapting fish habitat management to climate change. A facilitated discussion on adaptation options for fisheries and fish habitat management with climate change followed. A description of potential adaptation strategies and action items appears in the section below, with a summary in table 5.2. See box 5.1 for a general summary of projected climate change effects on fish on the peninsula and related adaptation strategies for fish habitat management at ONF and ONP.

Adaptation Strategies and Actions for Hatcheries and Harvest

Olympic National Park has exclusive federal jurisdiction with the authority to determine regulations for sport fishing

and recreational shellfish harvest in the park, and thus can consider resilience to climate change among other factors used to set regulations. For example, it is anticipated that Sol Duc summer coho will be affected by climate change. Although the summer coho in the Sol Duc River is not a federally listed population, the population is known by the park to be depressed. Current park regulations for the Sol Duc River allow for a catch-and-release fishery from June 1 to October 31, with a minor area closure associated with a summer coho prespawning staging area below the Salmon Cascades. However, minor but measurable mortality occurs with all catch-and-release fisheries. Therefore, in the face of climate change, it may be appropriate for the park to consider a complete closure of fisheries in the Sol Duc River when summer coho are present to eliminate all harvest mortality and thus help the population remain viable.

As warranted by climate change and associated stressors, the park will foster fish population protection through recreational harvest management, considering potential area or time closures for fish or shellfish as necessary, and protecting any identified cold water refugia (using stream temperature information or modeling tools such as NetMap; Benda et al. 2009; <http://www.netmaptools.org>; and G. Reeves²). Biologists will consider fish life history in determining when and where these management actions would be most effective. As it does currently, the setting of fishing regulations within the park in the future will occur in consultation with the state of Washington and the affected Olympic Peninsula tribes to ensure that the park's regulations are consistent with, or not in opposition to, fishing regulations set by the state or federal government.

Besides the authority to manage recreational fisheries within the park's boundaries, there is also National Park Service guidance (NPS 2006) for the use of hatcheries within the park. National Park Service 2006 Management Policies require that, whenever possible, native plants and animals should be relied upon to maintain their own populations, although management intervention is allowed to protect rare, threatened, or endangered species. In these

² Reeves, G. 2009. Personal communication. Research fisheries biologist. USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331.

Table 5.2—Current and expected sensitivities of fish to climate change on the Olympic Peninsula, associated adaptation strategies and actions for fisheries and fish habitat management at Olympic National Forest (ONF) and Olympic National Park (ONP)^a

Current and expected sensitivities	Adaptation strategies and actions
Novel ecosystem response to shifting climate and hydrology	• Shift to a new paradigm in fish habitat management that recognizes that pre-existing channel conditions may no longer be an accurate representation of the potential state. • Incorporate climate change into the ONF Strategic Plan.
Changes in fish distribution, population size, and viability	• Implement strategic monitoring; build from existing monitoring programs.
Changes in timing of fish life history events	• Use tools such as NetMap to identify areas most likely to exhibit a climate change signal. • Monitor restoration projects to determine strengths and weaknesses of existing projects, and improve design of future restoration projects. • Look for early indications of change to determine how quickly some of the climate-related changes are occurring, and use that information to adjust management priorities.
Changes in habitat quantity and quality	• Implement habitat restoration projects that focus on re-creating watershed processes and functions and that create diverse, resilient habitat.
Increase in culvert failures, fill-slope failures, stream adjacent road failures, and encroachment from stream-adjacent road segments	• Decommission unneeded roads. • Remove sidecast, improve drainage, and increase culvert sizing on remaining roads. • Relocate stream-adjacent roads.
Greater difficulty disconnecting roads from stream channels	• Design more resilient stream crossing structures.
Major changes in quantity and timing of streamflow in transitional watersheds	• Make road and culvert designs more conservative in transitional watersheds to accommodate expected changes.
Increased erosion and sediment delivery to channels.	• Consider adding large wood to small headwater channels to restore natural sediment routing (ONF lands). • Consider thinning in steep landslide-prone areas to accelerate development of large wood inputs to streams (ONF lands).
Increased thermal stress on cold-water-adapted fish species Decreased fish numbers owing to reductions in suitable habitat and productivity	• Limit mortality associated with recreational fishing through time and area closures as necessary.
Increased risk of disease introduction from hatchery fish Increased disease virulence with warmer stream temperatures	• Encourage implementation of Hatchery Scientific Review Group recommendations for hatchery reforms. • Follow 2006 National Park Service policies regarding the planting of hatchery fish within parks. • Control spread of exotic species.

Table 5.2—Current and expected sensitivities of fish to climate change on the Olympic Peninsula, associated adaptation strategies and actions for fisheries and fish habitat management at Olympic National Forest (ONF) and Olympic National Park (ONP)^a (continued)

Current and expected sensitivities	Adaptation strategies and actions
Decline in native fish populations owing to increased competition from exotic species Increased spread of aquatic invasive species	• Monitor to detect increases in invasive populations; initiate control measures aggressively. • Educate the public about measures to prevent the spread of invasive species. • Focus habitat protection and restoration efforts on existing wild fish strongholds and streams that are less influenced by hatcheries.
Loss of cold water refugia for cold-water-adapted fish species	• Identify and protect cold water refugia.
Decrease in area of headwater streams.	• Continue to correct culvert fish passage barriers. • Consider re-prioritizing culvert fish barrier correction projects.
Decrease in habitat quantity and connectivity for species that use headwater streams.	• Restore habitat in degraded headwater streams that are expected to retain adequate summer streamflow (ONF).
Increased sensitivity for species that spawn in late summer (e.g., summer chum, summer coho, spring chinook)	• Limit mortality associated with recreational fishing through time and area closures as necessary.

^a Sensitivities are based on projected climate change effects on the Olympic Peninsula, including increased winter precipitation and runoff, more precipitation falling as rain rather than snow, increased storm intensity, greater winter and spring streamflows in some types of watersheds, increased flood frequency and magnitude in some types of watersheds, elevation shifts in transition (rain-on-snow) zones, reduced summer streamflows, and increased stream temperatures.

cases, animals (including fish) can be subjected to a captive breeding program (hatchery) to maintain or increase their abundance. However, the park must follow all planning procedures and provide for public comment and review before initiating such a program. In the future, this review will include an analysis of the appropriateness of management intervention in the face of climate change.

Olympic National Forest does not have jurisdiction over fishing regulations, seasons, or closures on national forest lands, nor do they control hatchery supplementation in streams and rivers that flow through the national forest. Authority for these activities resides solely with the state of Washington and the Olympic Peninsula tribes as co-managers. As in the past, ONF will continue to work with the state of Washington and the tribes to help identify and promote regulations needed to limit harvest mortality on high-priority species in key areas. The ONF will also continue to work with the co-managers and the National Marine Fisheries Service to help evaluate and implement

hatchery supplementation programs, where necessary, to maintain viable populations of high-priority fish species on ONF lands.

Both the forest and park can continue to encourage the state, tribes, and U.S. Fish and Wildlife Service to implement the Hatchery Scientific Review Group recommendations (HSRG 2004) for hatchery reforms on the peninsula. The intent of these science-based recommendations is to redesign hatchery programs to help conserve wild salmon and steelhead populations and support sustainable fisheries. Implementation of these reforms will likely help salmon on the Olympic Peninsula remain viable in the face of climate change.

Adaptation Strategies and Actions for Fish Habitat Management

The goal of fish habitat management on ONF and ONP is to maintain or restore diverse, resilient habitat capable of supporting native fish populations over the long term.

Box 5.1—Summary of projected climate change effects on fish on the Olympic Peninsula and related adaptation strategies for fish habitat management at Olympic National Forest and Olympic National Park.

- Projected increases in winter peak flows, increases in summer stream temperatures, and lower summer streamflows suggest there will be declines in freshwater habitat quality and quantity for salmon, steelhead, bull trout, and resident fish on the Olympic Peninsula.
- Climate-induced warming in winter and spring could lead to earlier and perhaps longer growing seasons, increased aquatic food web productivity, and more rapid juvenile salmon growth and development rates that benefit parts of the freshwater life cycle of the Olympic Peninsula's salmon and steelhead.
- Climate plays a crucial role in aquatic ecology, but the relative importance of climatic factors is quite different for different species, and even different populations of the same species. For example, those stocks that typically spend extended rearing periods in freshwater are likely to have a greater sensitivity to freshwater habitat changes than those that migrate to sea at an earlier age. Effects of climate change will also differ within and across watersheds.
- In the face of climate change, it may be appropriate for the park to consider a complete closure of fisheries in some locations when vulnerable fish populations are present to eliminate harvest mortality and thus help the population to remain viable.
- Increased restoration efforts, focused on maintaining, reconnecting, and reestablishing ecosystem processes and functions, and proactive management in priority areas will likely increase ecosystem resilience to climate change at Olympic National Forest and Olympic National Park.
- On the Olympic National Forest, maintaining and restoring connectivity and fish passage in headwater areas that are likely to go dry, and restoring damaged habitat in headwater streams that are expected to retain adequate stream flows will help maintain viable resident fish populations in as many areas as possible.
- The park and forest will control, to the extent possible, exotic aquatic species, invasive riparian plants, and fish diseases.
- Protection of cold-water refugia will be critical for many species as summer water temperatures increase. Streams with cold-water refugia could be prioritized over streams that are currently warm or are likely to become too warm with changing climate.
- Monitoring will also be critical to document current status and detect changes that are occurring with warming temperatures, and thus, implementation of strategic monitoring will be important for the forest and park in adapting fish habitat management to climate change. Existing monitoring programs can be used as a base to develop more extensive programs.

Recent habitat restoration efforts have typically attempted to maintain or re-create key watershed processes and functions, assuming that doing so would eventually re-create the historical river morphology and habitat conditions. Current restoration efforts are generally consistent with actions that will lead to increased ecosystem resilience under changing climate. However, increased restoration efforts and proactive management in priority areas will likely increase ecosystem resilience to climate change. Further effort will be required to reevaluate priorities in light of climate change.

Preexisting channel conditions and locations may no longer be an accurate representation of the potential future state of fish habitat. To increase ecosystem resilience to

climate change, ONF and ONP will emphasize maintaining and reestablishing ecosystem processes and functions, considering how past and current management practices contribute to current and future habitat conditions. Olympic National Forest and ONP will also consider how the magnitude of potential changes in climate and streamflow regimes will differ both between and within watersheds and assess how anticipated changes in climate will alter future stream characteristics. For example, increased frequency and magnitude of high-intensity rainfall events will likely increase the number of landslides and debris torrents, thus increasing sediment loading and subsequent stream aggradation.

Numerous management actions can be taken to reduce the incidence of human-induced landslides, such as decom-

missioning unstable roads, removing sidecast material, and increasing the size and number of culverts to reduce the potential for plugging or flow diversion. At ONF, erosion on hill slopes and in steep headwater stream areas once intensively managed for timber production could potentially be reduced by adding large wood to channels to reestablish the sediment storage and routing function that large wood provides in streams. In addition, if trees are left along debris flow channels, they will cause the debris flow to behave differently and have much different effects on the channel. However, because an increased rain:snow ratio will likely amplify both natural and human-induced landslides, and associated higher runoff will alter the stream channel morphology, management actions are unlikely to fully offset climate change effects on erosion and stream morphology.

Consideration of synergisms among changing processes with climate change will also be important. For example, summer flows are anticipated to decrease, but increased porous sediment deposition associated with winter flooding may exacerbate low summer surface flows. Understanding and preparing for these potential synergisms will be important in adapting to changing conditions associated with climate change.

Roads and associated channel crossings are a major issue for fish habitat quality. Many adaptation actions for road management discussed in chapter 4 are also relevant to adaptation in fish habitat management. For example, roads adjacent to streams or the marine environment are particularly susceptible to flood and storm damage and are more likely to alter natural ecosystem function through restrictions in channel meanders, acceleration of flow velocity, and alteration of large wood recruitment. Thus, whenever possible, managers will consider moving roads out of flood plains (ONF and ONP) and marine coastal zones (ONP). Similarly, undersized channel crossings (either bridges or culverts) affect the natural function of stream channels through increased channel velocity and associated channel degradation, disruption of downstream transport of sediment and large wood, and increased potential for plugging and initiating landslides or debris torrents. Therefore, to the extent practicable, ONF and ONP will attempt to construct any new stream crossings with structures sized to meet the

needs for natural channel function under flows anticipated with climate change. This may require larger structures than have been used in the past. Olympic National Forest and ONP will continue to remove or replace existing undersized stream crossings with appropriately-sized structures as opportunities arise and funding is available (see chapter 4 for further detail).

Reduced summer streamflows in headwater tributaries will likely reduce the amount of resident fish habitat available in many upper stream reaches during dry periods. The magnitude of stream habitat reductions will differ from watershed to watershed. Intermittent streamflows may increase the importance of providing barrier-free migration corridors in the upper watersheds so that resident fish can reoccupy intermittent stream reaches when flow returns. The ONF currently prioritizes resident fish culvert barrier correction projects based on the total amount of habitat that would be reconnected. Culvert barrier corrections tend to focus on the larger, longer streams first and then up into the headwaters. The ONF will continue to correct culvert fish passage barriers as funds are available. Considering potential streamflow reductions in small high-gradient resident fish streams associated with climate change, ONF may need to reconsider how to prioritize removal of culvert barriers to facilitate passage of resident fish.

Increased cooperation and strong partnerships can help natural resource agencies and other groups address ecosystem stressors and climate change more effectively through a shared vision and pooling of resources. Olympic National Forest and ONP will increase communication and coordination on fisheries research, habitat restoration, and monitoring between the park and forest. They will also work to increase communication with neighboring tribes, the state of Washington, other government entities, and local watershed groups on restoration priorities and climate change issues, seeking opportunities to collaborate with other landowners and managers in priority watersheds.

Reduced summer streamflows will create challenges in meeting adequate instream flows for fish in some watersheds. The city of Port Townsend has already experienced problems in meeting their required instream flows for summer chum as specified in the Biological Opinion for

their special use permit. The forest will work with the city to encourage them to adopt adequate water conservation measures and increase efficiency of their delivery systems so that the Big Quilcene River water levels do not fall below specified levels. The ONF could also review existing water withdrawal permits and review how users are withdrawing water from the streams across the forest to provide an early warning for fish habitat issues as summer streamflows decline.

Owing to resource limitations and differences in anticipated climate change effects between watersheds, a strategic focus of efforts and use of resources is essential to most effectively deal with fish habitat issues related to climate change. The ONF and ONP identified some general priority actions for adaptation, as well as some preliminary priorities for species protection, habitat protection, and monitoring. One general priority for ONF and ONP is to control, to the extent possible, exotic aquatic species, invasive riparian plants, and fish diseases. Many exotic fish species introduced to the Pacific Northwest are well-suited to warmer water temperatures (e.g., American shad, bass, perch, channel catfish, etc.). American shad is an Atlantic Ocean species that prefers slightly warmer waters than salmon. Populations of American shad in the Columbia River have increased substantially in the last several decades and are likely competing with native fishes for habitat and food resources during the summer and fall (Petersen et al. 2003). Invasive New Zealand mud snails and zebra mussels occur in other parts of Washington. Several knotweed species (especially Japanese knotweed) currently thrive in some watersheds on the peninsula. Detecting the presence of, or increases in, invasive species populations requires monitoring and prompt action to effectively control or eliminate them. Preventing the spread of exotic fish and shellfish and keeping stream temperatures as low as possible through shading will help to keep the potential spread of fish disease to a minimum, because exotic species may spread diseases to native fish and diseases become more virulent with increasing stream temperatures. Ensuring that stocked fish meet health guidelines will also help to control disease spread. Finally, educating the public about invasive

species and disease will further minimize the spread of those factors.

Olympic National Forest will explore ways to incorporate climate change in the Forest Strategic Plan. The Forest Strategic Plan identifies focus areas for restoration and areas where projects, such as commercial thinning, may achieve multiple objectives. In prioritizing thinning activities, increased attention could be given to the positive impacts that thinning activities can have on riparian and aquatic habitat quality. For example, thinning in high-risk landslide-prone areas may help to accelerate the establishment of large trees that provide wood to streams.

Several fish species, including spring chinook salmon, Ozette Lake sockeye salmon, resident trout, bull trout, Olympic mudminnow, summer coho salmon, and summer chum salmon, are proposed as potential priorities for protection because of their sensitivity to changes in stream temperature and hydrology expected with climate change. Climate change effects will differ between watersheds, and a variety of habitat types and locations will be particularly sensitive. These areas can be prioritized for restoration and protection. For example, transitional watersheds (which receive some precipitation as rain and some precipitation as snow) are likely to have the greatest increases in winter streamflow with climate change. Thus, road and culvert designs on both ONF and ONP could be modified to accommodate expected changes in transitional watersheds. Extent of headwater streams will likely be reduced with climate change-related changes in hydrology. On ONF, maintaining and restoring connectivity and fish passage in headwater areas that are likely to go dry, and restoring damaged habitat in headwater streams that are expected to retain adequate streamflows, will help maintain viable resident fish populations in as many areas as possible. Protection of cold water refugia will be critical for many species as summer water temperatures increase. Streams with cold water refugia could be prioritized over streams that are currently warm and are likely to become too warm with changing climate. Wild fish strongholds, such as the Sol Duc, Calawah, and Hoh River watersheds, and streams that are less influenced by hatcheries could be prioritized over other watersheds for a wide range of actions to help ensure

continued viability of wild fish populations in the face of climate change.

Monitoring will be critical to document current status and detect changes that are occurring with warming temperatures, and thus, implementation of strategic monitoring will be important for ONF and ONP in adapting to climate change. Olympic National Park has a long-term ecological monitoring program that can be used as a foundation for a more extensive monitoring program designed to interpret effects of climate change on fish populations in both fresh and salt water areas of the Olympic Peninsula. Tools such as NetMap (Benda et al. 2009; <http://www.netmaptools.org>) can also be used to identify areas that are most likely to exhibit a climate change signal. Finally, monitoring of restoration projects (e.g., culvert fish passage corrections, road decommissioning, engineered logjams, and the Elwha dam removal) will continue to be key in determining strengths and weaknesses of existing projects, and improving design of future restoration projects.

Priorities for monitoring at ONF and ONP include effects of changing climate on fish life history (e.g., emergence timing, and fitness of juvenile fish over the course of a growing season), which will be important in determining how climate change is influencing fish on the peninsula. Collection of otoliths could help identify changes in life history patterns. Monitoring of habitat loss, particularly in headwaters and at higher elevations, will also help to determine what types and how fast habitat is being lost so that management activities can be tailored accordingly.

Challenges and Future Directions in Adaptation in Fish and Fish Habitat Management

Clear actions can be taken by ONF and ONP to adapt to climate change. However, implementation of adaptation in fish and fish habitat management also faces some challenges. As noted in chapter 4, the predominant Emergency Relief for Federally Owned Roads Program policy of replacing existing infrastructure with the same infrastructure after a failure makes it difficult for ONF and ONP to improve infrastructure to meet current standards and accommodate effects of climate change. Similarly, restrictions on activities in wilderness areas sometimes prevent

both agencies from being able to move high-risk roads out of flood plains without Congressional action. Both ONF and ONP have limited funding for activities that would contribute to adaptation. Other state and federal policies may become limiting in the future. For example, the state of Washington has historically overallocated water, although the full allocated rights have not yet been used. New water rights may be allocated based on existing summer flows and channel conditions, which are likely to change in the future. At the federal level, there is no clear pathway to bring climate change information into Endangered Species Act [ESA 1973] consultations, National Environmental Policy Act (1969) analyses, or Clean Water Act (1977) degraded waterbody designations. Olympic National Forest and ONP will communicate these challenges to state and federal decisionmakers and seek solutions that will help overcome these challenges and facilitate climate change adaptation.

Olympic National Forest and ONP may also need to initiate research and explore new types of actions to adapt fisheries and fish habitat management to climate change. For example, more information will be needed on how the effects of climate change differ across the landscape, and an understanding of this variation will be a key factor in the development and implementation of new adaptive actions. It is possible that forest structure and composition could be managed to reduce evapotranspiration and maximize water retention and summer base flow. Stand structure could be manipulated to retain snow, and it is possible that forest structural conditions could be managed to promote increased fog drip. Determining whether these and other potential actions could help ONF and ONP adapt to climate change will require experimentation, monitoring, and feedback to management.

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Chapter 6: Climate Change and Vegetation Management at Olympic National Forest and Olympic National Park

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Vegetation on the Olympic Peninsula

The Olympic Peninsula has steep and dissected topography, which results in temperature and precipitation gradients and varied climatic environments (Peterson et al. 1997). The western, coastal side of the peninsula is characterized by a wet and humid maritime climate. Higher elevations on the western side of the peninsula receive as much as 5 m of precipitation per year (Henderson et al. 1989). The northeastern portion of the peninsula, in contrast, is characterized by a drier, more continental climate owing to the rain-shadow effect of the Olympic Mountains (and prevailing winds from the southwest during the winter), and rainfall in this area is as low as 0.5 m per year at lower elevations (Henderson et al. 1989). Most precipitation falls between October and March, resulting in low summer soil moisture, particularly in the northeastern portion of the peninsula.

Dominant forest species differ with climatic conditions found on the peninsula (Buckingham et al. 1995) (fig. 6.1). Lower elevation forests on the western side of the peninsula are dominated by Sitka spruce, with western hemlock and western redcedar as common associates (Sitka spruce zone in fig. 6.1) (See a "Common and Scientific Names"). Red alder and bigleaf maple are also abundant in some locations. At lower to middle elevations, western hemlock and Douglas-fir are the dominant overstory species (western hemlock zone in fig. 6.1). Pacific silver fir dominates mid to upper slope forests, except in very dry locations, sometimes sharing dominance with Douglas-fir and western hemlock (Pacific silver fir zone in fig. 6.1). Mountain hemlock is dominant at higher elevations (mountain hemlock zone in fig. 6.1) in all but the driest locations, where subalpine fir is

dominant (subalpine fir zone in fig. 6.1) (Henderson et al. 1989).

In the northeastern portion of the peninsula, distributions with elevation differ. Lower elevation forests are dominated by western hemlock and Douglas-fir (western hemlock zone in fig. 6.1). Grand fir, western redcedar, and Pacific silver fir share dominance with Douglas-fir and western hemlock at many mid-elevation sites on the east side of the peninsula (western hemlock and Pacific silver fir zones in fig. 6.1), but Douglas-fir is dominant on south-facing slopes in dry areas (Douglas-fir zone in fig. 6.1). Subalpine fir is a major overstory species at higher elevations, with lodgepole pine dominant in some areas (subalpine fir zone in fig. 6.1). Mountain hemlock and subalpine fir give way to subalpine meadows at the highest elevations (parkland mountain hemlock zone in fig. 6.1).

Potential Climate Change Effects on Vegetation on the Olympic Peninsula

Climate, in concert with landscape and local-scale variables, dictates vegetation distribution across landscapes by placing both thermal and water constraints on plant regeneration, establishment, and growth. Past species response to changing climate observed in the paleoecological (pollen and fossil) record shows that the abundance and distribution of plant species shift individually in response to climate fluctuations (Davis and Shaw 2001, Delcourt and Delcourt 1991, Whitlock 1992); different species respond in varied ways to changing climate, leading to new species assemblages and communities. Increasing temperatures associated with climate change, and corresponding increases in summer drought stress and fire frequency in

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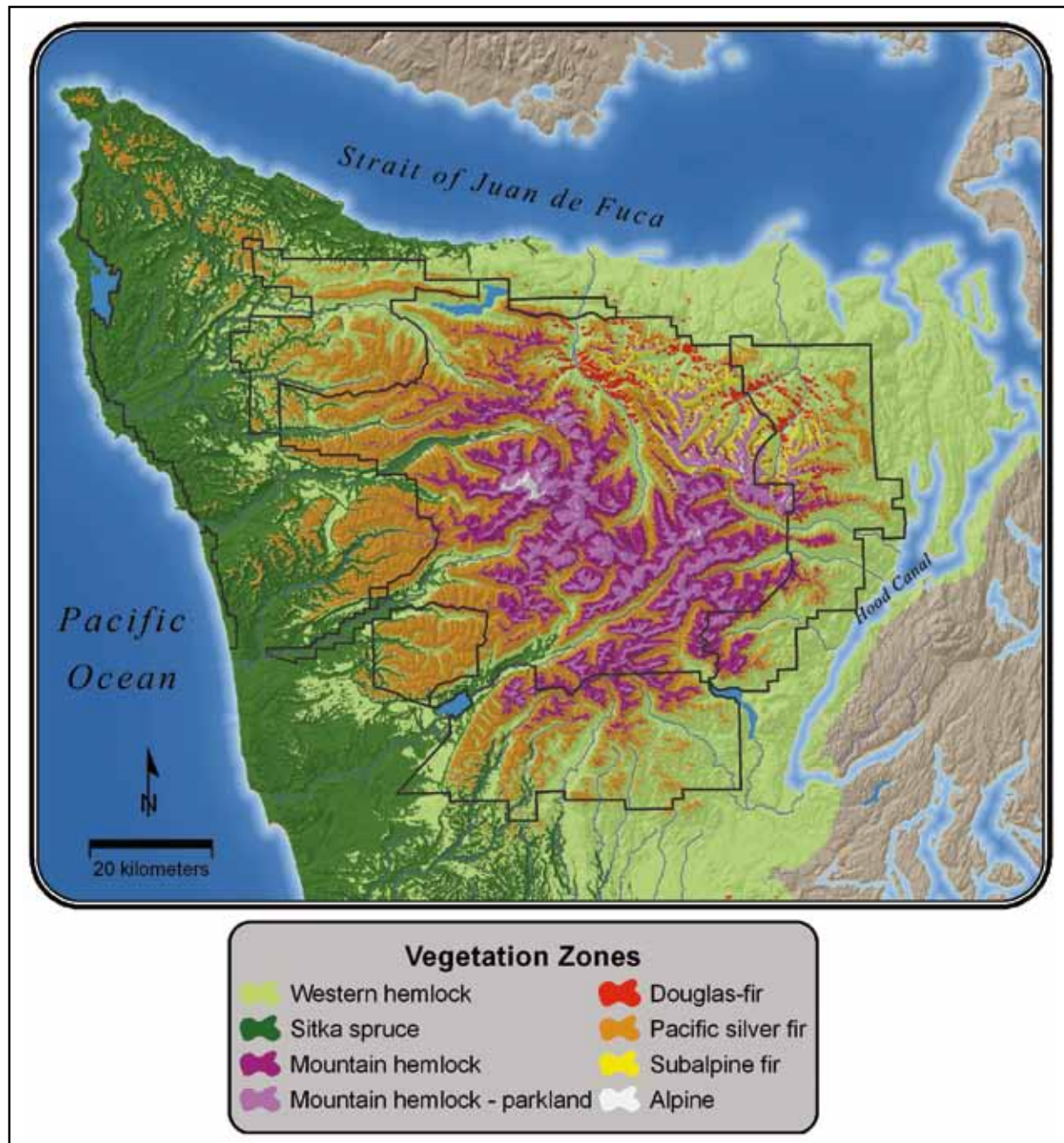


Figure 6.1—Vegetation zones (based on climate zones and potential climax or dominant species within climate zones) on the Olympic Peninsula.

the Pacific Northwest, will probably lead to changing species distribution in the region, resulting in forest types different from those we see today (Zolbrod and Peterson 1999). There are several information sources useful for predicting potential climate change impacts on vegetation and future forest composition and structure, including

long-term paleoecological records, modern tree ring records of tree growth and establishment, current trends with recent warming, and model predictions for the future. The following section reviews these information sources for the Olympic Peninsula.

Paleoecological Records of Climate and Species Distribution

Paleoecological records from the Pacific Northwest and elsewhere show that during historical warm periods, many tree species moved poleward and upward in elevation. Poleward and upward shifts in elevation of species distributions involve changes in species abundance, rather than a species extirpation in areas where it was formerly dominant; shifting distributions represent leading edge dynamics rather than trailing edge contraction. For example, during a warmer period in the 19th century, western hemlock became dominant in areas where Pacific silver fir and mountain hemlock were dominant on Mount Rainier in the Washington Cascade Range (Dunwiddie 1986), suggesting that western hemlock will move up in elevation in a warmer climate (Zolbrod and Peterson 1999). Several studies have shown the range expansion of subalpine fir into alpine tundra at higher elevations in the northeastern portion of the Olympic Peninsula during historical warm periods (Brubaker and McLachlan 1996, Gavin et al. 2001, McLachlan and Brubaker 1995). The range expansion of subalpine fir around Moose Lake in the northeastern portion of the peninsula during a warm period around 11,000 BP was also associated with increased charcoal content in lake sediments, suggesting fire size and frequency increased near the lake (Gavin et al. 2001).

During the warm and dry Holocene period circa 10,000 to 6,000 BP, red alder, Douglas-fir, and lodgepole pine were abundant in forests of primarily western hemlock and spruce at lower elevations on the Olympic Peninsula (Henderson et al. 1989, Heusser 1977, Peterson et al. 1997, Whitlock 1992). The abundance of these species in the Pacific Northwest has been associated with higher fire frequency (Cwynar 1987, Prichard et al. 2009). A study in the nearby north Cascade Range also found increased abundance of lodgepole pine, in association with high fire frequency, circa 10,500–8,000 BP (Prichard et al. 2009). In addition, western white pine became locally important in the Pacific Northwest during this period (Cwynar 1987), and Oregon white oak, a species usually associated with drier climates, was very common during this period in the northeastern Olympics (Petersen et al. 1983, Peterson et

al. 1997). The range expansion of western redcedar, and further range expansion of western hemlock and Sitka spruce, occurred only after a period of lower temperatures and higher precipitation during the Holocene warm period, suggesting that the range of these species on the peninsula was limited by drought during that warm period (Whitlock 1992).

The paleoecological record from the Pacific Northwest shows that species with life history traits that allow survival during periods of frequent disturbance and in stressed environments have persisted during past periods of rapid climate change (Brubaker 1988, Whitlock 1992). For the Pacific Northwest, these species include red alder, Douglas-fir, and lodgepole pine, suggesting that these species will be successful in a rapidly warming climate (Whitlock 1992). Other examples of species that have persisted over millions of years of climatic change on the Olympic Peninsula include Oregon white oak, giant chinquapin, bigleaf maple, and Pacific madrone (Henderson et al. 1989).

Warmer and drier conditions at lower elevations on the Olympic Peninsula would likely result in expansion of the range of Douglas-fir and lodgepole pine. Other species that may expand their ranges under these conditions include western white pine, Oregon white oak, giant chinquapin, and Pacific madrone. Increased disturbance frequency may lead to the range expansion of red alder. The paleoecological record for the Pacific Northwest also suggests that many species, including western hemlock and subalpine fir, will become more abundant at higher elevations with warming on the peninsula.

Modern Records of Climate, Tree Growth, and Fire

Before climate-induced changes in species distribution become apparent, changes in patterns of species establishment, growth, and mortality occur that eventually lead to broader range shifts (Littell et al. 2008). Dendroecological (tree ring) records from the past several hundred years allow observation of changes in growth of tree species with climate variation. Tree ring records show that individual tree growth and net primary productivity are sensitive to annual changes in climate in the Pacific Northwest

(Brubaker 1980, Ettl and Peterson 1995, Graumlich et al. 1989, Hessler and Peterson 2004, Holman and Peterson 2006, Littell et al. 2008, Nakawatase and Peterson 2006, Peterson and Peterson 2001). Effects of future climate change on both tree growth and establishment will differ by species (owing to varied physiologies and allocation patterns) and with elevation and topography (Ettl and Peterson 1995, Holman and Peterson 2006).

At higher elevations on the Olympic Peninsula, tree growth and establishment are limited by snowpack amount and duration and associated growing-season length; greater snowpack amount and duration lead to a shorter growing season and decreased growth in high-elevation trees. For example, tree growth at the mid- and high-elevation subalpine fir-mountain hemlock and Pacific silver fir-western hemlock forests of the Hoh watershed on the western Olympic Peninsula is limited by snowpack and associated growing-season length (Holman and Peterson 2006, Nakawatase and Peterson 2006). Mountain hemlock growth in the Pacific Northwest is limited by spring snowpack depth and low summer temperatures (Peterson and Peterson 2001). Similarly, subalpine fir at high-elevation, wetter sites on the Olympic Peninsula grows more slowly during years with lower summer temperature (Ettl and Peterson 1995), and regionally, growth of subalpine fir in the wetter portions of its range is negatively correlated with winter precipitation and spring snowpack depth (Peterson et al. 2002). Increasing temperatures with climate change will lead to more precipitation falling as rain rather than snow, earlier snowmelt, and thus lower snowpacks and longer growing seasons on the peninsula (Elsner et al. 2010). Longer growing seasons on the peninsula will alleviate growth-limiting factors and likely result in increased growth and productivity in high-elevation forests. Longer growing seasons will likely also lead to higher tree establishment at higher elevations.

In the dry northeastern Olympics, tree growth and establishment are limited by low summer soil moisture. For example, tree growth in the Dungeness watershed in the northeastern portion of the Olympic Peninsula has been shown to be limited by summer soil moisture, although less so at higher elevations (Nakawatase and Peterson 2006). Douglas-fir, although more drought tolerant than other

major Olympic Peninsula tree species such as western hemlock, is limited by water supply at lower elevations in the Pacific Northwest (Littell et al. 2008).

Increasing temperatures, lower winter snowpack, and early snowmelt with climate change will likely result in decreased soil moisture in parts of the Pacific Northwest, including many areas west of the Cascade Range in Washington state (Elsner et al. 2010). For the state of Washington, soil moisture content on July 1st is projected to decrease through the 21st century; for mean historical values (from the 1915 to 2006 period), July 1st soil moisture content is defined as 50 percent and is projected to be in the 38th to 43rd percentile by the 2020s, 35th to 40th percentile by the 2040s, and 32nd to 35th percentile by the 2080s (Elsner et al. 2010) (fig. 6.2). These decreases in summer soil moisture will likely lead to increased stress to tree species in some portions of the Pacific Northwest.

Increased drought stress will likely result in decreased tree growth and forest productivity in the northeastern forests of the Olympic Peninsula. In the Sitka spruce forests on the west side of the peninsula, carbon dioxide fertilization could lead to increases in productivity (Norby et al. 2005), if other factors, such as nutrient availability, do not limit growth. However, growth may also decrease in these Sitka spruce forests if summer soil moisture becomes sufficiently limiting with warming (Holman and Peterson 2006, Nakawatase and Peterson 2006).

Tree ring and modern fire records both show that years with widespread fire and fire extent are associated with warmer and drier spring and summer conditions in the Western United States (Heyerdahl et al. 2008, Littell et al. 2009, McKenzie et al. 2004, Taylor et al. 2008, Westerling et al. 2006). Warmer spring and summer conditions in the Western United States lead to relatively early snowmelt, and lower summer soil and fuel moisture, and thus longer fire seasons (Westerling et al. 2006). Wildfire area burned in mountainous areas in the Western United States was positively related to low precipitation, drought, and high temperatures in the 20th century (Littell et al. 2009). Increased temperatures and drought occurrence in the Pacific Northwest from climate change will likely lead to increased fire frequency and extent. In addition, the intensity and severity

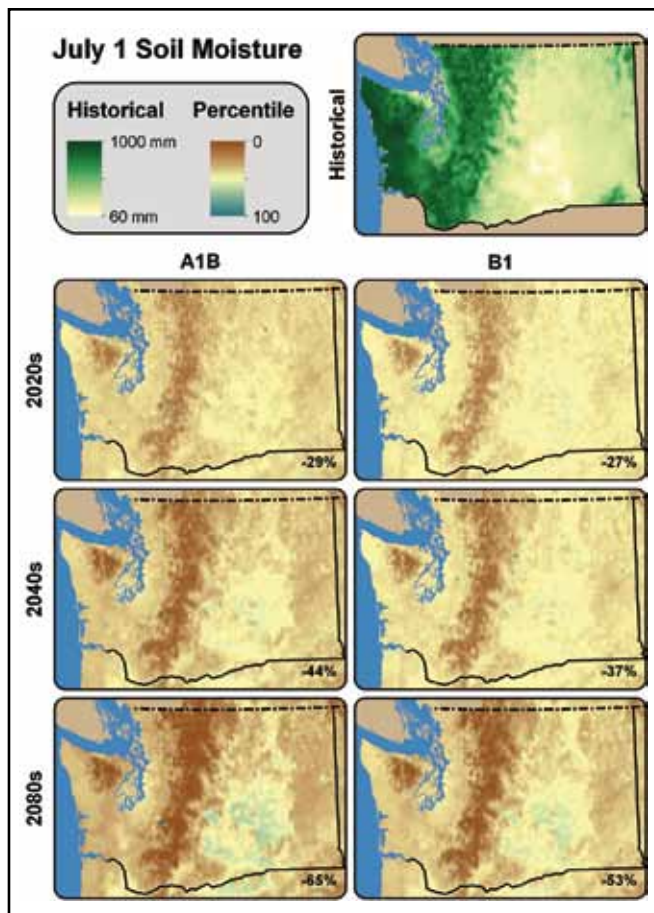


Figure 6.2—Summary of projected July 1 soil moisture (volumetric soil water content) for the 2020s, 2040s, and 2080s (A1B and B1 Intergovernmental Panel on Climate Change emissions scenarios) as a percentile of simulated historical mean from 1916 to 2006 (by using the Variable Infiltration Capacity model). For future projections, percentiles less than 50 (browns) represent a decrease in soil moisture, and percentiles greater than 50 (blues) show an increase in soil moisture. Percentage change values represent spatially averaged July 1 soil moisture across Washington state. (Adapted from Elsner et al. 2010.)

of fires may increase in some areas if higher temperatures exacerbate low moisture content in fine fuels.

Climate and fire on the Olympic Peninsula have been closely related in the past (Henderson et al. 1989). Warmer and drier periods of the past were likely characterized by increased fire frequency, particularly on the east side of the Olympic Peninsula (Gavin et al. 2001, Henderson et al. 1989). Historical fires have been most frequent in the drier western hemlock, subalpine fir, and Douglas-fir vegetation

types in the eastern half of the Olympic Peninsula (Henderson et al. 1989, Pickford et al. 1980). Henderson et al. (1989) calculated the average fire-return period for the last 800 years in these vegetation types on the peninsula and found that the Douglas-fir zone had a fire-return period of 138 years, the subalpine fir zone had a fire-return period of 208 years, and the western hemlock zone had a fire-return period of 234 years. Decreases in fire-return intervals in these forest types would likely favor tree species that can survive fires or regenerate after fires, such as Douglas-fir and lodgepole pine, at the expense of less fire-tolerant species, such as western hemlock. Individual trees can withstand climatic variation, but disturbance events that result in mortality of mature trees could trigger changes in distribution and abundance of forest species on the peninsula.

Trends With Recent Warming

Plant and animal species in different ecosystems across the world have begun to respond to recent warming over the last few decades (Parmesan 2006, Parmesan and Yohe 2003, Root et al. 2003). Most plant responses to recent warming have involved alteration of species' phenologies, or timing of life history stages (Bradley et al. 1999, Menzel 2000, Menzel et al. 2001, Parmesan 2006). Advances in timing of flowering, for example, have been reported for plant species in Great Britain (Fitter and Fitter 2002), and evidence exists that the growing season has lengthened in the Northern Hemisphere in the last 50 years (Menzel and Fabian 1999, Parmesan 2006). Shifts in timing of flowering and the abundance of insect pollinators could lead to the decline of some plant species if pollinators are absent during times of peak flowering.

Shifts in species' distribution with warming in recent decades have been documented at several locations, including mountain ranges in western Europe (Grabherr et al. 1994, Lenoir et al. 2008) and southern California (Kelly and Goulden 2008). Consistent with paleoecological records, these shifts have generally involved movement upward in elevation or poleward (Parmesan 2006). Upward movement of tree lines has been documented in numerous mountainous locations across the world, including locations in Canada (Lescop-Sinclair and Payette 1995, Luckman

and Kavanagh 2000), Sweden (Kullman 2001), Bulgaria (Meshinev et al. 2000), Russia (Moiseev and Shiyatov 2003), and New Zealand (Wardle and Coleman 1992). However, tree-line dynamics are complex and dependent on precipitation and microsite patterns in addition to temperature (Malanson et al. 2007, Parmesan 2006). A meta-analysis of response of tree lines at 166 sites (from around the world, but mostly in North America and Europe) to recent warming found that tree lines at sites with more winter warming were more likely to have advanced than tree lines at sites with less warming. In addition, tree lines with a diffuse form, characterized by decreasing tree density with increasing altitude or latitude, were more likely to have advanced than those with an abrupt form, characterized by a continuous canopy with no decline in density right up to tree line (Harsch et al. 2009). It is possible that diffuse tree lines are more responsive to warming because tree growth, but not survival, is limited by climatic factors. In contrast, winter stress factors that cause plant damage and limit survival may have a stronger influence on abrupt tree lines (Harsch et al. 2009).

The frequency of some drought-related disturbance events has increased with recent warming. Tree mortality events in the Southwestern United States have been attributed to late 20th-century warming and related drought (Breshears et al. 2005, 2009). Increased temperatures have led to drier fuel levels, longer fire seasons, and an increase in years with widespread fire across the Western United States (Littell et al. 2010, Westerling et al. 2006).

Insect outbreaks, such as that of the mountain pine beetle, have been recorded across a broad spectrum of latitude and temperature regimes in the past in western North America. However, the severity and distribution of some recent outbreaks differ from what can be inferred from historical records, and higher temperature associated with climate change is believed to be a significant factor in these differences (Aukema et al. 2008, Carroll et al. 2004, Logan and Powell 2001). For example, the expansive mountain pine beetle outbreak in British Columbia has expanded into northern areas and into areas east of the Rocky Mountains in Alberta, where mountain pine beetles were not successful in the past because of cold winter temperatures (Carroll

et al. 2004). Current conditions on the Olympic Peninsula do not preclude mountain pine beetles from infesting and killing hosts, and the suitability for mountain pine beetle outbreaks at higher elevations in the Olympics is expected to increase under moderate warming (Littell et al. 2010). Besides the effects of changing climate on insect reproductive cycles, timing and severity of outbreaks will depend on availability of susceptible ages and sizes of lodgepole pine, western white pine, and whitebark pine and the stand conditions within which they reside.

The exotic balsam woolly adelgid can infest both Pacific silver fir and subalpine fir on the Olympic Peninsula. This insect generally does not kill trees quickly, but will result in the slow demise of infested trees. Mitchell and Buffam (2001) observed that 3 to 4 years of warmer than average summers resulted in increased adelgid damage in subalpine fir at higher elevations in Oregon and Washington. They stated that, “If there was a permanent or long-term (decades) increase in summer temperatures, it is likely we would see an expanded range for the balsam woolly adelgid within the subalpine fir ecotypes—upward in elevation and to other new environments.” This suggests that, with warmer temperatures, balsam woolly adelgid will have greater effect on subalpine fir than is now being experienced on the Olympic Peninsula.

Besides the increased fire risk in drought-stressed forests, increased moisture stress may leave forests in the Western United States more susceptible to insect attack (Allen and Breshears 1998, Breshears et al. 2005, Hicke et al. 2006, Shaw et al. 2005). As temperature increases, any increase in moisture stress will increase the susceptibility of Douglas-fir on the peninsula to attack by Douglas-fir beetle. On the Olympic Peninsula, Douglas-fir beetle outbreaks are generated by wind events, which result in significant amounts of blowdown. Beetle populations build up in the downed trees, and then can attack and kill standing green Douglas-firs. These outbreaks will subside within 3 years if no subsequent blowdowns occur, and the numbers of standing trees that are killed will depend on the relative moisture stress of these trees. Historically, after blowdowns, mortality has been higher in the drier, eastern habitats of the peninsula than in the wetter, western habitats. Any

changes in moisture regimes would affect the distribution of Douglas-fir beetle-caused mortality from a wind event on the peninsula. Recently burned forests may also lead to increases in Douglas-fir beetle populations, and subsequent mortality of additional green trees. In turn, these insect outbreaks can alter fuel and forest stand conditions which, at certain points after infestation, could result in increased risk of high-severity fire (Jenkins et al. 2008). All of these disturbances may increase opportunities for establishment by exotic species (Joyce et al. 2008). In this way, disturbances could act synergistically to drive ecosystem change on the Olympic Peninsula (McKenzie et al. 2009).

Tree disease could also potentially increase with warming on the peninsula. The effects of climate change on host physiology, adaptation or maladaptation, and popula-

tion genetics that affect host-pathogen interactions is uncertain (Kliejunas et al. 2009). However, based on existing knowledge of tree disease in western North America, it can be inferred that climate change will result in reductions in tree health and advantageous conditions for some pathogens (Kliejunas et al. 2009). Any drought stress that is realized owing to changing conditions will exacerbate the impacts of many pathogens (Kliejunas et al. 2009).

Model Predictions for Future Vegetation Patterns With Climate Change

Along with past records, models can be used to project future ecosystem response to changing climate. Output from three different types of climate change impact models—gap, climate envelope, and mechanistic dynamic

Box 6.1—Model types that assess potential effects of climate change on vegetation. Adapted from Robinson et al. (2008)

Gap models

- Gap models simulate forest interactions and dynamics on a small, gap-sized patch of land (usually 0.01 ha and larger).
- The geographic extent of analysis ranges from forest stands to regions.
- Ingrowth, growth, and death of individuals of one or more species on the patch are simulated over time.
- Dynamics in gap models are based on species-specific parameters, competition (e.g., relative height), light, temperature, and soil moisture.
- Output includes density, basal area, biomass, and leaf area index by species and by stand. Information on each live tree is also available (e.g., species and diameter).
- Gap models use monthly temperature and precipitation, and so can respond to novel climate.
- Some gap models have recently been adapted to be sensitive to changes in soil moisture and carbon dioxide concentrations.

Climate envelope models

- Climate envelope models (CEMs) are statistical models that predict future species distribution based on the relationship between current species distribution and climate variables (and sometimes other variables).
- CEMs use basic climate information as input.
- The geographic extent of analysis is variable, but regional analyses are typical. Modeling unit differs with input information.

- CEMs represent a snapshot in time and do not show variability in species distribution over time.
- These models assume that climate is the primary determinant of a species distribution and that the current relationship between a species and climate will hold under changing climate.
- CEMs do not account for competition, dispersal, or evolutionary change in vegetation communities.
- CEMs do not account for increases in carbon dioxide (CO₂) and changes in disturbance regimes.

Dynamic global vegetation models

- Dynamic global vegetation models (DGVMs) simulate key physiological processes in plant communities to infer vegetation type over time.
- DGVMs use soil and climatic information (hourly to yearly).
- DGVMs can respond to novel climate and are sensitive to changes in CO₂ and fire regimes.
- The geographic extent of analysis ranges from landscape to global, with modeling unit ranging from a 30 m² to several-square kilometer pixel.
- Output shows distribution of broad vegetation functional types over time but not individual species.
- DGVMs can identify limiting factors in different regions.
- DGVMs do not consider complex topography, land use change, management, pests, or herbivores.

global vegetation models (box 6.1)—has been produced for the Olympic Peninsula. All of these model types have strengths and limitations but can be conceptually useful in assessing potential climate change effects on vegetation. Output from these different model types for the Olympic Peninsula is described below.

Gap model results for the Olympic Peninsula—

A gap modeling study for the subalpine and upper montane zones of the Olympic Mountains under a warming climate (Zolbrod and Peterson 1999) suggested that in the wetter southwest areas, dominant tree species will shift upwards 300 to 600 m; gap model study results predict that Pacific silver fir will increase in subalpine meadows and mountain hemlock forests and western hemlock will increase in Pacific silver fir forests. In the drier northeast, study results suggest that drought-tolerant species will become dominant at lower elevations. At higher elevations, subalpine fir will dominate north aspects, and lodgepole pine will dominate south aspects. In general, productivity will increase in the southwest owing to longer growing seasons (and lack of moisture limitations), and productivity will decrease in the northeast owing to increased evapotranspiration and lower soil moisture content during the summer.

Climate envelope model results for the Olympic Peninsula—

Statistical ecological models, also known as climate envelope models, were developed for the state of Washington by Littell et al. (2010 with data from Rehfeldt et al. 2006) to determine the potential for climate change to alter distribution of important tree species, including Douglas-fir, lodgepole pine, ponderosa pine, and whitebark pine. Under a moderate carbon dioxide-emission scenario (1 percent per year increase in greenhouse gases after 1990) (Rehfeldt et al. 2006), the envelope models suggested that there will be a significant decline in the area of suitable climate for Douglas-fir at lower elevations and in the southern portion of the Olympic Peninsula. A decrease in area of suitable climate for pine species, which could include whitebark pine and lodgepole pine, is also projected to occur at higher elevations on the Olympic Peninsula.

As noted in box 6.1, several assumptions and limitations are associated with climate envelope models. First, climate envelope models assume that climate is the primary determinant of a species distribution and that the current relationship between a species and climate will hold under changing climate. In addition, these models do not account for several important determinants of plant species distribution, including competition, dispersal, evolutionary change in vegetation communities, and changes in disturbance regimes.

Dynamic global vegetation model results for the Olympic Peninsula—

The MC1 (Bachelet et al. 2001) dynamic global vegetation model (DGVM) is based on fundamental ecological processes and provides projections of future change in broad vegetation types with changing climate. Vegetation types in MC1 are based on life form (e.g., tree, shrub, or grass; evergreen or deciduous; broadleaf or needleleaf) and biome physiognomy (e.g., forest, savanna, or shrub-steppe) (see Neilson 1995). Species-level information is not included in MC1 output but can be inferred at coarse scales based on modeled vegetation type and local vegetation information. Additional limitations of MC1 are that it does not include complex topography, which may be important with changing climate in mountainous regions such as the Olympic Peninsula, or the effects of land use change, management, insects, or herbivores (see box 6.1).

MC1 model projections are based on future climate projections from global climate models (GCMs). The Mapped Atmosphere-Plant-Soil System (MAPSS) Team (Forest Service, Pacific Northwest Research Station, Corvallis, Oregon) ran the MC1 model for the Pacific Northwest region, at a scale of 800 m, with inputs from three GCMs under three future carbon dioxide emissions scenarios. The three GCMs used in the analysis included the CSIRO-MK3.0 model from Australia (Dix et al. 2009, Gordon et al. 2002), the Hadley CM3 model from the United Kingdom (Gordon et al. 2000, Pope et al. 2000), and the MIROC 3.2 medium-resolution model from Japan (Hasumi and Emori 2004). These three GCMs were chosen to bracket the range of scenarios available for the Western United States. In general, the Commonwealth Scientific and Industrial Research

Organization (CSIRO) model projections show a relatively cool and wet Pacific Northwest, whereas the Model for Interdisciplinary Research on Climate (MIROC) model projections show a hot and wet Pacific Northwest, and the Hadley projections show a hot and dry Pacific Northwest. The carbon dioxide emissions scenarios used in the analysis included the Intergovernmental Panel on Climate Change (IPCC) special report on emissions scenarios (Nakićenović and Swart 2000) B1 (relatively low future carbon dioxide emissions), A1B (moderate future carbon dioxide emissions), and A2 (relatively high future carbon dioxide emissions) scenarios.

Here we present MC1 output on vegetation shifts and fire dynamics on the Olympic Peninsula through the end of the century for the three GCMs described above and the B1 and A2 emissions scenarios (relatively low and high emissions scenarios, respectively) (figs. 6.3 through 6.8). The MC1 output is based on model runs that included a relatively high carbon dioxide fertilization effect (Norby et al. 2005) and potential nitrogen limitation. Changes in vegetation type in figures 6.3 through 6.5 indicate that the climate will no longer be suitable for the former vegetation type and that changes in species composition and abundance are likely. However, changes in species composition and abundance will likely be gradual because of

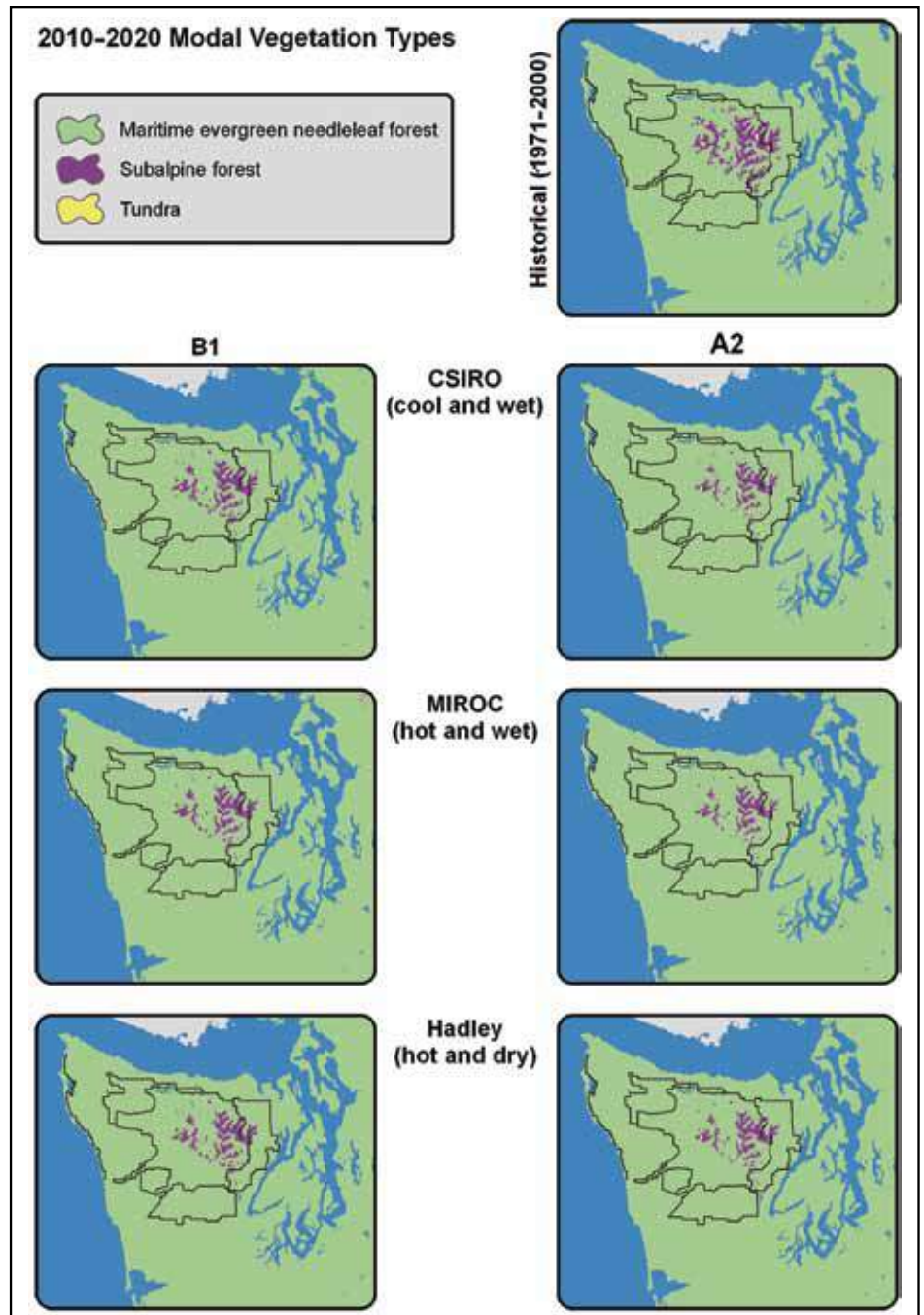


Figure 6.3—Projected modal vegetation types on the Olympic Peninsula for the 2010–20 period compared to modeled historical vegetation types. Projections are from the MC1 model for three global climate models (GCMs) (rows) and two Intergovernmental Panel on Climate Change (IPCC) carbon dioxide emissions scenarios (columns). The Commonwealth Scientific and Industrial Research Organization’s (CSIRO) GCM projects a relatively cool and wet Pacific Northwest, whereas the Model for Interdisciplinary Research on Climate (MIROC) projects a hot and wet Pacific Northwest, and the Hadley model projects a hot and dry Pacific Northwest. The B1 emissions scenario is characterized by relatively low future emissions, and the A2 scenario is characterized by relatively high future emissions. Olympic National Park and Olympic National Forest are outlined in black. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

Table 6.1—Dominant and associated species for current vegetation (elevation/moisture) zones on the Olympic Peninsula with potential dominant species in 2100^{a b}

Current vegetation zones	Current dominant species	Current associates	Potential dominant species in 2100
Sitka spruce	Sitka spruce (-), western hemlock (-), western redcedar (+)	Douglas-fir (+), red alder (+), Pacific silver fir (+), bigleaf maple (+)	Douglas-fir, western redcedar, red alder
Western hemlock	Western hemlock (-), Douglas-fir (+)	Western redcedar (-), lodgepole pine (+), western white pine (+), grand fir (-), bigleaf maple (-)	Douglas-fir, lodgepole pine, western white pine
Douglas-fir	Douglas-fir (+), lodgepole pine (+)	Western hemlock (-), western redcedar (-), madrone (+), western white pine (+), Rocky Mountain juniper (+), golden chinquapin (+)	Douglas-fir, lodgepole pine, western white pine
Pacific silver fir	Pacific silver fir (-), western hemlock (+)	Alaska yellowcedar (-), western redcedar (+), Douglas-fir (+), mountain hemlock (-), western white pine (+)	Western hemlock, western redcedar, Douglas-fir, western white pine
Mountain hemlock	Mountain hemlock (-), Pacific silver fir (+)	Subalpine fir (+), Alaska yellowcedar (+), western white pine (+), western hemlock (+), Douglas-fir (+)	Pacific silver fir, western hemlock, western white pine
Subalpine fir	Subalpine fir (-), lodgepole pine (+)	Whitebark pine (-), Alaska yellowcedar (-), Pacific silver fir (-), Douglas-fir (+), western hemlock (+)	Lodgepole pine, Douglas-fir
Alpine	—	—	Subalpine fir, mountain hemlock, Alaska yellowcedar, whitebark pine

— = no tree species present.

^a Potential dominant species were determined assuming that the next century will be hotter, with increasing summer drought stress, and that disturbance frequency (either fire on the east side of the peninsula or windstorms on the west side of the peninsula) will increase over the next century to facilitate species transition. It was also assumed that species dispersal would not be a limiting factor for movement in response to changing climate. Expected increases or decreases in abundance of current dominant and associate species are indicated with a (+) or (-), respectively.

^b Henderson, J.A. et al (1989).

the high tolerance of mature trees to climatic variation; disturbances such as fire will likely be the main triggers for major compositional change. To interpret the MC1 output for the Olympic Peninsula, we focused on coarse-scale changes in vegetation type and disturbance, and the factors that led to those changes, and related them to likely changes in species composition and abundance (table 6.1).

In many of the future scenarios in MC1, there is a decline in the extent of the high-elevation tundra and subalpine vegetation types on the Olympic Peninsula by 2040–2060 (fig. 6.4), and there is also an almost complete loss of the tundra and subalpine vegetation types under

most scenarios by 2070–2099 (fig. 6.5). This suggests that suitable conditions for tundra and subalpine vegetation will decline substantially or disappear by the end of the 21st century with warming on the peninsula. Large-scale dispersal of plant species to the Olympic Peninsula will likely be limited because of isolation from mainland areas by water and lower elevation zones (Peterson et al. 1997, Zolbrod and Peterson 1999). Thus, changes in distribution and abundance of plant species must occur within the existing populations and communities on the peninsula, and species adjustments to changing climate are expected to be mainly altitudinal or between aspects (Zolbrod and

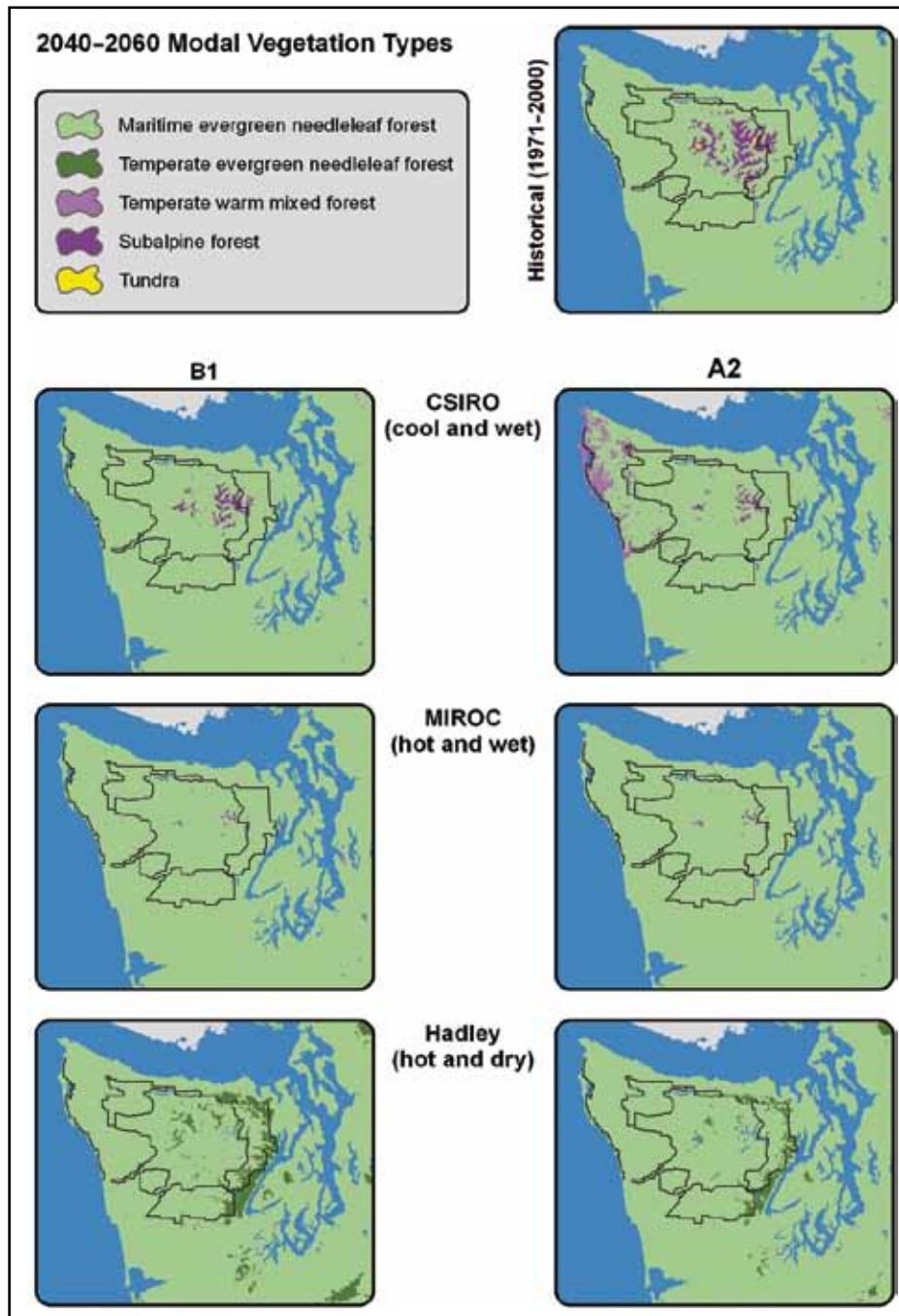


Figure 6.4—Projected modal vegetation types on the Olympic Peninsula for the 2040–60 period compared to modeled historical vegetation types. Projections are from the MC1 model for three global climate models (GCMs) (rows) and two Intergovernmental Panel on Climate Change IPCC carbon dioxide emissions scenarios (columns). The Commonwealth Scientific and Industrial Research Organization's (CSIRO) GCM projects a relatively cool and wet Pacific Northwest, whereas the Model for Interdisciplinary Research on Climate (MIROC) projects a hot and wet Pacific Northwest, and the Hadley model projects a hot and dry Pacific Northwest. The B1 emissions scenario is characterized by relatively low future emissions, whereas the A2 scenario is characterized by relatively high future emissions. Olympic National Park and Olympic National Forest are outlined in black. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

Peterson 1999). In the former range of tundra and subalpine vegetation types, other species will likely become dominant, including tree species from lower elevations (see subalpine fir and alpine vegetation types in table 6.1).

Under the CSIRO GCM A2 scenario (cool and wet Pacific Northwest), there is a range expansion of the temperate warm mixed-vegetation type in the northwestern portion of the peninsula in the 2040–60 period (fig. 6.4). This vegetation change is in response to increased precipitation (specifically in the summer compared to the rest of the year), which allows for range expansion of deciduous broadleaf species. In the northwestern portion of the peninsula, this could include species such as vine maple, bigleaf maple, and red alder. However, by the end of the century, the maritime evergreen needleleaf forest again becomes more dominant than the temperate warm mixed-vegetation type (fig. 6.5). This is because precipitation increases under the CSIRO A2 scenario toward the end of the century, but the summers are not as wet relative to the rest of the year as they were in mid century. Evergreen needleleaf species are likely to maintain dominance under those conditions (Neilson 1995). Although the CSIRO scenarios are generally characterized by a relatively cool and wet Pacific Northwest, the distinct seasonality in rainfall and lower summer precipitation levels under the

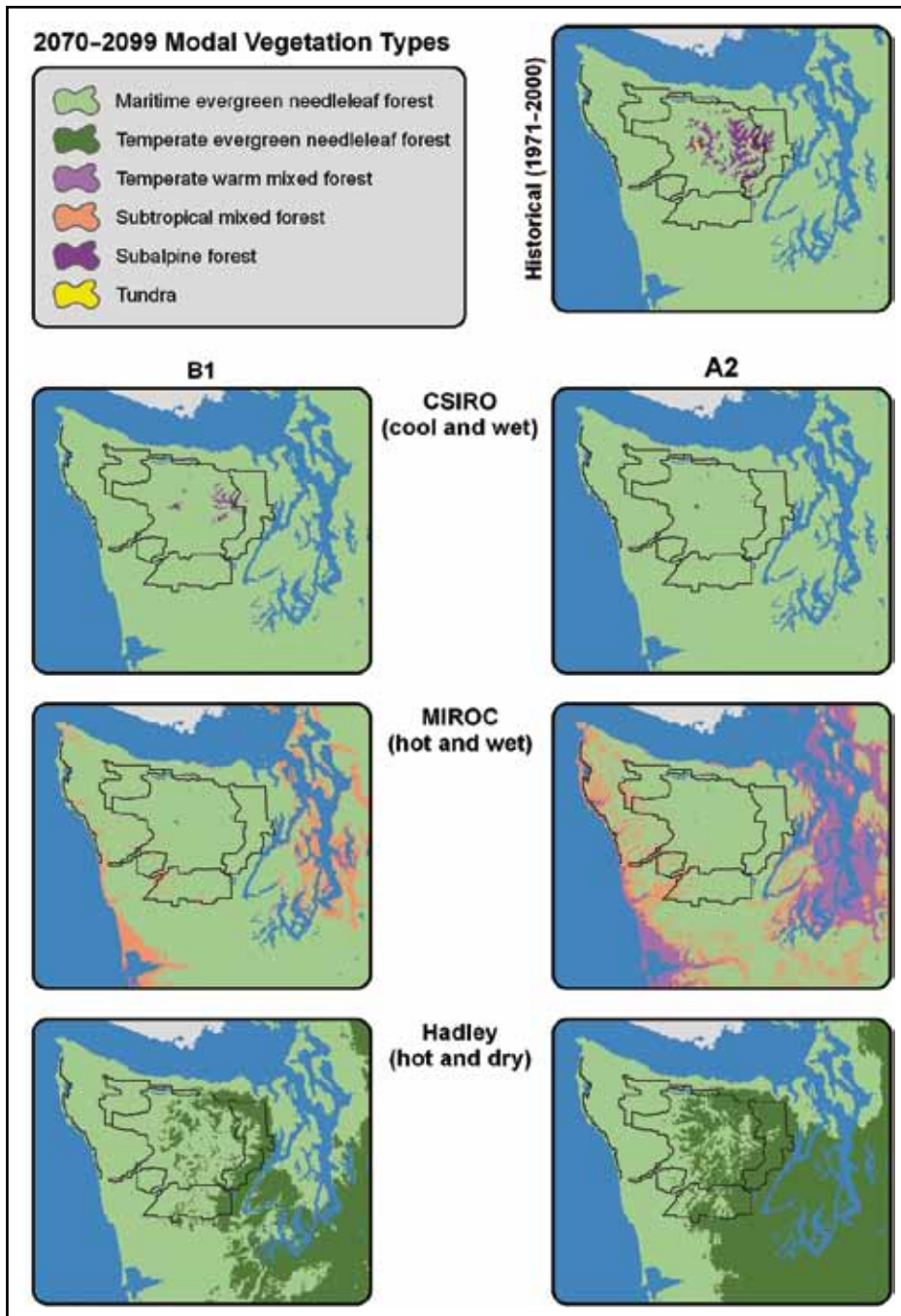


Figure 6.5—Projected modal vegetation types on the Olympic Peninsula for the 2070–99 period compared to modeled historical vegetation types. Projections are from the MC1 model for three global climate models (GCMs) (rows) and two Intergovernmental Panel on Climate Change (IPCC) carbon dioxide emissions scenarios (columns). The Commonwealth Scientific and Industrial Research Organisation's (CSIRO) GCM projects a relatively cool and wet Pacific Northwest, whereas the Model for Interdisciplinary Research on Climate (MIROC) projects a hot and wet Pacific Northwest, and the Hadley model projects a hot and dry Pacific Northwest. The B1 emissions scenario is characterized by relatively low future emissions, and the A2 scenario is characterized by relatively high future emissions. Olympic National Park and Olympic National Forest are outlined in black. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

CSIRO scenarios lead to increased fire activity at lower elevations on the eastern side of the peninsula by the end of the century (fig. 6.8). Fire-tolerant species, such as Douglas-fir and lodgepole pine, will likely expand their ranges on the east side of the peninsula with increased fire.

With the MIROC GCM (hot and wet Pacific Northwest) as input to MC1, there is a range expansion of the temperate warm mixed-forest and subtropical mixed forest vegetation types by the end of the 21st century, mainly on the west side of the Olympic Peninsula (fig. 6.5). The range expansion of these temperate and subtropical forest types is at the expense of the currently dominant maritime evergreen needleleaf forest. This shift to temperate and subtropical vegetation types is a response to increases in average monthly temperatures and a decrease in winter frosts. Higher summer temperatures may eventually lead to drought stress in forest types that are not currently stressed in the summer months, mainly Sitka spruce forests, leading to shifts in dominance to more drought-tolerant species, such as western redcedar (table 6.1).

Under the hot and dry scenario with the Hadley model, MC1 shows a range expansion of the temperate evergreen needleleaf forest on the east side of the Olympic Peninsula by mid 21st century, with even greater expansion by the end of the century (figs. 6.4 and 6.5). This

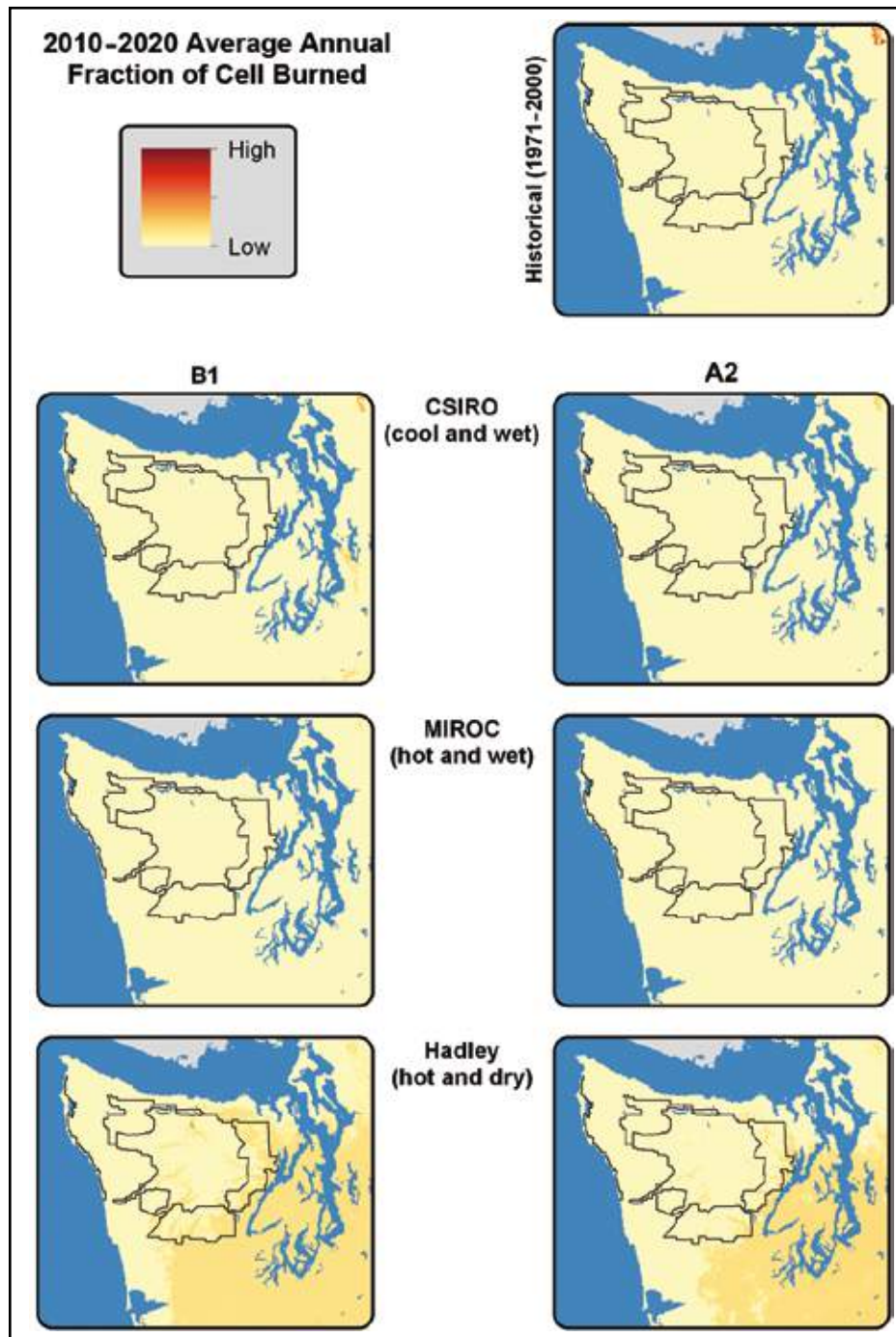


Figure 6.6—Projected average annual fraction of cell burned on the Olympic Peninsula for the 2010–20 period compared to modeled historical fire activity. This output is derived by averaging the area of a cell that is burned over the period of interest. Number are not shown in the legend because they are not intuitive. However, darker colors indicate more fire. Projections are from the MC1 model for three global climate models (rows) and two Intergovernmental Panel on Climate Change carbon dioxide emissions scenarios (columns). The B1 emissions scenario is characterized by relatively low future emissions, and the A2 scenario is characterized by relatively high future emissions. CSIRO = Commonwealth Scientific and Industrial Research Organization; MIROC = Model for Interdisciplinary Research on Climate. Olympic National Park and Olympic National Forest are outlined in black. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

shift is driven by increased fire activity on the east side of the peninsula with increasing temperatures and summer drought under the hot and dry Hadley scenario (figs. 6.6 through 6.8). In other locations in the Western United States, temperate evergreen needleleaf forests are characterized by regular fire occurrence and are dominated by pine species. The range expansion of this vegetation type on the east side of the peninsula suggests that fire- and drought-tolerant species, such as Douglas-fir, lodgepole pine, and western white pine, will become more abundant in east-side vegetation types, including the western hemlock and Douglas-fir types (table 6.1).

Overall, MC1 output indicates that vegetation change is expected by mid century across GCM and emissions scenarios. More substantial vegetation changes are expected by the end of the century. Decline in the extent of alpine and subalpine vegetation types is expected across scenarios. Other changes in vegetation and fire activity differ by GCM and the associated future changes in temperature and precipitation.

Vegetation Management at Olympic National Forest and Olympic National Park

The following section provides information on vegetation management at Olympic National Forest (ONF) and Olympic National Park

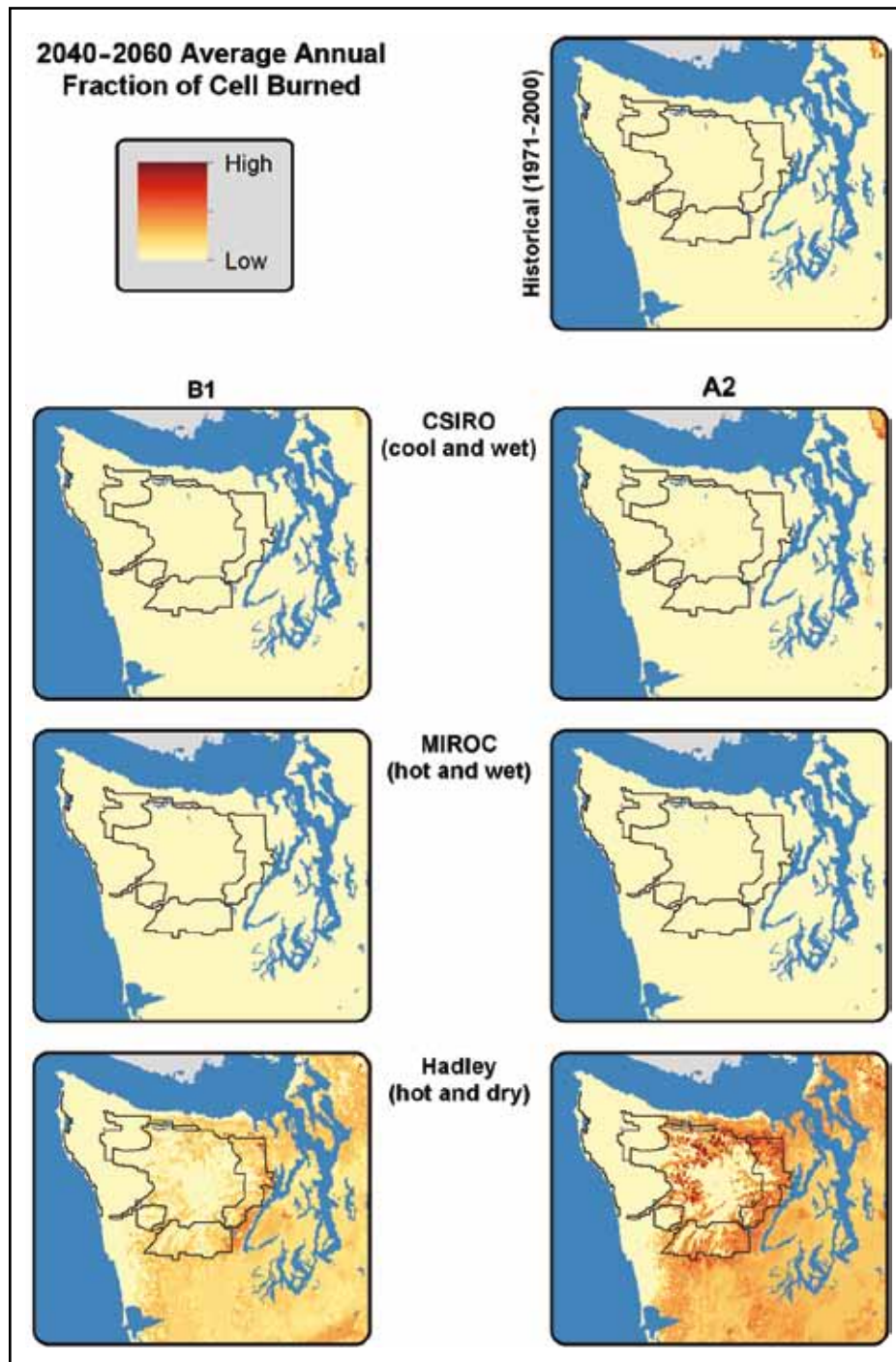


Figure 6.7—Projected average annual fraction of cell burned on the Olympic Peninsula for the 2040–60 period compared to modeled historical fire activity. This output is derived by averaging the area of a cell that is burned in a year over the period of interest. Number are not shown in the legend because they are not intuitive. However, darker colors indicate more fire. Projections are from the MC1 model for three global climate models (rows) and two Intergovernmental Panel on Climate Change carbon dioxide emissions scenarios (columns). The B1 emissions scenario is characterized by relatively low future emissions, and the A2 scenario is characterized by relatively high future emissions. Olympic National Park and Olympic National Forest are outlined in black. CSIRO = Commonwealth Scientific and Industrial Research Organization; MIROC = Model for Interdisciplinary Research on Climate. Olympic National Park and Olympic National Forest are outlined in black. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

(ONP), including (1) the context in which ONF and ONP manage vegetation, (2) guidance and constraints on vegetation management at ONF and ONP, and (3) the primary issues and activities relevant to vegetation management at ONF and ONP. This information, coupled with the likely effects of climate change on vegetation on the Olympic Peninsula (described previously), provide a basis on which to develop climate change adaptation options for vegetation management at ONF and ONP.

Native Plants and Revegetation

The ONF has instituted a native plant program that aims to maintain biodiversity and ecosystem health through the use of locally adapted, self-perpetuating populations of native plant species. Olympic National Forest uses both internal capacity and contractors to develop and maintain locally adapted sources of native plant seed and plant material to ensure these materials are available when needed for revegetation (fig. 6.9). Several grass seed production fields have been established. All propagule sources (seeds, cuttings, transplants) across the forest are mapped to help ensure that genetically appropriate native plant materials are used for site restoration. On-forest expertise has been developed to help in creating and implementing revegetation and restoration plans that maximize use of native plants.

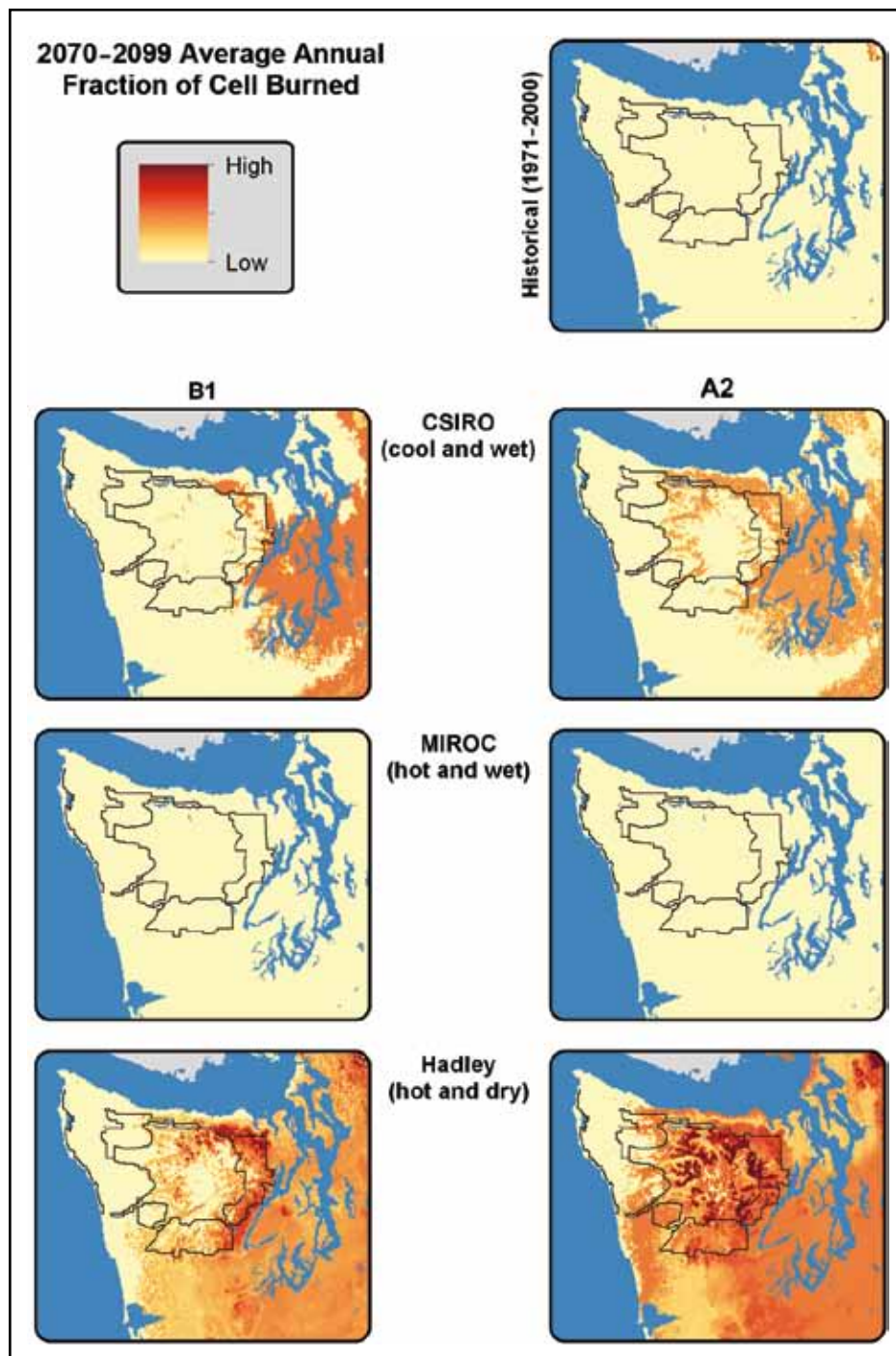


Figure 6.8—Projected average annual fraction of cell burned on the Olympic Peninsula for the 2070–99 time period compared to modeled historical fire activity. This output is derived by averaging the area of a cell that is burned over the period of interest. Number are not shown in the legend because they are not intuitive. However, darker colors indicate more fire. Projections are from the MC1 model for three global climate models (GCMs) (rows) and two Intergovernmental Panel on Climate Change carbon dioxide emissions scenarios (columns). The B1 emissions scenario is characterized by relatively low future emissions, and the A2 scenario is characterized by relatively high future emissions. Olympic National Park and Olympic National Forest are outlined in black. CSIRO = Commonwealth Scientific and Industrial Research Organization; MIROC = Model for Interdisciplinary Research on Climate. (Data from R. Neilson and the MAPSS Team, USDA Forest Service and Oregon State University, Corvallis, Oregon.)

Olympic National Park conducts revegetation activities in a variety of locations. Staff specialists conduct regular inventory and monitoring in wilderness areas, particularly along trails and at campsites, to determine if areas require revegetation. Park teams carefully select, plan, execute, and monitor success of restoration projects. Projects involve obtaining plant material, staging, site preparation, planting, mulching, and site protection/facilities improvement. Most restoration projects require plant seeds, cuttings, or transplants produced from native plant materials collected in the immediate vicinity.

Exotic Species Management

Exotic plants have become established in many locations at ONF. Some exotic species are considered invasive because their introduction causes or is likely to cause economic or environmental harm, and control efforts are focused on these invasive species. Invasive species infestations are primarily located in disturbed areas along road systems, in timber sale units, at administrative sites, in high public use areas (e.g., parking areas, viewpoints), in previously disturbed areas such as plantations, and in areas used for recreation such as campgrounds and dispersed recreation sites. Integrated manual, mechanical, herbicide, and restoration treatments are used at ONF to treat invasive plant infestations. Ongoing invasive



Figure 6.9—Wet meadow plant community adjacent to a road scheduled for decommissioning on Olympic National Forest. Seed and cuttings of several species were collected from this site and used in the revegetation of the decommissioned roadbed. (Photo by Cheryl Bartlett, U.S. Forest Service, Olympic National Forest.)

plant management efforts include prevention practices such as cleaning heavy equipment, using weed-free straw and mulch, using pelletized or certified weed-free animal feed, and restoring disturbed areas. Olympic National Forest is also involved in invasive species working groups to coordinate control efforts, including the Olympic Knotweed Working Group.

Similar to ONF, exotic plants occur in many locations at ONP, and 190 known exotic plant species occur in the park (Buckingham et al. 1995). To combat this problem, the North Coast and Cascades Network of the National Park Service established an exotic plant management team (EPMT) in 2002. The EPMT and park natural resources staff work together to prevent introduction and control the spread of all exotic plants. Prevention involves working with park staff to increase knowledge; minimizing and repairing soil disturbance; preventing spread on equipment, tools, and boats; regulating wilderness stock use; working with park maintenance staff to ensure outside contractors use weed-free gravel sources; and collaborating with other agencies and neighbors. Exotic plant control methods include hand pulling, mowing, girdling, and targeted spraying of glyphosate and narrow-spectrum, low-toxicity herbicides. In addition, exotic plant monitoring is included in the North

Coast and Cascades Network plan for long-term ecological monitoring.

Sensitive and Rare Plants

Olympic National Forest has 70 sensitive flora species, including 37 vascular plants, 17 fungi, 12 lichens, and 4 bryophytes (mosses). The ONF runs a sensitive species program that includes biological evaluations of proposed actions on national forest lands to avoid and minimize negative impacts on the viability of sensitive species or a trend toward federal listings. The forest develops and implements conservation assessments and other tools for sensitive species, and develops and implements management practices to ensure that species do not become threatened or endangered because of Forest Service actions.

The Olympic Peninsula has the highest concentration of rare plants in Washington, owing to the broad range of habitats and the geographic isolation of the peninsula. Rare plants at ONP include endemics or near-endemics, isolated populations, and species more common to the north (or east). Five of the seven peninsula endemics occur exclusively in subalpine and alpine zones, and the other two species occur from montane to alpine zones (Buckingham et al. 1995). Rare plant conservation actions at ONP include surveys of areas of proposed management or research activities, detailed surveys of distribution, and site-specific protection plans.

Prescribed Fire, Wildland Fire Use, and Hazardous Fuel Treatment

Olympic National Forest conducts slash pile burning for brush disposal and hazardous fuel reduction, and occasionally uses prescribed fire for restoration purposes. For example, in 2005, a prairie restoration burn was conducted in the Skokomish watershed.

The Olympic National Park fire program is directed by a fire management plan, approved in 2005 (NPS 2003). Under the plan, prescribed burning is occasionally used, and fire managers may choose to monitor natural lightning-ignited fires to meet specific objectives. The park must complete a burn plan before any prescribed fire is permitted, and each planned fire must meet a specific set of conditions.

When fire cannot be used, hazardous fuel reduction is done by using manual removal or other means.

Vegetation Monitoring

Vegetation monitoring at ONF includes several different efforts. Botanists conduct rare plant monitoring in association with the University of Washington, Botanic Gardens Rare Plant Care and Conservation Program. Botanists intermittently monitor status of known populations of rare (to ONF) tree species. Silviculturists conduct informal ongoing silvicultural prescription effectiveness monitoring that includes monitoring of treatments such as understory precommercial thinning, commercial thinning, precommercial thinning with skips and gaps (skips are areas without tree harvest within a thinned stand; gaps are areas where all trees are harvested within a thinned stand), tree planting, and logging system effects on vegetation. Annual aerial surveys of insects and disease are also conducted regionally.

Olympic National Park conducts forest monitoring as a part of the National Park Service North Coast and Cascades Network.² The goal of this monitoring is to determine trends in tree mortality, recruitment, and growth in forests representing the range of environments in network parks. Attributes monitored include tree species, diameter, indicators of health, and factors contributing to death. Forest ecologists monitor three forest types (Sitka spruce, western hemlock-Douglas-fir, and subalpine fir) in the network in stands at least 80 years old. At this time, subalpine fir forests are monitored at Mount Rainier and North Cascades National Parks but not at ONP.

Forest Thinning Program at Olympic National Forest

Timber harvest activities began on the Olympic Peninsula in the mid 1800s and at ONF in the 1920s. Until the 1990s, timber management generally consisted of clearcutting, broadcast burning, and tree replanting. Douglas-fir was the primary tree species chosen for artificial regeneration.

These management practices resulted in the regeneration of over one-third of ONF into relatively young even-aged forests. These resulting plantations and managed forests were designed to maximize the production of wood products and are therefore densely stocked and structurally and compositionally simplified. The 1994 Northwest Forest Plan (NWFP) (USDA and USDI 1994) led to a movement toward management for ecological priorities, mainly the protection, enhancement, and acceleration of late-successional forest conditions. Timber production became a collateral opportunity rather than a primary objective.

Olympic National Forest has instituted a multiple-objective commercial thinning program with the purpose of accelerating the process of late-successional forest development by creating conditions that encourage the growth of a diverse understory and multilayered stand structure. This thinning is conducted primarily in forest stands between 40 and 80 years old that are designated as late-successional reserves (fig. 6.10); stands in this age range are the most economically viable stands to thin given the age limitations under the NWFP in late-successional reserve management. However, thinning in adaptive management areas is concentrated in stands 40 to 120 years old (fig. 6.11). The thinning treatments at ONF are prioritized based on habitat improvement potential for the northern spotted owl, marbled murrelet, and Roosevelt elk; aquatic species needs; and economic considerations. Priority is generally given to young-growth forest located near old-growth forest to increase the area of contiguous late-successional habitat.

To promote structural diversity, tree thinning prescriptions include variable-density thinning (thinning with skips and gaps) and provisions for snags and coarse woody debris for wildlife habitat. The skips (no thinning) are designed to function as small reserves distributed across the treatment area, providing a refuge for plant and animal species sensitive to disturbance. The variation in the landscape created by the gaps and the thinned areas are designed to provide for the habitat needs of other species. When adjusted for

² Acker, S.A.; Woodward, A.; Boetsch, J.R. [et al.]. [N.d.] Forest vegetation monitoring protocol for the North Coast and Cascades network. [Natural Resource Report NPS/NCCN/NRR—no. TBD.] Manuscript in preparation. Fort Collins, CO: National Park Service. http://science.nature.nps.gov/im/units/nccn/Reports/Monitoring/NCCN_Monitoring_Plan_20050930.pdf. (12 March 2010).

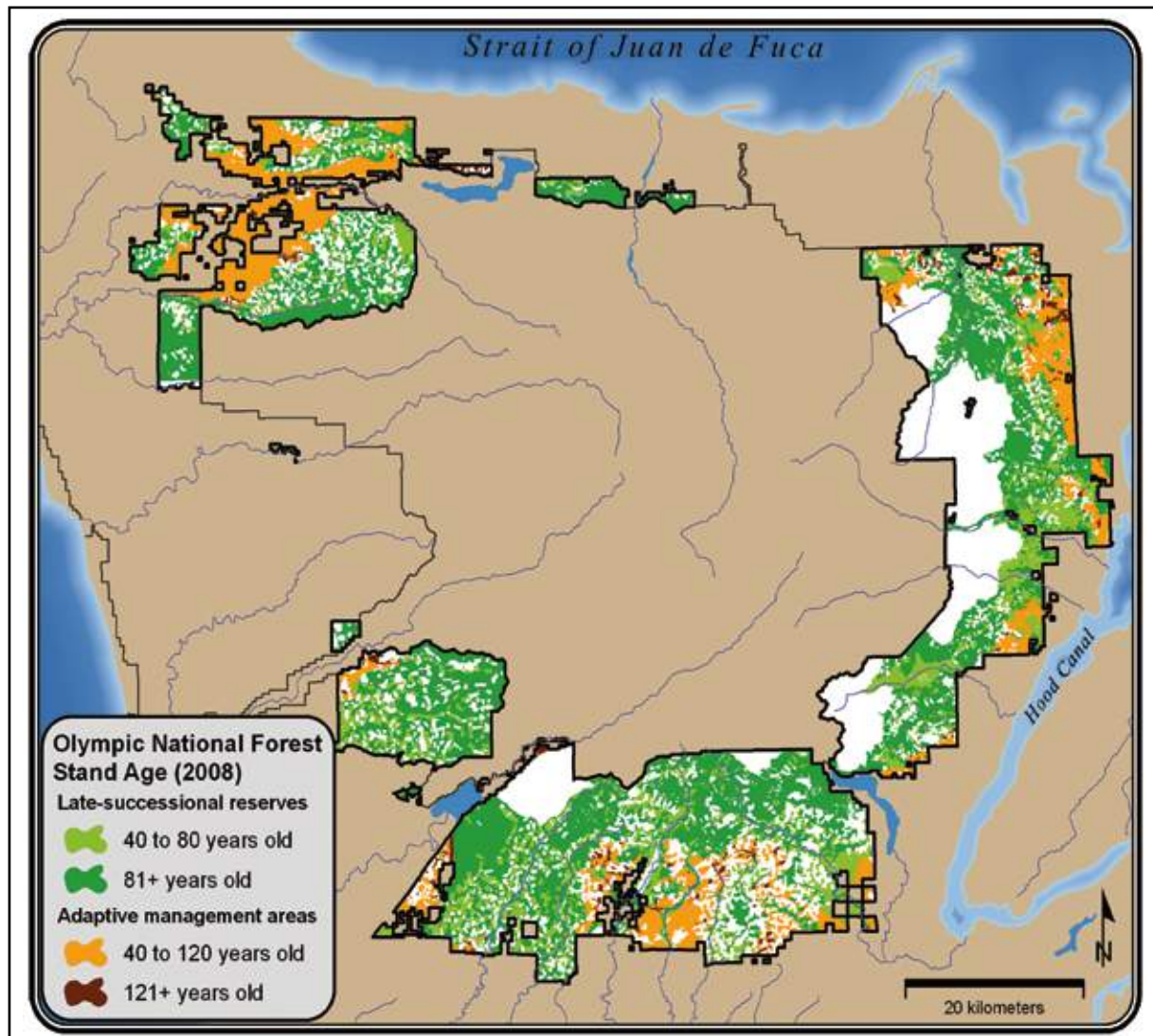


Figure 6.10—Location and age of late-successional reserve (LSR) and adaptive management area (AMAs) stands on Olympic National Forest (ONF). Thinning, with the goals of increasing forest structural diversity and improving wildlife habitat, is one of the primary vegetation management activities on ONF. Thinning on ONF is conducted primarily in LSR forest stands between 40 and 80 years old, as stands in this age range are the most economically viable stands to thin, and thinning in LSRs more than 80 years in age is not permitted. Although thinning is not permitted in LSRs older than 80 years, thinning in AMAs is concentrated in stands greater than 40 but less than 120 years old. Thus, 40- to 80-year old LSR stands (in light green) and the 40- to 120-year old AMA stands (in orange) are the locations where ONF has the most opportunity for active management in adapting to climate change.

tree species, initial tree size, and crown class, variable-density thinning generally increases average tree growth by about 25 percent (Roberts and Harrington 2008). Thinning in young stands is also often associated with improved tree health, vigor, long-term wind firmness, and possibly resilience to climate change. The redistributed sunlight,

moisture, and nutrients can also further promote understory vegetative diversity and vigor (Thysell and Carey 2001).

Precommercial thinning at ONF is conducted primarily in single-story stands that are 15 to 35 years old, depending on tree form, tree density, and stand accessibility. Some thinning has also been conducted on understory tree canopy layers in young stands, and skips have also been used.



Figure 6.11—Thinning activities on Olympic National Forest. The forest has instituted a multiple-objective commercial thinning program with the purpose of accelerating late-successional forest development by creating conditions that encourage the growth of a diverse understory and complex multilayered stand structure. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

This thinning enhances or maintains species diversity by reducing competition around ecologically important minor tree species and other vegetation that would normally be eliminated through suppression mortality by faster growing tree species. In addition, precommercial thinning is used to improve tree growth, vigor, form, and rate of development of late-successional forest characteristics.

Genetic Resources Program at Olympic National Forest

Olympic National Forest established a conifer orchard in 1957 to maintain a seed bank of high-quality seed for use in reforestation and restoration. Orchard trees are grouped in blocks not only by species but also based on seed zones (by elevation, latitude, and longitude) so that collected seed is adapted to the areas in which it is planted. Douglas-fir, Sitka spruce, western hemlock, western white pine, and Pacific silver fir blocks are included. To plant trees resistant to the introduced disease white pine blister rust, western white pine and whitebark pine tree selections are tested through a regional disease resistance program (fig. 6.12). All the white pine seed harvested from the orchard has exhibited disease resistance, and the forest has developed a partnership with the Washington Department of Natural Resources, and the



Figure 6.12—Whitebark pine seedlings tested for resistance to white pine blister rust at Dorena Genetic Resource Center. (Photo courtesy of USDA Forest Service, Olympic National Forest.)



Figure 6.13—Whitebark pine cone collection as a part of the Olympic National Forest gene conservation program. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

Quinault Indian Nation to share in orchard management and the seed crop. The forest also maintains an ex situ gene conservation seed collection of Douglas-fir, western white pine, and whitebark pine by individual tree (fig. 6.13). Seed storage by tree allows for maximum flexibility in the creation of custom seed lots for various future applications.

Adapting Vegetation Management to Climate Change at Olympic National Forest and Olympic National Park

Process Used to Develop Adaptation Strategies for Vegetation Management

To develop adaptation strategies for vegetation management on the Olympic Peninsula, the geneticist, silviculturists, and natural resources staff officer from ONF and forest ecologist and other natural resources staff from ONP engaged in a year-long exchange of ideas with scientists from the Forest Service Pacific Northwest Research Station (PNW), University of Washington (UW), and UW Climate Impacts Group (CIG). These exchanges involved discussion of potential impacts of climate change on vegetation on the Olympic Peninsula and discussion of various models that project potential impacts of climate change on vegetation. This exchange contributed to the development of vegetation management strategies described below.

Participants identified limited experience with various models and model output as a challenge for managers in thinking about how to address potential effects of climate change, and as a result, ONF and ONP natural resources staff and UW and PNW scientists met to review various model types, model output, and the strengths and weaknesses of different models. A subsequent workshop focused on reviewing potential vegetation sensitivities to climate change and developing adaptation strategies and actions for vegetation management on the peninsula. Participants in the second workshop included regional scientists and natural resources staff from ONF and ONP. The workshop included a presentation from CIG scientist Jeremy Littell on climate projections for the state of Washington. Other presentations addressed the potential impacts of climate change on vegetation communities (J. Halofsky, UW) and on plant phenology and physiology (Connie Harrington,

PNW), as well as current vegetation management at ONF (Carol Aubry) and ONP (Steven Acker). David L. Peterson (PNW) also gave a presentation on developing strategies for adaptation to climate change. The facilitated dialogue between scientists and managers that followed focused on development of adaptation options and action plans for vegetation management at ONF and ONP. The discussion was specifically focused on the following questions: (1) What are the principal vegetation sensitivities (e.g., tree growth, disturbance, geographic locations) on the Olympic Peninsula? (2) What are your priorities for adaptation? (3) Which approaches and techniques would you use to facilitate adaptation? and (4) How might the park and forest collaborate to adapt to climate change? Key points from the discussion are described in the section below and in table 6.2. See box 6.2 for a general summary of projected climate change effects on vegetation on the Olympic Peninsula and related adaptation strategies for vegetation management at ONF and ONP.

Key Vegetation Sensitivities With Climate Change on the Olympic Peninsula

Workshop participants identified several vegetation assemblages on the Olympic Peninsula, and the species that inhabit them, as being particularly sensitive to climate change. Establishment of trees and other woody species will likely increase with warming and decreased snowpack in subalpine and alpine meadows (Zolbrod and Peterson 1999). Tree encroachment and increased establishment of lower elevation species in alpine and subalpine plant communities may put some species that currently inhabit these locations at risk, especially rare and relict species. Warming temperatures and changes in hydrology with climate change could have significant impacts on moisture levels and species composition in wetlands on the peninsula, especially bogs and fens (Burkett and Kusler 2000). Increased drought stress and disturbance frequency may also put Sitka spruce rain forests at risk for compositional change (Holman and Peterson 2006, Nakawatase and Peterson 2006).

Changing disturbance regimes with climate change will likely affect vegetation on the Olympic Peninsula. Storm intensity is projected to increase (Salathé et al. 2010),

Table 6.2—Current and expected vegetation sensitivities to climate change on the Olympic Peninsula, and associated adaptation strategies and actions for vegetation management at Olympic National Forest (ONF) and Olympic National Park (ONP)^a

Current and expected vegetation sensitivities to climate change	Adaptation strategies and actions
Increased opportunity for exotic species establishment	• Continue to implement early detection/rapid response for exotic species treatment (ONF). • Increase exotic species control efforts (ONP). • Continue to exchange information on exotic species spread and control between ONF and ONP.
Potential for mortality events and regeneration failures, particularly after large disturbances	• Develop a gene conservation plan for ex situ collections for long-term storage. • Identify areas important for in situ gene conservation. • Maintain a tree seed inventory with high-quality seed for a range of species, particularly species that may do well in the future under hotter and drier conditions. • Increase production of native plant materials for postflooding plantings.
Increased forest drought stress and decreased forest productivity at lower elevations	• Consider increasing the amount of thinning and possibly altering thinning prescriptions to reduce forest drought stress (ONF). • Use girdling, falling and leaving trees, prescribed burns, and wildland fire (ONP) to reduce stand densities and drought stress. • Maximize early successional tree species diversity by retaining minor species during precommercial thinning activities to promote greater resilience to drier conditions. • Consider including larger openings in thinning prescriptions and planting seedlings in the openings to create seed sources for native drought-tolerant species.
Altered ecosystem structure and potential disruption of process and function	• Prioritize actions that will help maintain ecosystem function. • Focus on actions that will help minimize mass die-off and effects of major disturbances. • Create structures and processes that are viable over the long term.
All of the above	• Conduct integrated and consistent inventory and monitoring of vegetation. • Focus monitoring on sensitive locations such as wetlands and high elevations, on endemic or at-risk species, and on plant phenology. • Use feedback from monitoring in implementation of adaptive management.

^a Sensitivities are based on projected climate change effects on Olympic Peninsula, including decreased summer soil moisture, changing patterns of vegetation establishment, growth and mortality, shifting species distributions, shifting phenology, increased fire frequency, increased winter flood frequency and magnitude, and potential for increased insect outbreaks.

potentially leading to increased frequency of landslides and windthrow. Fire frequency and extent are projected to increase on the peninsula (see MC1 model output figs.

6.6–6.8). There is potential for more frequent and more severe disturbances owing to insects, including mountain pine beetle (Littell et al. 2010), and possibly Douglas-fir

Box 6.2—Summary of projected climate change effects on vegetation on the Olympic Peninsula and related adaptation strategies for vegetation management at Olympic National Forest Olympic National Park

- Increased temperatures with climate change, and corresponding increases in summer drought stress and fire frequency in the Pacific Northwest, will lead to changing species distribution in the region, resulting in forest types different from those we see today.
- Increased temperatures with climate change will lead to longer growing seasons on the peninsula, which will alleviate growth-limiting factors and likely result in increased growth and productivity in high-elevation forests.
- Increased drought stress with climate change will likely result in decreased tree growth and forest productivity in the northeastern forests of the Olympic Peninsula.
- Paleocological (pollen and fossil) records from the Pacific Northwest and elsewhere show that during historically warm periods, many tree species moved poleward and upward in elevation, suggesting that on the Olympic Peninsula, species distributions will shift to higher elevations with warming.
- With warming on the Olympic Peninsula, warmer and drier conditions at lower elevations will likely result in expansion of the range of Douglas-fir and lodgepole pine.
- Increased temperatures and drought occurrence with climate change will likely lead to increased fire frequency and extent on the Olympic Peninsula, particularly in the northeastern portion.
- Species phenology, or timing of life history events, is also likely to shift in response to climate change on the peninsula.
- Olympic National Forest (ONF) and Olympic National Park (ONP) identified alpine and subalpine meadows, wetlands, and Sitka spruce rain forests as being particularly vulnerable to warming climate.
- Both the forest and park affirmed the maintenance of functioning ecosystems in the face of climate change as a primary goal to continue to provide ecosystem services. Management actions that will help to maintain ecosystem function, such as restoration activities that create structures and processes that are viable over the long term, will be prioritized, when possible.
- To conserve genetic resources, ONF will maintain a tree seed inventory with high-quality seed for a range of species, especially those that are adapted to a drier climate or greater variation in climate, and will develop a plant conservation framework for forest trees and habitats at risk under changing climate that includes a plan for ex situ seed collection.
- Both the forest and park will be prepared to treat increases in exotic plant species after disturbances by continuing to implement the early detection, rapid response program.
- The forest and park will work to conduct more integrated and consistent inventory and monitoring of vegetation.
- At ONF, increasing the amount and prioritization of thinning activities in forest stands could potentially increase resilience to climate change, because thinning can increase water availability and tree growth and vigor by reducing competition.
- At ONP, prescribed fire and wildland fire in wilderness could be managed to reduce stand density and drought stress.

beetle, and balsam woolly adelgid (Mitchell and Buffam 2001). Increases in these disturbances will increase opportunities for exotic species establishment (Joyce et al. 2008). Disturbances may also interact to drive ecosystem change (McKenzie et al. 2009).

Changes in plant phenology (Parmesan 2006), increased drought stress (Elsner et al. 2010, Littell et al. 2010), and changing disturbance regimes (Littell et al. 2010) could lead to significant changes in plant regeneration patterns on the Olympic Peninsula. Workshop participants

suggested that propagule production could be reduced owing to a warmer climate and associated stresses. In addition, site availability for seedling establishment may be limited under changing climate; an increase in tree mortality could result in increased cover of clonal species such as salal, which can limit opportunities for other species to become established. However, warming may lead to increased fire frequency (Littell et al. 2009, Westerling et al. 2006), which will likely increase opportunities for seedling establishment, including seedlings of species that

were not dominant on a site before a fire event. Changes in regeneration patterns may lead to changing distribution and abundance of currently common species on the peninsula, leading to changes in ecosystem structure and function.

Goals and Priorities for Adaptation in Vegetation Management

Both ONF and ONP affirmed the maintenance of functioning ecosystems in the face of climate change as a primary goal to continue to provide ecosystem services. Management actions that will help to maintain ecosystem function will be prioritized, when possible. Examples include actions to help minimize extensive tree mortality and effects of major disturbances, and restoration activities that create structures and processes that are viable over the long term. In addition, restoration planning will consider the functional role of species and habitats. For example, Sitka spruce may serve the same functional role as Douglas-fir in terms of stand structure (large trees or wood, or both) but not in terms of seed production and type of seed for wildlife (Peter and Harrington 2010).

Biodiversity is the sum of species, ecosystem, and genetic diversity (Lovejoy and Hannah 2005). Maintenance of native plant biodiversity is an ongoing priority for ONF and ONP and includes such actions as protection, restoration, and monitoring of rare plant species or populations; planting a variety of species; and in situ and ex situ gene conservation. However, it is unclear which levels of biodiversity should be maintained in a changing climate. The definition of exotic species will also need to be reexamined periodically, and possibly modified, because of shifting species distribution with climate change. The definition of exotic species will likely influence how vegetation and biodiversity are managed with climate change.

Adaptation Strategies and Actions for Vegetation Management at Olympic National Forest and Olympic National Park

Olympic National Forest will implement the following actions to maintain biodiversity and increase ecosystem resilience. These actions are likely to be effective under a variety of possible future scenarios.

- Maintain a tree seed inventory with high-quality seed for a range of species. One way to maintain seed inventory for tree species is to collect seed from the ONF conifer seed orchard, where seed is collected and stored by individual tree or by seed zone to maximize flexibility.
- Working in partnership with ONP and other land managers, develop a plant conservation framework for forest trees and habitats at risk under changing climate, with an emphasis on nontree species associated with those habitats. An essential component of the framework will be a gene conservation plan for ex situ seed collections for long-term storage, including seed collections from rare species and encompassing the range of variation in widespread species. New areas that may become important for in situ gene conservation will be identified. Forest tree species will be evaluated for relative sensitivity to climate change, and tools and options, such as assisted migration, will be reviewed. A 5-year action plan will be the result of this effort.
- Continue to increase disease resistance in western white pine and whitebark pine. Both of these species are threatened by white pine blister rust, which has caused mortality and reduced vigor in susceptible conifer hosts in many parts of the Western United States (McDonald and Hoff 2001).
- Increase the capacity to restore forest lands after large disturbances:
 - Increase seed production and storage for native tree species that are adapted to a drier or more variable climate. Lodgepole pine, western white pine, western redcedar, and Oregon white oak are candidate species.
 - Be prepared to treat increases in exotic plant species after disturbances by continuing to implement the early detection/rapid response program.
 - Be prepared to seed/plant appropriate native plant species after flooding by increasing the ONF native plant materials program.

Monitoring will be critical in detecting changes in phenology and plant species regeneration, growth, and mortality on the peninsula with changing climate (Joyce et al. 2008). Both ONF and ONP currently conduct vegetation inventory and monitoring, but the forest and park will conduct more integrated and consistent inventory and monitoring of vegetation. Monitoring can be focused on sensitivities identified through expert knowledge of Olympic Peninsula vegetation and climate-sensitive vegetation model projections (such as MCI projections described previously). For example, monitoring could be focused on sensitive locations such as wetlands and high elevations, on endemic or at-risk species, and on plant phenology (both vegetative and reproductive events). Identifying species and ecosystems that are most susceptible to climate change through monitoring can inform prioritization of protection and restoration activities.

Control of exotic species will maximize the resilience of native vegetation on the peninsula with changing climate (Joyce et al. 2009). The ONF will continue to implement their strategy of early detection/rapid response for exotic species treatment, and ONP will increase exotic species control efforts. Treatment of species that have the potential to delay development of desired forest structure will be prioritized. For example, treatment of Japanese knotweed may be prioritized because this species prevents establishment of conifers in riparian forests and thus has a negative effect on coarse wood input to streams and on stream habitat quality. The ONF and ONP could undertake an explicit process to identify desired future forest structure and composition in different locations. The forest and park will also continue to exchange information on exotic species spread and control.

Thinning forest stands at ONF is another potential way to increase resilience to climate change, because thinning can increase water availability and tree growth and vigor by reducing competition (Roberts and Harrington 2008). The ONF currently has a forest thinning program focused on promoting late-successional forest conditions and improving wildlife habitat in young-growth stands, which could help to increase forest and wildlife resilience to climate change. Approximately 0.7 percent of the young-growth stands on the forest are treated annually, and increasing the

amount of thinning could help to further increase resilience to climate change. However, funding for thinning at ONF is limited, and ONF has limited options on where thinning can occur owing to restrictions under the NWFP (fig. 6.10).

In addition to considering an increase in amount of thinning, shifting the strategy in placement of thinning treatments could help to increase broad-scale resilience to climate change. Thinning treatments could be prioritized in locations where climate change effects, particularly increased summer drought, are expected to be most pronounced. Thinning for climate change resilience may also require changes in thinning prescriptions, primarily decreases in forest density and increases in gap size to provide for establishment and vigorous growing conditions for desired tree, shrub, and herbaceous species.

Currently, many unthinned young-growth forests at ONF are characterized by high intertree competition, low tree and plant species diversity, low structural complexity, and declining structural stability (as compared to unmanaged old-growth forests) (Roberts and Harrington 2008). In young-growth forest stands under age 35, tree thinning could be used to reduce intertree competition that causes reductions in species diversity and suppression mortality and stress on trees. This thinning would be conducted to maximize tree growth and vigor by utilizing a uniform thinning with some skips to provide variation in understory growing conditions. This prescription could increase early successional tree species diversity by favoring retention of minor tree species regardless of their size. A wider range of tree species and more complex forest structure may provide resilience to a broader range of climatic conditions (Puettmann et al. 2009).

If the severity of wind events increases with climate change, thinning activities can initially result in increased wind damage until the trees become adapted to the new environment (Roberts et al. 2007). However, over the long term, thinning of young growth can improve tree resistance to wind damage by decreasing tree height-to-diameter ratios (an indicator of the slenderness or taper of a tree bole) (Cremer et al. 1982). Uniformity of young-growth size and density, owing to their even age and high stocking, reduces

the rate of crown differentiation, resulting in high height-to-diameter ratio development (Mitchell 2000, Roberts et al. 2007). Forests developing at these higher densities and located in wind-exposed areas may be too structurally unstable to survive disturbance to old age.

In young-growth forest stands over age 40, thinning could be used to increase structural stability, individual tree vigor, and variability in overstory and understory growing conditions to improve resilience of vegetation to climate change. An initial commercial thinning entry could be used to reduce intertree competition and maximize individual tree growth and vigor. A second commercial thinning entry could be implemented 10 to 20 years later and use variable-tree spacing with skips and gaps. This would likely further release individual trees from competition and provide variability in growing conditions for understory vegetation to improve plant vigor and increase plant diversity (Carey and Wilson 2001).

To favor some of the tree species that may increase in abundance with climate change, such as relatively shade-intolerant western white pine, thinning prescriptions may include larger openings than those created in past thinnings. The ONF could also plant trees in openings to create seed sources for native species expected to increase in abundance with climate change.

Other tools can also be used to improve vegetative growth and vigor by increasing water availability. Within wilderness areas of ONF and ONP, managers employ minimal active management to protect wilderness values and ecosystem processes. In this context, ONP will focus on managing wildland fire in wilderness to create gaps and reduce stand density. In addition, at both ONF and ONP, girdling and prescribed burns could be used to reduce stand density and thus drought stress. To improve wildlife habitat, girdled, thinned, and fire-killed trees can be left as structure rather than being removed.

Key Questions and Future Directions

Climate change is one of many factors that must be considered by managers at ONF and ONP. Thus, projects will not be focused on climate change alone. However, expected effects of climate change can be incorporated into manage-

ment strategies and the project planning process.

Climate change adaptation in vegetation management is essentially a long-term management experiment. Many of the proposed changes in vegetation management discussed above, such as the potential changes in thinning prescriptions, will provide opportunities to implement adaptive management, where feedback from monitoring provides direction for future management. It will be necessary for ONF and ONP to continue to support research, conduct monitoring, and develop tools to address effects of climate change. For example, a sensitivity rating for vegetation based on expected compositional changes could be developed to prioritize management actions. Identifying important triggers for life history events will also be critical in predicting likely vegetation change. These triggers will inform decisions in the future on such activities as assisted migration of plant species that are not currently found on the Olympic Peninsula. Until that time, ONF and ONP will work to increase ecosystem resilience and maintain ecosystem function by using the strategies and actions that have been outlined here.

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Chapter 7: Climate Change, Wildlife Management, and Habitat Management at Olympic National Forest and Olympic National Park

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Potential Climate Change Effects on Wildlife on the Olympic Peninsula

Although wildlife, or native animals, have some ability to cope with changing climate, human-caused climate change, in combination with other stressors to wildlife such as habitat loss and fragmentation, can greatly affect wildlife species and biodiversity (Hannah et al. 2005, Inkley et al. 2004). Similar to plant species, wildlife species will respond individually to climate change, with some species responding negatively and some positively. Species will respond to both direct and indirect effects of climate change. For example, increasing temperatures and changing precipitation will have direct physiological effects on some species. Other species will be affected mostly indirectly through climate-induced changes in phenology (timing of life history) relative to forage plants and invertebrate prey; shifts in geographic ranges and the density and ranges of competitor, forage, prey, and symbiotic species (and subsequent changes in biotic interactions); and effects from other stressors such as disturbance, insects, and disease. Related changes in habitat characteristics and quality will affect animal species viability. These effects will interact with existing stressors, leading to complex responses of wildlife populations to changing climate.

Change is already evident in some wildlife species in response to warming over the last few decades. Changes in species physiology, distribution, and phenology are widely documented and directly attributed to recent warming (Parmesan 2006, Parmesan and Yohe 2003, Root et al. 2003). These recent responses, along with past responses evident in the paleoecological record, and existing knowledge of species physiology and biogeography, can help in projecting how wildlife species will respond to future climate change. By using these lines of evidence, we discuss the potential direct and indirect effects of climate change on wildlife species and populations on the Olympic Peninsula and summarize potential climate change effects on Olympic Peninsula habitats.

Direct Effects of Climate Change on Wildlife

Climate change will lead to warmer temperatures and likely drier summers on the Olympic Peninsula, and these changes will have direct physiological effects on some species. Many species on the peninsula rely on specific microhabitats or microclimates to maintain metabolic functions within physiological parameters. Structural habitat components that mediate microclimate include forest canopy that reduces evaporation and solar radiation; large decaying logs, hollow snags, and leaf litter; and alpine

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environments in which slope, aspect, geologic attributes, and microtopography are controlling factors. Changes in the macroclimate or macrohabitat could either place more importance on these features or negate their ability to meet an animal's needs. For example, species such as the American marten (See "Common and Scientific Names") rely on thermal cover provided by snow in subalpine and montane habitats during winter (Buskirk et al. 1989, Taylor and Buskirk 1994). Reduced snowpack on the Olympic Peninsula because of climate change (Elsner et al. 2010) could expose the marten and other species to lethally cold temperatures during winter.

Bats also rely on specific microclimates in winter hibernacula. Hibernating bats require a cool, stable temperature in the winter to maintain a reduced metabolic rate (Brigham 1993, Fenton 1983, Fenton and Barclay 1980). Bats that either delay entering winter torpor because of higher ambient temperature or are aroused from torpor early because of unseasonably warm weather patterns could face energetic stress if insect prey is unavailable at those times (Humphries et al. 2002).

Endothermic (warm-blooded) species, such as birds and mammals, may have to expend more energy to maintain constant temperature (homeostasis) with higher ambient temperatures in the summer months (Root and Hughes 2005). Thus, higher temperatures may lead to changes in endothermic species' microhabitat choices (e.g., increased retreat to shady habitats) during the summer. However, warmer winters and springs will likely result in less thermal stress on some species. Furthermore, changes in the spatial distribution of preferred habitat (with specific vegetation structure and species composition) will likely have a more direct effect on vertebrate species spatial distribution than on behavioral changes that are directly related to temperature.

Ectothermic (cold-blooded) species, such as reptiles, may benefit from increased temperatures on the peninsula because the peninsula has a relatively cool environment, and reptiles rely on the environment to warm themselves. Other ectothermic species, such as amphibians, rely on cool, moist microhabitat conditions to prevent overheating and desiccation. High temperatures can be lethal to amphibians,

but amphibian species are generally adapted to a range of temperatures typical for their environment, making direct mortality from high temperatures rare (Carey and Alexander 2003). However, the amount and timing of precipitation can greatly affect the yearly reproductive output of an amphibian population (Carey and Alexander 2003). For example, because most amphibians lay eggs in standing water (Duellman and Trueb 1985), too little rainfall can result in egg and larval desiccation (Carey and Alexander 2003). At the opposite extreme, too much precipitation at certain times during egg and larval development can lead to egg and larval mortality (Carey et al. 2005). Adult terrestrial amphibians are also susceptible to desiccation because of high rates of water loss from the skin and respiratory systems (Shoemaker et al. 1992). Survivorship may further decline during severe drought because low moisture levels can limit amphibian activity, mobility, ability to evade predators, and food supply (Carey and Alexander 2003).

These examples illustrate that the extremes in temperature and precipitation, rather than the means, often have major effects on animal species. Because events such as drought and intense precipitation are expected to increase on the Olympic Peninsula, species will need to cope with increased frequency of extreme events. The Olympic torrent salamander (fig. 7.1), Cascades frog (fig. 7.2), and Van Dyke's salamander are examples of species that may be directly affected by extremes in temperature and precipitation, and related changes in hydrology.

Indirect Effects of Climate Change on Wildlife

Phenological shifts—

Warming temperatures with climate change will likely alter seasonal climate patterns. For example, on the Olympic Peninsula and in temperate ecosystems in general, climate change will likely result in earlier snowmelt, a shorter winter season, earlier onset of spring, and a longer growing season (Elsner et al. 2010, Menzel et al. 2003). Plant and animal life cycles are closely linked with changing seasons, and changes in seasonality with climate change will likely lead to altered phenology, or timing of life history events, of both plant and animal species. These phenological shifts



Figure 7.1—The Olympic torrent salamander is endemic to the Olympic Peninsula and is an example of a species that will likely be sensitive to extremes in temperature and precipitation, and related changes in hydrology, with climate change. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)



Figure 7.2—The Cascades frog will likely be sensitive to changes in hydrology and wetland habitats that occur with climate change on the Olympic Peninsula. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)

will likely influence wildlife, their food sources, and habitat attributes on the Olympic Peninsula.

Animal life history events that can be affected by changing seasonality include emergence from hibernation, mating, and migration. Plant species also respond to changing seasonality by shifting the timing of bud break, flowering, and fruiting, and insects respond by varying timing of emergence. However, the shifts in timing of life history events between trophic levels (e.g., plants, herbivores, predators) may not be proportionate or parallel. Varied phenological response to warming between trophic levels could result in mismatches in formerly coordinated phenology of animals and their food sources, leading to decreasing fitness and possibly mortality in some wildlife populations (Both et al. 2006, ISAB 2007, Parmesan 2006, Root and Hughes 2005). For example, for species that have specialized diets and carefully balanced energy budgets, such as bats, a shift in the timing of invertebrate prey availability could result in reduced survival or fecundity.

Concurrent with a 1.4 °C rise in local temperatures at the Rocky Mountain Biological Laboratory in Colorado between 1975 and 1999, yellow-bellied marmots began emerging from hibernation about 23 days earlier (Inouye et al. 2000). However, the flowering plant phenology did not shift in that period because warmer temperatures were

coupled with increased precipitation and snowpack. Thus, the change in marmot behavior decoupled the relative phenology of marmots and their food plants (Inouye et al. 2000). Analogous mismatches could occur on the Olympic Peninsula. In contrast to the Colorado example, however, warmer temperatures on the Olympic Peninsula will likely lead to decreased snowpack, regardless of changes in precipitation, owing to the relatively warm conditions on the peninsula (Elsner et al. 2010). Thus, plant emergence and growth could remain synchronous with emergence of the Olympic marmot (fig. 7.3) and other hibernating wildlife species. Shifts in timing of migration could also impair foraging efficiency of some species. For example, some bird species are arriving earlier at summer breeding grounds in response to warming in the second half of the 20th century (Butler 2003, Inkley et al. 2004, Inouye et al. 2000, Sparks 1999, Tryjanowski et al. 2002). However, food resources at summer breeding grounds may not be as available earlier in the spring (Inouye et al. 2000) because warming patterns differ spatially and species respond individualistically to changing climate.

Changes in seasonality could also influence habitat suitability. For example, some amphibians produce eggs and move to breeding ponds based on temperature and moisture.



Figure 7.3—The Olympic marmot is endemic to the Olympic Peninsula. Warming temperatures with climate change will likely reduce snowpack and alter forage species composition and phenology in the alpine and subalpine habitats that marmots inhabit. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)

These species may encounter mismatches between breeding phenology, pond drying, and arrival at the pond (WGA 2008).

Examples of species shifting phenology in response to climate change in the late 20th century are not isolated (ISAB 2007). Rather, substantial evidence exists that phenological shifts are already underway for a variety of plant, animal, and insect species (e.g., Parmesan 2006, Parmesan and Yohe 2003, Root et al. 2003, Walther et al. 2002). A meta-analysis by Parmesan and Yohe (2003) concluded that most of 677 species studied show trends toward spring advancement in the last few decades, with earlier frog breeding, bird nesting, first flowering, tree budburst, and arrival of migrant birds and butterflies. These consistent and directional responses to warming of about 0.6 °C (Pachauri and Reisinger 2007) over the last century suggest that there will be even more far-reaching effects on species as the climate warms at an increasing rate (Root et al. 2003). Although quantitative data on phenological shifts on the Olympic Peninsula are lacking, peninsula species likely have and will be similarly affected by increasing temperatures.

Distribution shifts—

Species occurrence (range) partially depends on the availability of suitable climatic conditions, along with other factors such as habitat suitability, food availability, and interactions with other species (MacArthur 1972). Wildlife species respond to climate and habitat variability in the short term through shifts in geographic range (migration) when suitable conditions are not present in the former range. Where suitable climates and habitat are no longer present, mortality and local population contraction and extirpation often occur in parts of a species' former range (Grayson 2006). For example, contraction or local population extirpations may occur at the southern end of a species range with warming, while at the same time, there are increases in northward colonization. Over time, extirpation and colonization events cumulatively result in shifts of species' distribution ranges. Shifts in animal species' geographic ranges owing to physiological constraints and changes in plant species distribution and habitat structure, as well as shifts in the abundance and phenology of associated species (competitors, predators, prey, and forage species) will interact to determine how climate change affects species and communities.

Species ranges will probably move northward and to higher elevations as temperature increases (Parmesan 2006). However, range shifts will depend on factors such as degree and speed of vegetation change, specific habitat conditions, shifts in distribution of competitors and predators, changes in precipitation patterns, species' physiological requirements, and species' differential sensitivity and response to various aspects of changing climate (e.g., increase in minimum temperature versus maximum temperature) (Inkely et al. 2004). The ability of wildlife species to disperse or migrate will depend on the availability of migration corridors and suitable habitats, and the concurrent movement of forage, prey, and cover (Inkely et al. 2004). For example, high-elevation species will likely be particularly sensitive to warming temperatures and experience range contractions (Moritz et al. 2008) because contiguous, higher elevation habitat may not be available to colonize. Soil formation at higher elevations is a slow process, and vegetation establishment at higher elevations

may not occur quickly enough to provide habitat under rapid warming. Snowpack at higher elevations may also be prohibitive. Similarly, it may be more difficult for endemic and specialist species with strict habitat requirements or dependencies on specific forage species to find suitable habitat conditions under changing climate, whereas generalist species with high climatic tolerance, broad habitat and forage requirements and high dispersal ability will likely increase in abundance under a changing climate (Pounds et al. 2005). Barriers such as topographic features and habitat fragmentation could further inhibit potential range shifts (Inkley et al. 2004). For example, the Strait of Juan de Fuca will inhibit northward movement of terrestrial species on the peninsula, although new species could move onto the peninsula from the south.

Recent observed shifts in species ranges are consistent with those expected under a warming climate, and examples of shifts in species ranges from around the world are numerous (Parmesan 2006, Parmesan and Yohe 2003, Root et al. 2003, Walther et al. 2002). An analysis of recent range shifts of 99 species of birds, butterflies, and alpine herbs in the Northern Hemisphere showed an average shift in species' range boundaries of 6.1 km northward or 6.1 m upward in elevation per decade (Parmesan and Yohe 2003). Similarly, an analysis of 40 years of Audubon Society Christmas Bird Count observations showed that 177 of 305 bird species seen in North America during the first weeks of winter have moved northward (Audubon 2009). The average distance moved was 56 km, but more than 60 species moved more than 160 km north. Annual altitudinal shifts were correlated with annual temperature.

There is also evidence that small mammals are shifting their ranges in response to warming; an analysis by Moritz et al. (2008) in Yosemite National Park showed that half of 28 small mammal species monitored over the last century shifted their elevation limits upward an average of about 500 m, consistent with the observed warming trend in the region. As expected, range shifts are associated with population losses for some species, and other species' extinctions are attributed to recent climate change (Beever et al. 2003; Parmesan 1996; Pounds et al. 1999, 2006). Moritz et al. (2008) found that range contractions were more

likely for high-elevation small mammal species, whereas range expansions were more likely for lowland species that are short lived and more productive than their long-lived, less fecund counterparts.

Some Olympic Peninsula species will probably respond similarly to increasing temperature by shifting their ranges upward in elevation. The degree and rate of species' distribution changes will depend on several factors, including species' physiological constraints, the speed and nature of vegetation change, habitat suitability, barriers to dispersal, and interactions with other species. For subalpine meadow and alpine meadow habitat specialists such as the Olympic marmot (fig. 7.3), western heather vole, and Olympic pocket gopher, there may not be any suitable habitat conditions available at higher elevations. These species are found at the highest elevations of many ridge systems; on other ridge systems or mountains, these species will not be able to survive unless snowpack is sufficiently low in summer and deep soils and meadow vegetation develop. However, declines in snowpack with warming will be lower at the highest elevations (>2000 m): (Elsner et al. 2010), and soil development may take decades to centuries. Furthermore, it is not clear if these rodents will be able to establish new populations if there are barriers to their dispersal.

Biotic interactions—

As species individually shift their ranges in response to a warming climate, novel predator-prey interactions and new interspecific interactions will develop among species (ISAB 2007, Schmitz et al. 2003). Predicting future interspecific interactions is very difficult, although clearly new interspecific interactions, as with all climate change effects, will positively affect some species and populations, and negatively affect others. For example, movement of a predator out of portions of a prey species' range will allow the prey species to expand but may reduce predator fitness owing to decreased prey availability. In contrast, the movement of a predator into new areas could negatively affect prey species. The range expansion of the coyote into high-elevation areas on the peninsula, for example, may be having a negative impact on Olympic marmot (fig. 7.3) populations (Griffin et al. 2008, Witzuk 2007). Bobcat

populations could have similar effects on prey species if they begin spending more time at higher elevations with warming temperatures and reduced snowpack. Movement of competitors could also influence species abundance and viability. Although not necessarily related to climate change, the negative influence of the barred owl (native to North America but relatively new to western North America) on the specialist northern spotted owl is a good example of how new competitive interactions can lead to pronounced effects on species distributions and viability (Kelly et al. 2003).

Changes in interspecific interactions with climate change will include changing interactions with exotic species, as well as pests and pathogens. New exotic species will likely establish with changing climatic conditions (Hellmann et al. 2008). Some existing exotic species will likely expand with climate change, because ecosystem disturbance and shifts in native species ranges will provide opportunities for exotic establishment. Some exotic species are invasive, with characteristics that facilitate their expansion and dominance under changing climate, such as broad climatic tolerances and high dispersal ability (Hellmann et al. 2008).

Parasites, pests, and pathogens are also expected to respond to climate change. Forest pests and pathogens could have widespread effects on wildlife habitat quality on the peninsula (see chapter 6 for more details). Increased temperatures and moisture at mid-latitudes could accelerate parasite vector and pathogen life cycles, improve survival by relaxing overwintering restrictions, and lead to northward expansion of tropical and subtropical pathogens (Harvell et al. 2002, Inkley et al. 2004). Shifting ranges of wildlife species will lead to new disease exposures (Brooks and Hoberg 2007), and shifts in parasite vectors will introduce new diseases (Kovats et al. 2001, WGA 2008). Climate warming can also increase host susceptibility to diseases (Harvell et al. 2002). Increases in parasites and infectious diseases associated with climate change have the potential to influence the size of wildlife populations and accelerate species extinctions (Harvell et al. 2002, WGA 2008).

Interaction with other stressors—

Climate change will not act alone in influencing wildlife populations on the Olympic Peninsula in the coming decades. Instead, climate change will act synergistically with other stressors to affect wildlife populations (Inkley et al. 2004, WGA 2008). Current stressors that influence wildlife on the peninsula and many ecosystems across the Western United States include land use legacies, ongoing habitat loss and fragmentation, altered disturbance regimes, disease, and exotic species. Land use changes and introduction of exotic species can impede the ability of species to adaptively respond to climate change (Hansen and DeFries 2007). For instance, many land use changes impose barriers to species' migration to favorable new environments, small population sizes and isolation resulting from land uses impedes gene flow, and landscape fragmentation reduces corridors for movement (Joyce et al. 2008). At Olympic National Forest (ONF), historical widespread logging activity reduced the area of late-successional forest and isolated existing late-successional forest patches, which could impede adaptive response of species with low dispersal ability. Highways and land converted to agricultural, residential, or industrial uses further fragments the Olympic Peninsula. The spread of exotic species on the peninsula may cause a reduction in forage plants on which some wildlife species depend, thus making it more difficult for these species to respond adaptively to climate change. These interactions increase uncertainty and complicate actions to mediate climate change effects, but also suggest that treatment of other stressors (e.g., exotic species and habitat fragmentation) may help alleviate the negative effects of climate change.

Potential Genetic Responses to Climate Change

It is possible that wildlife species will respond to changing climate through genetic change. However, the expected rates of increase in temperature with climate change are greater than those of the past, making it difficult to predict genetic response (ISAB 2007). Evidence exists for adaptive genetic change in some species in response to changing climate, including mosquitoes, fruit flies, birds, and squirrels (Bradshaw and Holzapfel 2006, ISAB 2007). The adaptive

genetic changes all involved adaptation to the timing of seasonal events or to season length (Bradshaw and Holzapfel 2006). In mosquitoes, which have the shortest generation times of this group, evolutionary change occurred in as little as 5 years. Changes for squirrels and birds were smaller and became apparent only over longer periods (10 to 30 years), suggesting that larger and longer lived species may experience population decline or be replaced by other species (Bradshaw and Holzapfel 2006). Habitat fragmentation and resulting population isolation that prevents gene flow is a barrier to this type of genetic response. Although such evolutionary responses occur, there is little evidence that the responses are of the type or magnitude to prevent species extinctions (Parmesan 2006), because the rate and magnitude of climate change may overwhelm a species' capacity for genetic change (Barnosky and Kraatz 2007).

Potential Climate Change Effects on Olympic Peninsula Habitats

Related to the potential direct and indirect effects of climate change on wildlife, there are also many potential climate change effects on wildlife habitats on the Olympic Peninsula. A description of potential effects of climate change on Olympic Peninsula habitat types and related species follows (see chapter 6 for more detailed information on potential vegetation changes).

Varied climatic conditions on the peninsula result in highly varied ecological communities, and thousands of years of geographic isolation have resulted in fauna that are distinct from those in the Cascade Range to the east. There are several endemic wildlife species, including the Olympic marmot (fig. 7.3), the Olympic pocket gopher, and Roosevelt elk. Wildlife on the Olympic Peninsula is noteworthy not only for its endemic species, but also for species missing from the Olympics yet found elsewhere in western mountains, including American pika, white-tailed ptarmigan, ground squirrels, Canada lynx, red fox, wolverine, grizzly bear, and bighorn sheep. Historically, mountain goats and coyote did not occur on the Olympic Peninsula.

Glaciers and snowfields—

At the highest elevations on the Olympic Peninsula, warming temperatures will likely cause loss of snowpack and

snowfields and recession of glaciers (Elsner et al. 2010). The greatest effects of reduced snowpack and glacial recession will be hydrologic; loss of glaciers, decreased snowpack, and earlier snowmelt with warming temperatures will reduce water availability in summer months in glacier- and snowmelt-fed streams, lakes, and wetlands (Elsner et al. 2010). Although glaciers and snowfields currently provide habitat for only a few species, such as the gray-crowned rosy finch, the loss of snowpack with warming may allow vegetation establishment in these areas, leading to improved habitat conditions for other high-elevation wildlife species. In the short term, vegetation establishment will be limited to areas with substrate that is favorable to rapid soil development, such as shallow-gradient slopes with deep layers of fine-grained glacial till. The more rocky (scree, talus, boulder) areas from which snow or glaciers retreat will not be hospitable to soil development in the short term.

Alpine tundra—

Alpine tundra provides seasonal habitat for a variety of wildlife species on the Olympic Peninsula, including Roosevelt elk, North American black bear, and the western heather vole (table 7.1). Similar to effects on glaciers and snowfields, warming temperatures will likely reduce snowpack and cause earlier snowmelt in alpine tundra habitats. These conditions could favor tree establishment, provided that the soils in tundra areas can sustain trees. Several paleoecological studies show the expansion of subalpine fir into alpine tundra in the northeastern portion of the Olympic Peninsula during historically warm periods (Brubaker and McLachlan 1996, Gavin et al. 2001, McLachlan and Brubaker 1995). Warmer temperatures and increased tree establishment may lead to loss of tundra habitat (see MC1 model output in chapter 6). The paleoecological record does not provide evidence that the highest (>1800 m in elevation) alpine habitats underwent great change during past warm periods (Gavin et al. 2001, McLachlan and Brubaker 1995), suggesting that only high levels of warming (>1–2 °C) may result in major changes in the highest alpine areas. However, anthropogenic climate change may be characterized by more extreme temperature increases than past warming periods, and warming greater than 1.0 to 2.0 °C is projected

Table 7.1—Olympic Peninsula habitat types, generally from highest to lowest elevation, and associated species most likely to be influenced by climate change and related changes in habitat^a

Habitat type	Associated species likely to be influenced by climate-induced habitat changes
Alpine tundra	Black bear, mountain goat, Olympic marmot, Olympic pocket gopher, Roosevelt elk, western heather vole
Talus fields	Gray-crowned rosy finch
Subalpine	Black bear, bobcat, coyote, mountain goat, snowshoe hare, Clark's nutcracker
Wet meadows	Black bear, coyote, Olympic marmot, Roosevelt elk, western heather vole, dog star skipper butterfly
Dry meadows	Black bear, coyote, Olympic marmot, Olympic pocket gopher, Roosevelt elk, dog star skipper butterfly, Taylor's checkerspot butterfly
Montane forest	American marten, black bear, bushy-tailed woodrat, coyote, mountain beaver, northern flying squirrel, Pacific fisher, Roosevelt elk, snowshoe hare, barred owl, Northern spotted owl, ensatina
Lowland forest	American marten, black bear, bushy-tailed woodrat, coyote, mountain beaver, northern flying squirrel, opossum, Pacific fisher, porcupine, Roosevelt elk, barred owl, marbled murrelet, northern spotted owl, northern alligator lizard, ensatina, Van Dyke's salamander, warty jumping slug
Riparian and flood-plain habitat	Pacific fisher, American dipper, hairy woodpecker, harlequin duck, hooded merganser, red-breasted sapsucker, wood duck, chorus frog, red-legged frog, Van Dyke's salamander, western toad, warty jumping slug
Lakes, wetlands, and bogs	Garter snake, Cascades frog, long-toed salamander, northwestern salamander, western toad, Makah copper butterfly
Prairies and balds	Roosevelt elk, American kestrel, pallid horned lark, dog star skipper butterfly, Taylor's checkerspot butterfly
Caves and mines	Keen's myotis bat, little brown bat

^a Species are grouped by vertebrate phylogenetic class (mammals, birds, reptiles, amphibians) and invertebrates, and listed alphabetically within group. The species included in this table were identified by Olympic National Forest; Olympic National Park; Forest Service, Pacific Northwest Research Station; and U.S. Geological Survey specialists as being high profile or most likely to be influenced by climate change, or both. This is not an exhaustive list of species that will be influenced by climate change on the peninsula.

to occur in the Pacific Northwest by the middle to late part of the 21st century (Mote and Salathé 2010). Even in the persistent alpine tundra habitats, increased summer drought could decrease berry production, likely causing reduced fitness of berry-dependent species such as North American black bear. Decreased berry production and berry crop failures may also force species such as black bear to search for other food sources, which could bring them into greater conflict with humans.

Talus fields—

Decreased snowpack and earlier snowmelt will likely cause changes in microenvironments in talus fields, particularly decreased moisture in the later parts of the growing season. However, cover of talus fields may increase with decreased

snow cover, providing additional habitat for species such as the gray-crowned rosy finch (table 7.1).

Subalpine habitat—

Subalpine habitats on the Olympic Peninsula will likely experience decreased snowpack and earlier snowmelt with warming temperatures. These conditions will cause changes in vegetation community composition, with likely increases in tree establishment and growth, and thus loss of meadow habitat. Mortality of whitebark pine caused by white pine blister rust, and potentially by climate-induced outbreaks of mountain pine beetle (see chapter 6), will impact species that depend on whitebark pine, most notably the Clark's nutcracker (fig. 7.4).



Figure 7.4—Species such as the Clark's nutcracker that depend on whitebark pine will be impacted by mortality of whitebark pine caused by white pine blister rust, and potentially by climate-induced outbreaks of mountain pine beetle. (Photo courtesy of USDA Forest Service, Olympic National Forest.)

Meadows—

Wet meadow habitat, which occurs primarily in high snow areas on the west side of the Olympic Peninsula, will likely decrease with warming because of changes in hydrology (decreased snowpack and earlier snowmelt leading to earlier runoff and increased summer drought). Decreases in this habitat could influence wet meadow-dependent species, such as the western heather vole (table 7.1). However, dry meadow habitat, which occurs primarily in the rainshadow in the northeastern portion of the Olympic Peninsula, may increase with increased fire frequency and increased drought limitations on tree species distribution (Littell et al. 2010). Increased area of dry meadows could provide additional habitat for species such as the Olympic marmot (fig. 7.3), Olympic pocket gopher, and Taylor's checkerspot butterfly (fig. 7.5) (table 7.1). Alternatively, upward-elevation shifts in tree line could result in tree encroachment of meadows and decreased meadow habitat. Also, increased temperatures may lead to changes in species composition in both wet and dry meadows, with the potential for increases in exotic species.

Montane forests—

Montane forest habitats on the Olympic Peninsula, including forests dominated by Pacific silver fir, Douglas-fir, and western hemlock, will likely experience a variety of



Figure 7.5—Taylor's checkerspot butterfly is a federally listed sensitive species that uses meadow and prairie habitat on the Olympic Peninsula. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)

changes with a changing climate. Reduced snowpack and more precipitation falling as rain rather than snow will shift the timing of runoff and increase summer drought (Elsner et al. 2010), and thus potentially decrease the area of headwater riparian habitat in montane forests. Decreases in headwater habitat could influence species that depend on this habitat, such as the Olympic torrent salamander (fig. 7.1) and Cope's giant salamander (fig. 7.6). Increased summer drought and reductions in soil moisture could influence species such as the mountain beaver (fig. 7.7) that require



Figure 7.6—Cope's giant salamander inhabits headwater streams and may be affected by decreased summer low flows on the Olympic Peninsula with climate change. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)



Figure 7.7—Increased summer drought and reductions in soil moisture with climate change could influence species such as the mountain beaver that require moist soils for digging burrows. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)

moist soils for digging burrows (table 7.1). Changes in hydrology may also affect seeps and springs, which provide critical habitat for peninsula species such as Van Dyke's salamander and the Olympic torrent salamander (table 7.1).

Increased temperatures with climate change will likely lead to shifts in plant species distribution, influencing the composition and thus habitat characteristics of montane forests on the Olympic Peninsula. Species such as western hemlock and Douglas-fir will likely increase in abundance in forests currently dominated by Pacific silver fir. Species such as Douglas-fir and lodgepole pine may increase in abundance in forests currently dominated by western hemlock and Douglas-fir. Changes in species phenology, and related changes in production of wildlife food sources such as berries, will likely influence the quality of habitat provided by montane forests for species such as the North American black bear. Increased frequency of disturbances, such as fire, insect outbreaks, wind events, and drought, will also influence montane forest habitat. Initially (and without management intervention) increased disturbance frequency will likely lead to increases in snags and coarse woody debris, which will benefit some species such as birds, amphibians, and mammals that use these habitat elements. Drought- and fire-induced reduction in forest

density may lead to more open-canopied forests and larger residual trees. However, repeated fires may eventually lead to a reduction in legacy structures and an increase in early seral forest, with negative consequences for species that rely on large trees and mature forest conditions, such as the northern spotted owl and marbled murrelet.

Prairies and balds—

Some prairies on the Olympic Peninsula were created and maintained by Native American burning (Peter and Shebitz 2006). Without fire, tree and shrub encroachment can reduce prairie habitat quality. Increased fire with warming on the peninsula may increase the quality of prairie habitat for dependent species such as the Taylor's checkerspot butterfly (fig. 7.5). However, increased temperatures could also lead to changes in plant species composition, with the possibility of increased exotic species and reduced habitat quality.

The presence of balds on the Olympic Peninsula is primarily controlled by edaphic conditions; balds largely exist in areas where soils are too shallow and dry to support trees (Chappell 2006). Increased fire frequency with climate change could increase the area of balds by killing small young trees on the margins (Chappell 2006). However, increased drought and fire frequency associated with climate change may also affect composition in the unique and relatively species-rich plant communities that inhabit balds, possibly increasing establishment of exotic species.

Lowland forests—

Similar to the outlook for montane forests, a variety of potential effects of climate change may occur in lowland forests of the Olympic Peninsula, including forests dominated by Douglas-fir, western hemlock, and Sitka spruce. Climate-induced changes in hydrology, phenology, forest species composition, and increased disturbance will affect these lowland forests. Increased drought could decrease forest productivity in lowland forests and increase abundance of more drought-tolerant species, such as Douglas-fir and western redcedar. Also, projected increases in winter precipitation and precipitation intensity on the peninsula (Elsner et al. 2010, Salathé et al. 2010) and the effects on hydrologic regimes (see chapter 4) will affect lowland

forests through increased frequency and magnitude of flooding and disturbance in riparian areas (scouring, removal of off-channel areas, deposition, and transport of woody debris). The current prevalence of exotic plant species in this forest type on the peninsula, coupled with projections for increased disturbance, suggest that exotics may become even more common with climate change in lowland forests. Because some exotic plants are also invasive and can outcompete native species on which wildlife species depend, an increase in exotic plants may have negative consequences for some wildlife species.

Increases in disturbances such as wind events and flooding may decrease the area of late-successional forests, on which species such as the northern spotted owl and marbled murrelet depend. However, increased disturbance may also lead to increased abundance of sprouting deciduous hardwoods, such as red alder and bigleaf maple, which can provide nesting and foraging habitat for some woodpecker species and Neotropical migrants, as well as leaf litter that increases habitat quality for some mollusks and salamander species. Increased disturbance and drought may also lead to increased abundance of mast-producing species, such as Pacific madrone and Oregon white oak (see chapter 6).

Riparian habitat—

As described above, altered hydrologic regimes will likely increase flood frequency and disturbance in riparian areas. Additional scouring, sediment deposition, and transport of woody debris from flooding will influence habitat characteristics in streams and adjacent riparian forests. Increased flooding severity may decrease flood-plain complexity and sinuosity of rivers, thereby reducing flood-plain habitat complexity and habitat quality for amphibian species. Increased disturbance frequency and severity in riparian areas could also reduce the area of mature riparian conifer forests and increase area of younger riparian forests dominated by deciduous hardwoods, which could degrade habitat quality for some birds and other species that use older conifers. However, deciduous hardwoods can provide valuable nesting habitat for cavity-nesting ducks and nesting and foraging habitat for some woodpecker species and Neotropical migrant birds.

Besides increased flooding, changes in hydrology with climate change will exacerbate summer drought, reduce streamflow, and produce drier conditions in adjacent riparian areas. These increases in extremes (both flooding and drought) may make riparian and flood-plain habitat less hospitable for wildlife species, such as the Pacific chorus frog, western toad, and red-legged frog (table 7.1). More frequent disturbance may also make these areas more prone to exotics, such as Japanese knotweed, which may outcompete native species and influence habitat quality for species such as songbirds. However, increased heat and drought may improve habitat for some species, such as the northern alligator lizard, because the peninsula is currently a relatively cool environment, and reptiles rely on the environment to warm themselves.

Lakes, wetlands, and bogs—

Reduction in snowpack and changes in timing of runoff with warmer temperatures will likely lead to drying of some wetland habitats, such as alpine ponds and wetlands, reducing habitat quality for dependent species such as the Cascades frog (fig. 7.2), northwestern salamander, long-toed salamander, and garter snakes. Wildlife species that depend on wetlands may be particularly sensitive to changing habitat conditions with climate change because there is little opportunity for migration to other suitable habitat (Burkett and Kusler 2000).

Cliffs, caves, and mines—

Increases in air temperatures with climate change could affect the temperatures of cliff habitats, thus affecting nesting conditions for birds that rely on cliff habitats. However, cave and mine habitats, along with other forest structures with similar microclimates, will likely remain thermal refugia, and for this reason, may become more important with climate change.

Wildlife and Habitat Management at Olympic National Forest and Olympic National Park

This section provides information on wildlife and habitat management at ONF and ONP, including (1) the context in which ONF and ONP manage wildlife and habitat,

(2) guidance and constraints on wildlife and habitat management at ONF and ONP, and (3) the primary issues around and activities currently conducted in wildlife and habitat management at ONF and ONP. This information, coupled with the likely effects of climate change on wildlife and their habitats on the Olympic Peninsula (described above), provide a basis on which to develop climate change adaptation options for wildlife and habitat management at ONF and ONP.

Policy Guidance and Goals

Both ONF and ONP manage wildlife habitat to maintain biodiversity, prevent extinctions of native species that are federally listed as threatened or endangered, and maintain healthy populations of all native species. Olympic National

Forest manages wildlife habitat under the direction of the Northwest Forest Plan (NWFP) (USDA and USDI 1994) and the 1990 Olympic Land and Resource Management Plan (USDA FS 1990). At ONF, a major land allocation under the NWFP is the late-successional reserve (LSR) allocation in which the goal is to maintain interactive, late-successional and old-growth forest ecosystems. A fundamental goal of LSRs is to provide habitat for late-successional and old-growth-related species, including the northern spotted owl. Other goals for managing wildlife habitat at ONF include maintaining biodiversity and sufficient habitat to ensure viable populations and prevent extinctions of all native species. Special attention is given to native species that are federally listed as threatened, endangered, or sensitive

Table 7.2—Federally listed threatened (T) and endangered (E), and state (WA-S) and federally listed sensitive (S) terrestrial wildlife species on the Olympic Peninsula^a

Common name	Scientific name	Status
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	S
Olympic marmot	<i>Marmota olympus</i>	WA-S
Pacific fisher	<i>Martes pennanti</i>	S
Keen's myotis	<i>Myotis keenii</i>	WA-S
Olympic pocket gopher	<i>Thomomys mazama melanops</i>	WA-S
Marbled murrelet	<i>Brachyramphus marmoratus</i>	T
Common loon	<i>Gavia immer</i>	WA-S
Bald eagle	<i>Haliaeetus leucocephalus</i>	S
Harlequin duck	<i>Histrionicus histrionicus</i>	S
Northern spotted owl	<i>Strix occidentalis caurina</i>	T
Cope's giant salamander	<i>Dicamptodon copei</i>	S
Van Dyke's salamander	<i>Plethodon vandykei</i>	WA-S
Olympic torrent salamander	<i>Rhyacotriton olympicus</i>	WA-S
Johnson's hairstreak butterfly	<i>Callophrys johnsoni</i>	S
Puget Oregonian snail	<i>Cryptomastix devia</i>	S
Evening fieldslug	<i>Deroceras hesperium</i>	S
Taylor's checkerspot butterfly	<i>Euphydryas editha taylori</i>	S
Keeled jumping-slug	<i>Hemphillia burringtoni</i>	WA-S
Warty jumping-slug	<i>Hemphillia glandulosa</i>	S
Malone jumping-slug	<i>Hemphillia malonei</i>	WA-S
Oregon megomphix mollusk	<i>Megomphix hemphilli</i>	WA-S
Olympic arctic butterfly	<i>Oeneis chryxus valerata</i>	WA-S
Dog star skipper	<i>Polites sonora siris</i>	WA-S
Blue-gray tailedropper slug	<i>Prophysaon coeruleum</i>	WA-S
Hoko vertigo snail	<i>Vertigo</i> n. sp. (new unnamed species)	WA-S

^a Species are grouped by vertebrate phylogenetic class (mammals, birds, reptiles, amphibians) and invertebrates, and listed alphabetically by scientific name within group.

(TES) or classified as sensitive under the Pacific Northwest regional forester's sensitive species program (table 7.2).

Besides managing for TES species, ONF manages for species classified as management indicator species. Indicator species are chosen to reflect an assemblage of species having similar habitat or ecosystem affinities and requirements, with an assumption that management that maintains or enhances the habitat of indicator species will also benefit the larger assemblage of species. Seven species, or groups of species, have been selected as indicators at ONF. These include primary excavators as indicators for snag-dependent cavity nesters; Roosevelt elk and Columbia black-tailed deer as game species indicators; American marten and pileated woodpecker as mature coniferous forest species indicators; northern spotted owl as an old-growth forest species indicator; and bald eagle as a riparian/mature forest species indicator. Additional management direction guides habitat maintenance for game species. The park's wildlife management program promotes sustaining a full range of natural genetic variability and long-term viability through maintenance of wildlife population age-structures, abundance, density, and distributions within normal ranges.

When adequate habitat exists and several additional criteria are met, National Park Service management policies (NPS 2006) direct park managers to restore extirpated native species such as the Pacific fisher, which is believed to have been extirpated from the state of Washington. In 1988, the Pacific fisher was listed as a state endangered species in Washington state, and in 2004 as a federal candidate species (west coast distinct population segment). In 2004, the Washington State Department of Fish and Wildlife completed a feasibility study, concluding that the Olympic Peninsula was best suited as a release site for the initial restoration of Pacific fisher to the state. In 2008, a multiyear, interagency program began to restore Pacific fishers to the Olympic Peninsula, with releases over a 3-year period in ONP. This program also addressed a National Park Service policy objective of restoring a full complement of native species to ONP. At present, the only native species absent from the park is the gray wolf. Although there are no current proposals to reintroduce the wolf, the return of wolves could influence populations and distributions of herbivores, which

would affect riparian vegetation communities (Beschta and Ripple 2008), and potentially ecosystem resiliency to climate change.

Habitat Improvement and Restoration Activities

Activities to improve wildlife habitat quality at ONF include snag and coarse wood creation, pruning, cavity treatments, forage plantings, and mechanical treatments to maintain open habitats. Snag creation, often conducted in thinning treatments, can include blasting or removing the tops of trees with chain saws, inoculation with local stem decay fungi, or girdling. Biologists also install nest boxes for northern flying squirrels. Coarse wood treatments include creating furrows in felled trees, piling fine or coarse downed wood, and bundling logs together from felled trees to create coarse wood structures. Pruning treatments include pruning of understory shrubs or hardwood trees to stimulate sprouting and increase availability of big game browse or suitability for shrub-nesting birds. Treatments include creating artificial cavities in topped or live trees to benefit cavity-using wildlife. Forage plantings for large game include planting willow and red-osier dogwood. Mechanical treatments (chain saws and loppers) include removing salmonberry and some small conifers from areas that were once meadow or openings created from earlier management practices.

Within ONF, road decommissioning and culvert installation improve habitat for fish and aquatic species, as well as some terrestrial wildlife species. For example, road decommissioning and culvert installation can improve water quality and access to habitats for species that have an aquatic phase, such as the Olympic torrent salamander (fig. 7.1), tailed frog, and Cope's giant salamander (fig. 7.6). Many vegetation management activities (described in chapter 6) can also be considered wildlife habitat restoration activities at ONF. For example, thinning in young stands (40 to 80 years old) focuses on creating forest structural diversity intended to accelerate the development of late-successional forest characteristics used by old-growth-dependent species such as the northern spotted owl and marbled murrelet. Young plantations that are proximal to old-growth forests receive priority for thinning treatments to increase the area

of contiguous old-growth habitat. Habitat improvement for Roosevelt elk is also a factor in setting priorities for thinning. Wildlife habitat provisions in silvicultural prescriptions focus on snag and coarse woody debris density and distribution at the watershed scale.

Olympic National Park works to restore ecosystems, habitats, and disturbance regimes altered by human activities or exotic species. As the park acquires private properties from willing sellers within the park boundaries, biologists work to restore these sites by planting native species propagated from adjoining areas.

Within aquatic systems of the park, management priorities include pollution prevention, protection of riparian and lake habitat, and water quality maintenance to meet the needs of aquatic organisms. A major restoration effort is underway to remove two dams from the Elwha River. Dam removal will occur over a 2-year period beginning late in 2011, with active fish and vegetation restoration projects occurring during several years thereafter. After this restoration project, the river will support all five species of Pacific salmonids that inhabited the river before dam construction. Succession of riparian communities over the next several years to decades will provide habitat for a variety of mammals and birds. In preparation for dam removal, biologists conducted baseline surveys in the Elwha valley to assess occurrence and distribution of North American black bear, riparian carnivores, small mammals, beavers, otters, amphibians, and birds. Prior studies on prey base adequacy for wolves examined Roosevelt elk and Columbia black-tailed deer distribution and density in the Elwha and other drainages in the park (Jenkins and Manley 2008).

Surveys and Monitoring

The ONF conducts surveys to assess wildlife populations on the forest. Surveys for wildlife species by ONF personnel in the last decade have generally focused on species listed as sensitive and included aerial surveys for bald eagles, documenting nesting success, and also searching for new nests. In 2009, the forest began the first formal surveys for Taylor's checkerspot butterfly (fig. 7.5). Biologists conduct surveys for other species opportunistically and sometimes not to any strict protocol. There is also documentation of

egg masses, larvae, and adult pond breeding amphibians in some areas, as well as surveys for the northern goshawk. The forest installed remote cameras to monitor the recently reintroduced Pacific fisher on the peninsula and is working with ONP, the Washington State Department of Fish and Wildlife, the U.S. Geological Survey, and the Forest Service Pacific Northwest Research Station to establish a survey protocol for Pacific fisher. Annual bat surveys in one portion of the ONF include bridge and building inspections to document use by Townsend big-eared bat and *Myotis* species.

Forest staff discontinued surveys for marbled murrelet and northern spotted owl in the late 1990s after the forest began to switch its harvest program to second-growth stands instead of old growth. However, the Forest Service Pacific Northwest Research Station oversees the Olympic Demography Study, which involves annual surveys by scientists at selected northern spotted owl activity centers on the forest. Olympic National Park biologists conduct surveys for northern spotted owl within the park boundaries at about 50 sites. Annual survey data from this work dates to the early 1990s.

Olympic National Park protects the largest population of Roosevelt elk in its natural environment in the world. Decades of protection from human harvest and habitat manipulation not only sustained high densities of elk, but also preserved the natural composition, social structure, and dynamics of this unique coastal form of elk found nowhere else. Population surveys and other studies of park elk populations since 1985 documented that herds on the west side of the park generally reside for most of the year wholly within the park, whereas east-side herds spend a portion of the year out of the park (Houston et al. 1987, 1990). Understanding these differences may be even more important with climate change as biologists work across boundaries to conserve species and their habitats.

Biologists monitor elk populations at ONP as a part of the National Park Service North Coast and Cascades Network monitoring program. Other components of the monitoring program address plant communities, landscape change, climate, high-elevation lakes, fish in large rivers, and land birds. Monitoring protocols are peer reviewed, and

each includes a data management component. Additional monitoring addresses northern spotted owls (and the barred owl invasion), and water quality at Lake Crescent. When project funds can be obtained, biologists monitor mountain goat populations, with at least five surveys completed since 1983. Long-term research has been, or is being conducted, on terrestrial, lotic, and lentic amphibians, Olympic marmot (fig. 7.3), North American black bear, Columbia black-tailed deer, marbled murrelets, and bald eagles (Weber et al. 2009).

Adapting Wildlife and Habitat Management to Climate Change at Olympic National Forest and Olympic National Park

Process Used to Develop Adaptation Strategies for Wildlife and Habitat Management

During 2009, a series of three workshops was held to discuss potential effects of climate change on Olympic Peninsula wildlife species and habitats, examine anticipated wildlife sensitivities to climate change, and develop potential adaptation strategies and actions for wildlife management at ONF and ONP. Workshop participants included natural resources staff from ONF and ONP, specialists from the Washington Department of Natural Resources and U.S. Fish and Wildlife Service, and scientists from the Forest Service Pacific Northwest Research Station, U.S. Geological Survey, and University of Washington.

The first workshop focused on potential climate change effects on wildlife on the peninsula, including general climate change effects, as well as effects anticipated within each Olympic Peninsula habitat type. Based on the anticipated climate change effects, participants identified species on the peninsula most likely to be impacted by climate change (table 7.1).

Participants in the first workshop concluded that further analysis of Olympic Peninsula wildlife species sensitivity to climate change would be useful in developing climate change adaptation strategies and actions for wildlife habitat management at ONF and ONP. During a second meeting, biologists participated in a climate change sensitivity assessment process for select wildlife species on the Olympic Peninsula, applying methods developed by Joshua

Lawler (School of Forest Resources, University of Washington). The climate change sensitivity assessment involved wildlife experts answering a series of questions about a particular species based on their knowledge and experience. Participants were asked to (1) classify a species' maximum annual dispersal; (2) determine whether barriers to dispersal exist for a given species; (3) rate a species' dependence on disturbance regimes; (4) rate a species' dependence on other species (i.e., interspecific dependencies); (5) rate a species' physiological sensitivity to temperature; (6) rate a species' sensitivity to changing precipitation; (7) rate a species' sensitivity to salinity, pH, and carbon dioxide; (8) classify a species reproductive strategy (on an r-selected to K-selected scale); and (9) identify any sensitive habitats that a given species occupies (see table 7.3 for specific questions). An automated electronic system collected and tallied responses and provided summary results to participants. Participants then rated how confident they were in the summary response, thus quantifying the degree of certainty in the group response to a given question. In addition, each participant subjectively rated each species' overall sensitivity to climate change.

Participants completed the sensitivity assessment for a limited number of species during the workshop, and individual experts conducted additional species assessments through an online database after the workshop. A sensitivity score for each species incorporated mean group responses from the workshop as well as responses from individuals in the online database. An additive function (sum scores for each question) (table 7.3), divided by the maximum possible score, and multiplied by 100) produced the sensitivity scores, on a 0 to 100 scale. Figure 7.8 illustrates results of the sensitivity assessment for the 21 Olympic Peninsula species analyzed by the group, as discussed below.

A third meeting focused on development of adaptation strategies and actions for wildlife management at ONF and ONP. Objectives of this third workshop were to (1) review Olympic Peninsula wildlife habitat and species sensitivities to climate change identified in the first two workshops and (2) through an interactive dialogue between scientists and managers, use the latest scientific information on climate change and impacts to wildlife to develop adaptation

Table 7.3—Questions posed to participants in the process used to assess the sensitivity of wildlife species to climate^a

Question 1. Maximum annual dispersal distance for this species is:						
(0) N/A	(1) >100 km	(2) 75–100 km	(3) 50–75 km	(4) 25–50 km	(5) 5–25 km	(6) 1–5 km (7) <1 km
Question 2. Do barriers to dispersal exist? Are there landscape elements that would prevent this species from moving in response to climate change?						
(0) No	(3) Yes					
Question 3. How dependent is this species on one or more disturbance regimes?						
(1) not dependent on the nature of any disturbance regime	(2) slightly dependent	(3) somewhat dependent	(4) moderately dependent	(5) more dependent	(6) definitely dependent	(7) highly dependent on the nature of one or more disturbance regimes
Question 4. Broadly, where does this species fall on the spectrum of generalist to specialist?						
(0) N/A	(1) generalist	(2)	(3)	(4)	(5)	(6) (7) specialist
Question 5. Species' sensitivity to temperature ^b :						
(0) N/A	(1) low sensitivity	(2)	(3)	(4)	(5)	(6) (7) high sensitivity
Question 6. Species' sensitivity to precipitation ^c :						
(0) N/A	(1) low sensitivity	(2)	(3)	(4)	(5)	(6) (7) high sensitivity
Question 7. Species' sensitivity to salinity ^d :						
(0) N/A	(1) low sensitivity	(2)	(3)	(4)	(5)	(6) (7) high sensitivity
Question 8. Species' sensitivity to pH ^e :						
(0) N/A	(1) low sensitivity	(2)	(3)	(4)	(5)	(6) (7) high sensitivity
Question 9. Species' sensitivity to CO ₂ ^f :						
(0) N/A	(1) low sensitivity	(2)	(3)	(4)	(5)	(6) (7) high sensitivity
Question 10. Species' reproductive strategy:						
(0) N/A	(1) r-selection (can exploit empty niches/ reproduce quickly)	(2)	(3)	(4)	(5)	(6) (7) K-selection (present as strong competitors in crowded niches/ invest heavily in fewer offspring)

Table 7.3—Questions posed to participants in the process used to assess the sensitivity of wildlife species to climate^a

Question 11. Occupies the following sensitive habitat types ^g					
Coastal lowlands/marshes/ estuaries	Perennial streams	Shallow wetlands/ shallow pools	Vernal pools or seasonal wetlands	Ecotones	Alpine/ subalpine
					Other

^a The number in parentheses before each answer choice represents the score that answer would produce for the calculation of the climate change sensitivity score. Sensitivity scores are on a scale of 0 to 100 and based on an additive function. In addition to the calculated sensitivity scores, after each question, each participant was asked to rate their level of confidence in the value that was collectively reached through this process, giving a measure of uncertainty to collective answers for each question.

^b Sensitivity to temperature is directly related to a species' physiological ability to tolerate temperatures that are higher or lower than the range that it currently experiences. If a species can tolerate a wide range of temperatures, it would be deemed less sensitive.

^c Sensitivity to precipitation should be based on the species' ability to tolerate higher or lower levels of precipitation than that which it currently experiences. If a species can tolerate a great deal more or less precipitation than usual, they should be deemed less sensitive.

^d Sensitivity to salinity refers to the species' ability to tolerate either higher or lower levels of salinity than it currently experiences. The ability to tolerate a wide range of salinity indicates that the species is less sensitive.

^e Sensitivity to pH refers to a species' ability to tolerate either higher or lower pH than it currently experiences. (This is most applicable to aquatic organisms.) If a species can tolerate a wide range of pH, it should be deemed less sensitive.

^f Sensitivity to carbon dioxide (CO₂) refers to the ability of a species to tolerate greater or lesser amounts of CO₂ than it currently experiences (this may be most important in plant species). If a species can tolerate a wide range of CO₂ levels, it should be deemed less sensitive.

^g If the species occupies none of these habitats, then the score is 0. If the species occupies one or more of these habitats, then the score is 7.

options and action plans for wildlife habitat management. Jessica Halofsky (University of Washington) provided an overview of potential impacts of climate change on wildlife and vegetation on the Olympic Peninsula. Michael Case (University of Washington) presented results of the sensitivity assessment for selected wildlife species on the peninsula, and wildlife specialists Susan Piper (ONF) and Patti Happe (ONP) gave presentations on wildlife habitat management at ONF and at ONP, respectively. A discussion on adaption options for wildlife management with climate change followed. Part of the discussion involved review of suggested adaptation strategies for wildlife management and biodiversity conservation in a recent journal article (Mawdsley et al. 2009). Key points from the discussion are described below and in table 7.4. See box 7.1 for a general summary of projected effects of climate change on wildlife on the Olympic Peninsula and related adaptation strategies for wildlife and wildlife habitat management at ONF and ONP.

Olympic Peninsula Wildlife Species Sensitivity to Climate Change

The wildlife species sensitivity assessment indicated that, in general, specialist species and species that use sensitive habitats will likely be more sensitive to climate change than more generalist species and species that use less sensitive habitats (fig. 7.8). Species that occupy sensitive habitats, such as the Olympic torrent salamander (head-water streams), Cascades frog and Van Dyke's salamander (aquatic habitats), dog star skipper butterfly (meadows), Makah copper butterfly (wetlands), and the Olympic marmot (fig. 7.3), mountain goat, Clark's nutcracker (fig. 7.4), and gray-crowned rosy finch (high-elevation habitats), were generally ranked as highly sensitive to climate change. Similarly, specialist species in terms of habitat and diet, such as Clark's nutcracker, northern spotted owl, gray-crowned rosy finch, Van Dyke's salamander, American marten, and northern flying squirrel, were ranked as highly sensitive to climate change. More generalist species, such as the barred owl, snowshoe hare (fig. 7.9), North American black bear, mountain beaver, and Roosevelt elk were not ranked as highly for sensitivity to climate change.

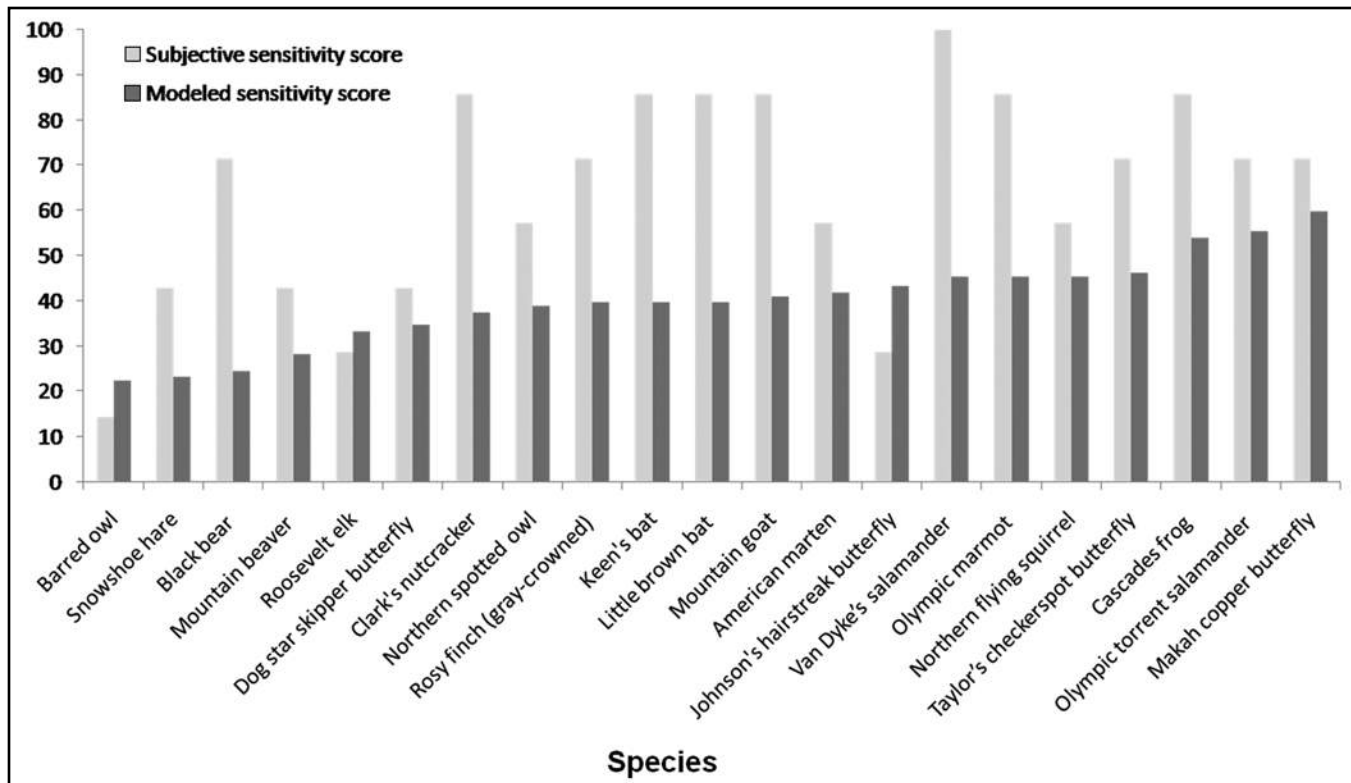


Figure 7.8—Modeled and subjective climate change sensitivity scores for selected species on the Olympic Peninsula. Modeled sensitivity scores were determined from experts' answers to questions and calculated based on an additive function (see table 7.3). Subjective sensitivity scores were experts' opinions on how sensitive a given species will be to climate change.



Figure 7.9—Snowshoe hare does not change fur color seasonally on the Olympic Peninsula as it does in other regions. Snowshoe hare is a generalist and thus may not be as sensitive to climate change as other species on the Olympic Peninsula. (Photo by Betsy Howell, USDA Forest Service, Olympic National Forest.)

The sensitivity assessment process assisted in initially identifying species and groups of species that will likely be most sensitive to climate change on the peninsula. The process also led to useful discussion and deeper thinking about how individual and groups of species may be affected by climate change. However, the sensitivity assessment is still under development, and participants identified several limitations of the tool. For example, there was a large discrepancy between the modeled sensitivity and the subjective sensitivity scores for some species, likely because there are effects of climate change and other factors that make species sensitive to climate change that are not captured in the assessment. Alternatively, experts' expectations for wildlife sensitivities to climate change are greater than the model suggests. In either case, the assessment process left a high level of uncertainty about the actual sensitivity of any of the species considered. Developers received critiques of

Table 7.4—Projected climate change sensitivities, and associated adaptation strategies and actions for wildlife and habitat management at Olympic National Forest (ONF) and Olympic National Park (ONP)^a

Current and expected sensitivities	Adaptation strategies and actions
Limited connectivity of late-successional forests	• Collaborate with neighbors about priority areas for treatments, and increase extent of protected areas.
Limited ability of species to respond to climate change owing to current stressors, such as habitat loss and fragmentation	• Increase thinning treatments in young-growth forests that promote late-successional forest conditions and improve habitat quality and suitability for some wildlife species at ONF. • Focus thinning treatments (to promote late-successional conditions) around existing late-successional forests to increase landscape connectivity and increase wildlife habitat quality at ONF. • Increase restoration treatments in, and protection of, headwater streams to increase late-successional habitat connectivity at ONF. • Add a climate layer to ONF's 10-year plan that shifts priorities for thinning treatments and road decommissioning and leads to increased habitat quality and connectivity.
Risk of large, high-severity fire	• Determine how to jointly manage fire (ONF and ONP). • Consider allowing fires to burn more frequently. • Monitor postfire regeneration to determine what can be expected after large fires. • Decrease stand densities and increase use of prescribed fire to lower wildfire severity.
Reduced late-successional habitat area and habitat quality	• Continue to create and protect legacy structures at ONF. • Increase density of legacy structures in younger forest near late-successional forest to increase habitat quality and connectivity at ONF. • Continue to thin stands at ONF to promote tree vigor and produce future legacy structures. • Continue to restore degraded sites.
Reduced habitat quality, particularly in riparian areas and wetlands	• Restore habitat in degraded headwater streams at ONF that are expected to retain adequate summer streamflow.
Increased spread of aquatic exotic plant species	• Control spread of exotic species.
Loss of cold water refugia for cold-water adapted amphibians	• Consider creating wetland habitats.
Change in wetland, bog, and fen distribution	
Increased risk of species extinction, particularly for endemics	• Consider inventory and monitoring opportunities to address questions for species sensitive to climate change, including listed species. • Conduct integrated surveys and monitoring for key species to obtain baseline information and determine when population changes are occurring. • Reduce existing pressures on species from sources other than climate change.

^a Sensitivities are based on projected climate change effects on the Olympic Peninsula, including changing habitat distribution and quality with changing vegetation patterns, shifts in geographic ranges of wildlife species, shifts in ranges of competitor, forage, prey, and symbiotic species (and biotic interactions), changing species phenology, increased fire frequency, potential for increased insect and disease outbreaks, changing hydrology, and reduced summer streamflows.

Box 7.1—Summary of projected climate change effects on wildlife on the Olympic Peninsula and related adaptation strategies for wildlife and wildlife habitat management at Olympic National Forest (ONF) and Olympic National Park (ONP).

- Climate change, in combination with other stressors to wildlife such as habitat loss and fragmentation, has the potential to greatly affect wildlife species and biodiversity on the Olympic Peninsula.
- Species will respond to both direct and indirect effects of climate change. For example, increasing temperatures and changing precipitation will have direct physiological effects on some species, such as amphibians. Other species will be affected mostly indirectly through:
 - Climate-induced changes in phenology (timing of life history) relative to forage plants and invertebrate prey
 - Shifts in geographic ranges and the density and ranges of competitor, forage, prey, and symbiotic species (and subsequent changes in biotic interactions) in response to changing climate
 - Effects from other stressors such as disturbance, insects, and disease
 - Climate-induced changes in habitat characteristics and quality
- Some Olympic Peninsula species will likely respond to increasing temperature by shifting their ranges upward in elevation. High-elevation species will likely be particularly sensitive to warming temperatures and experience range contractions because contiguous, higher elevation habitat may not be available to colonize.
- It may also be more difficult for endemic and specialist species with strict habitat requirements or dependencies on specific forage species to find suitable habitat conditions under changing climate.
- Active management by restoration thinning in existing young-growth forest at ONF is a strategy that may help to ensure maintenance of enough forest with desired late-successional habitat characteristics (currently rare) across the landscape. Thinning to promote late-successional conditions at ONF may be most effective around existing late-successional forests to increase landscape connectivity and increase wildlife habitat quality.
- Protection and restoration of headwater streams and encouraging vigorous conifer growth could help to prevent increasing stream temperatures with climate change and increase habitat connectivity.
- At the stand scale, ONF can continue to increase wildlife habitat quality through creation and protection of legacy structures, including old-growth trees, snags, and large downed wood, as these legacy structures have disproportionate habitat value for a large number of species.
- Because many actions that could help increase wildlife species' resilience to climate change will be most effective at large spatial scales and with consideration of landscape context, ONF and ONP will increase collaboration with neighbors to develop and increase the extent of a landscape strategy.

the assessment during the workshops and will consider the critiques in further refinement of the assessment tool and associated database. However, issues with the sensitivity assessment tool and database may stem from a fundamental lack of empirical data on wildlife species and their likely responses to changing climate. Additional empirical data and baseline assessments are needed to track changes in species' response in the early phases of climate change. Such early assessments will be vital as we attempt to forecast long-term changes in response to climate change.

Adaptation Strategies and Actions for Wildlife and Habitat Management at Olympic National Forest and Olympic National Park

Many actions that could help increase wildlife species' resilience to climate change will be most effective at broad spatial scales (Millar et al. 2007), especially for management targeted at increasing habitat connectivity. Given the many landowners on the peninsula, increasing habitat quality and connectivity will require collaboration with neighbors about where to apply treatments to benefit wildlife habitat. Dialogue with the Washington Department

of Fish and Wildlife, Washington Department of Natural Resources (a major landowner on the peninsula), and other federal agencies could help to develop and increase the extent of a landscape strategy. The ONF and ONP will also seek opportunities for collaboration with other peninsula landowners.

Logging activities through the end of the 20th century left a scarcity of late-successional forest at ONF. Late-successional forests provide high-quality habitat for many species, including the northern spotted owl. Some late-successional forests may decline with climate change and be replaced by natural regeneration. Active management by thinning in existing young-growth forest at ONF is a strategy that may help to ensure maintenance of enough forest with desired habitat characteristics across the landscape. Thinning can reduce habitat quality and suitability for certain species that prefer dense forest conditions typical of the stem exclusion phase of forest succession (Hagar et al. 1996, Hayes et al. 2003, Suzuki and Hayes 2003). However, thinning in structurally simple young-growth forests can also improve habitat quality and suitability for a variety of other species by promoting tree growth, species and structural diversity, and understory development (Carey and Wilson 2001, Hagar et al. 1996, Hayes et al. 2003, Suzuki and Hayes 2003). Young-growth thinning increases tree vigor by increasing availability of water, light, and nutrient resources; enhances tree species diversity by providing growing space for less competitive minor species; and provides growing space for understory vegetation to increase in abundance and diversity (Roberts and Harrington 2008).

Thinning to promote late-successional conditions at ONF may be most effective adjacent to existing late-successional forests to increase landscape connectivity and increase wildlife habitat quality (the exception to this would be around known owl and murrelet nesting sites, where concern for short-term disturbance could outweigh long-term habitat improvement). Alternatively, thinning treatments could be focused in areas dominated by young forests. For example, young forests dominate the northwestern corner of ONF, which is the least connected to the park. Focusing treatments in that portion of the forest may have the greatest effect on habitat quality.

Areas selected for thinning also need to be strategically located with the consideration of climate-altering disturbance processes and growing conditions. Some treatments may be a combination of habitat characteristic development and fire fuel reduction, depending on the location. Fuel reductions may be particularly important to high-value riparian areas, where habitat value would be susceptible to fire.

Another way to potentially increase late-successional habitat connectivity is through restoration thinning treatments and protection of headwater stream areas at ONF, because forests that surround headwater streams are widespread and connected. Protection of headwater streams, and encouraging vigorous conifer growth, could help to prevent increasing stream temperatures with climate change and prevent sediment movement downstream. Management activities that promote forest resilience around non-fish-bearing headwater streams could also improve habitat for amphibians, which are likely to be highly sensitive to climate change. For example, during thinning treatments, some trees could be dropped into streams to create instream structures that provide habitat and improve water holding capacity.

Currently, ONF uses a 10-year strategic plan to direct locations of thinning and road decommissioning activities (among others). The strategic plan emphasizes restoring and connecting fragmented terrestrial and aquatic habitats. The plan does not currently consider potential effects of climate change, but modifying treatment prioritization could help to incorporate climate change in the plan. For example, thinning treatments could be prioritized around existing late-successional forest and around headwater streams to increase late-successional habitat connectivity. A geographic information system analysis could be used to identify gaps in desirable conditions and determine where treatments would be most effective. Also, habitat surveys could help to determine where the best corridors for movement exist on the peninsula, and treatments could be positioned accordingly. Wildlife could also be given greater consideration in prioritization of road decommissioning on the forest; roads that inhibit species movement could be prioritized for decommissioning.

Another step for ONF and ONP is to determine how to jointly manage fire. The ONP will revise their fire plan in the near future and broaden the scope of the planning effort to include ONF. Allowing wildfires to burn more frequently at ONF and ONP may have some benefits, such as maintenance of alpine meadows, which will likely see increased tree encroachment with warming temperatures. Monitoring of recent burns and postfire regeneration could help determine if forage species are likely to regenerate after fire (e.g., Do important meadow species return after fire?). Management could also be tailored to decrease fire intensity. For example, decreasing stand density and increasing use of prescribed fire could help to decrease wildfire intensity, and firebreaks could be created to slow wildfire spread. These activities could be particularly useful in productive areas in the northeastern portion of the peninsula, where fire is more frequent and stands would likely respond to thinning through increased tree growth and vigor.

At the stand scale, ONF could continue to increase wildlife habitat quality through creation and protection of legacy structures, including old-growth trees, snags, and large downed wood. Legacy structures have disproportionate habitat value for a large number of species. Although not a specific habitat type, these structures may mediate structural deficiencies in younger stands by providing for critical habitat needs. Old-growth trees have furrowed bark, cavities or basal hollows, large limbs, and defects that can provide nesting or roosting substrate, prey, or resting cover for species that might not otherwise be able to inhabit a younger stand. For example, long-legged bats, pygmy nuthatches, violet-green swallows, and Vaux's swifts were documented reproducing in individual old-growth redwood trees with basal hollows or other cavities that were located in younger managed stands, and a variety of other bat and bird species used them for foraging or roosting (Mazurek and Zielinski 2004, Zielinski and Gellman 1999). Large standing hollow trees or fallen logs can provide hibernation dens for bears, natal and maternal dens for meso-predators such as the American marten and Pacific fisher, and cool, moist conditions for amphibians (such as Van Dyke's salamander) and mollusks. Overall, snags and coarse wood are very important to a variety of wildlife because of the

food or prey they provide, protection from the elements, or structures for rearing young.

Olympic National Forest currently induces mortality of large trees for snag creation. This practice could be continued and possibly increased for further habitat quality improvement. Increasing density of legacy structures in younger forests may be particularly effective near late-successional forest to increase habitat quality and connectivity. Protection of existing legacy structures will also be important in providing critical habitat elements for a variety of species that may help them to respond adaptively to climate change.

Although there is a need for legacy structure creation in the short term, there is also a need for high tree vigor for creation of future legacy structures. At ONF, stands could be thinned and trees left on site to elicit both a growth response and a positive effect on habitat quality. Thinning could also help forests to be more resilient to drought and disturbance with climate change.

Besides legacy structure protection and creation, other measures could be taken to further increase habitat quality at the stand scale. For example, creation of habitat structures, such as brush piles, could provide habitat for salamander species under increasing summer drought. Restoring currently degraded sites could also help to increase the area of high-quality habitat at ONF and ONP.

Policy Considerations and Next Steps

Policy will be highly relevant to wildlife management at ONF and ONP with climate change. Both ONF and ONP currently focus resources on species that are sensitive, threatened, endangered, or iconic, but it is uncertain what will happen in the future when climate-related changes could lead to many more extinction possibilities. Because of the number of endemic species on the peninsula, there will be an opportunity for the forest and park to direct the discussion on what to do about many species at risk of extinction. The forest and park will keep up-to-date on the federal threatened and endangered list, as well as the Washington sensitive species list. Integrated surveys and monitoring can be conducted for key species to obtain baseline information and determine when population changes are occurring (e.g.,

the endemic Olympic marmot and amphibians in the high lakes areas). The forest and park will consider expanded data sharing and joint or expanded monitoring projects with common protocols, involving other adjacent landowners whenever possible. Specific recommendations for managing the effects of climate change can be developed for species for which a large amount of information already exists.

Reducing existing pressures on species from sources other than climate change will also be important to protect TES species. The ONF and ONP will work to evaluate current activities to determine if stresses can be reduced for species that will be most impacted by climate change (e.g., focus on keeping streams cool for the Olympic torrent salamander, and increase coordination on exotic species control).

In the future, depending on agency policies and partnerships, ONF and ONP may also consider assisted migration and captive breeding for species that may otherwise go extinct. It is possible that the peninsula will be a refuge for species from other parts of the Pacific Northwest over the long term. However, criteria and methods for conducting assisted migration as a strategy, as well as potential ecosystem impacts, are unclear.

Although ONF and ONP are mandated to protect TES species, there are currently policy limitations on the actions that can be taken to protect these species. Under current policies, management actions that would affect native species to protect or restore TES species must be undertaken through a careful planning process and in a way that will not produce unacceptable impacts on resources or natural processes. For ONP, policy guidance on when or whether to intervene in ecosystem processes in the face of climate change is limited. For example, the population of Olympic marmot (fig. 7.3), an endemic species to the peninsula, is declining on the peninsula owing in part to unsustainable levels of coyote predation (Griffin et al. 2008), and warming temperatures may enhance coyote presence in the high-elevation marmot habitat. Potential options for coyote control are complicated under existing policies. Policy guidance regarding how or if to manage the situation is imprecise. Reintroduction of a top predator, the gray wolf,

could decrease coyote numbers but would likely have other ecosystem impacts and raise controversy. Similarly, there are limitations to actions that can be taken to control the barred owl and its negative impact on the northern spotted owl. Other similar situations may arise in the future with species ranges that may shift in response to climate change.

The Endangered Species Act (ESA 1973) guides agencies to consider the needs of individual species in their management activities, and conservation of individual species under the Endangered Species Act will likely continue for some time. In some cases, management for particular species whose presence is crucial to the maintenance of current ecosystem dynamics (e.g., top predators and major herbivores) may be required to maintain ecosystem function with changing climate. However, other efforts to maintain and restore ecosystem function will be important with the changes in forest species composition and disturbance that will likely occur with warming. With climate change, it may be particularly important to focus management on habitats, habitat structural components, and headwaters and cold water flows. Monitoring these habitats and habitat components will be particularly useful for detecting changes in habitat attributes and taking management action, when possible, to limit negative consequences for the species that use the habitats.

To garner public support for policies and actions related to climate change, ONF and ONP may need to expand outreach to explain the reasoning behind policies and actions. The park and forest can increase interaction with local communities about how they are addressing climate change in management and how climate change may affect the public. Education about potential changes in wildlife may be especially necessary because, for example, black bear conflicts increase when there are berry crop failures, which may become more frequent with climate change.

Overall, current wildlife management at ONF and ONP is consistent with strategies and actions that would help to increase species and ecosystem resilience to climate change. For example, ONP currently manages for ecosystem function, and ONF focuses much of their management on restoration. However, there are ways, outlined here, that

ONF and ONP could shift their strategies and foci to better address potential changes with warming temperatures.

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Chapter 8: Synthesis and Conclusions

Catherine Hawkins Hoffman, Kathy A. O'Halloran, Jessica E. Halofsky, and David L. Peterson¹

Utility of the Adaptation Planning Process

The Olympic Climate Change Case Study illustrated the utility of place-based vulnerability assessments and science-management workshops in facilitating climate change adaptation planning. We built on climate change education, and initial science-management discussions to develop specific and tangible ways for Olympic National Forest (ONF) and Olympic National Park (ONP) to incorporate climate change adaptation strategies into management. Development of science-based adaptation strategies was fostered by direct engagement of scientists and managers in the workshops. Presentations describing results of science-based vulnerability assessments helped to spur dialogue. The workshop format gave managers an open forum to brainstorm, express initial thoughts and ideas, and vet those ideas among peers. Careful facilitation of workshop discussions led to a productive dialogue (Schmoltdt and Peterson 1991).

This study is an unprecedented example of collaboration by the U.S. Forest Service and National Park Service in preparation for climate change. The process used, involving sensitivity assessments, reviews of current management and management constraints, and adaptation workshops, can provide an example for other land and resource managers on how to initiate the climate change adaptation process. Many ideas from the case study could apply to other locations or agencies, and contribute to current planning processes and management programs.

Lessons Learned

Where Is the Recipe?

For climate change adaptation, there is no recipe, no road map, and yet no time to lose; science and

management partners must tackle the climate change issue in a timely way, despite uncertainty.

It is challenging for agency managers to stay abreast of the rapidly evolving field of climate change science that contains as many questions as answers, further complicating decisionmaking. Consequently, the temptation is strong to wait for ready-made templates or fully developed, tried-and-true examples of how to adapt to climate change. There are numerous efforts underway nationally and internationally to develop adaptation concepts and processes. Comparing and contrasting these to learn from other examples is critical to advancing climate change adaptation. However, this issue must be addressed as soon as possible to limit unwanted effects of changing climate.

Timing

The case study was timed to build on the momentum of a previous effort and was sufficiently long to enable the completion of a critical step in the adaptation process.

The case study was timed to build on the momentum of previous adaptation work on ONF and to take advantage of available funding for the effort. The case study was conducted over a 1½ year period. Although this period was not sufficient to fully incorporate all resulting ideas into forest and park management, it was sufficient to complete a step in the adaptation process in which relevant science was presented and summarized, vulnerabilities were assessed, and initial adaptation strategies and options were developed.

Scale and Participants

For all workshops, we encountered the challenge of balancing between soliciting input from many people and having a group small enough to facilitate discussion.

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The need for progress within a specific timeframe, and for continuity and commitment to the process over many months, in addition to the scheduling, logistics, and orchestration of a large-group planning process, were primary factors that led to limiting this initial effort to the forest and park. The structure of the workshops, which differed in size and composition depending on the topic, engaged program managers and resource specialists, and efficiently used the time of all participants while also ensuring ample time for discussion. To keep the meetings to a reasonable size, the majority of participants at most workshops were personnel of ONF and ONP (including regional-level staff), and invited scientists. The wildlife workshop included staff from the Washington Department of Natural Resources, the U.S. Geological Survey, and the U.S. Fish and Wildlife Service. The first fish workshop was larger by design because fish (particularly salmonids) are one of the widest ranging, multijurisdictional organisms inhabiting the peninsula. Over 100 representatives from other federal agencies, the state, tribes, universities, and nongovernmental organizations attended this workshop. A clear next step is to include these and other partners in a broader climate change adaptation effort on the peninsula.

Scope

Framing the planning discussions around discrete topics allowed participants to discuss ideas within a group size that allowed all to contribute.

This was especially beneficial because some of the ideas and concepts were new, and participants ranged in knowledge of or engagement in climate change discussions. Participants were able to vet their ideas among peers and found it helpful to either validate or challenge their thinking.

How to Deal With Copious New Information

A common foundation and understanding of information needs to be developed among personnel to proceed in the adaptation process. This can be a time-consuming process.

The workshop format was useful to begin the conversation on how climate change may influence land management

and to consider appropriate actions. However, there is much uncertainty associated with climate change, and an enormous amount of climate change information for managers to absorb. Consequently, the planning process should include sufficient time to establish a common foundation of information among participants. In other words, personnel need to be on the same page before they are able to take the next step in the adaptation process, which is to directly incorporate adaptation ideas into projects and planning. Establishing that degree of understanding among all personnel can be a time-consuming process.

Structure for Results

Having more structure to the initial workshops, more prework, or having the workshops expand to several days may help in crafting more specific adaptation actions.

Initial discussions in group settings are often broad and general to explore different perspectives and solicit ideas. Additional steps may be required to distill and refine ideas and consider how these may affect management decisions and priorities. We dealt with this issue through iterative small group (three to four individuals) discussions after workshops. Additional structure may help in developing more specific adaptation options and would also enable more consistent partner participation, as several of the subsequent, small group discussions occurred opportunistically.

The Case for Splitting

The more focused the study emphasis, the more specific the adaptation strategies that resulted.

Bracketing specific disciplines (i.e., hydrology/roads, fish, vegetation, and wildlife) helped to move discussions from generic adaptation ideas, such as increasing ecosystem resilience, to more specific strategies that the agencies can more easily implement. In the vegetation focus area, ONF considered the idea of planting more drought-tolerant species to increase forest resilience, and determined that there are several drought-tolerant, native species that will likely do well in the future on the peninsula, including lodgepole pine and disease-resistant western white pine.

In the hydrology and roads focus area, forest and park engineers discussed the idea of resizing culverts to accommodate increasing streamflow volumes, and ONF proposed two alternative methods for culvert sizing—by using a hydrologic model to predict future peak flows, and by using the last 30 years of record to estimate future peak flows instead of the entire period of record. Plans are underway to explore these approaches.

These focus-area discussions produced tangible strategies. We are not certain that the engineers would have relished the Olympic marmot discussions, nor the wildlife biologists the culvert discussions. Some degree of splitting seemed advantageous.

The Case for Lumping—Synthesis Across Disciplines

Integrating the concepts and plans from various program areas was an important step that should be expanded in future work.

After the various workshops were conducted, we held a synthesis session to compile ideas from the different focus areas, identify common approaches, and determine if any adaptation strategies and actions presented potential conflicts with one another. The synthesis workshop and subsequent small meetings gave resource specialists the opportunity to provide input on adaptation strategies developed in areas outside of their primary area of expertise. For example, the fish biologists could give input on adaptation strategies developed for vegetation management and identify any potential conflicts with fish resources. This synthesis of adaptation options for different focus areas helped refine the adaptation ideas and focus on key strategies that were common across focus areas (see themes section below). The strategies that were common across focus areas are most likely to be implemented, because these strategies are most likely to have the biggest impact. In future adaptation planning, this synthesis portion of the work could be expanded, with periodic integrated discussions (across focus topics) held at regular intervals throughout the planning process.

Making It Real—Incorporate Geospatial Planning

The Olympic Climate Change Case Study process is an excellent first step as the agencies move forward in preparing for a changing climate, but scaling to local actions requires additional work.

To apply results from the workshops, more detailed and site-specific examples would assist managers and other landscape planning efforts. Ideally these adaptation concepts would have geospatial references. For example, the next iteration of planning for fish resources would include delineation of high-priority restoration sites. However, that level of effort was not possible within our funding and time limits.

Dealing With Uncertainty

We used several approaches to work with or around uncertainty, including focusing on changes that have been observed in the past and with recent warming; focusing on similarities between different climate and impacts scenarios, and the most likely and plausible trends; using local knowledge of forest and park specialists to predict system response to climate change; and focusing on no-regrets strategies.

A key lesson learned about dealing with uncertainty is that the full range of future climate and climate change effect projections must be considered when developing adaptation strategies. We quickly realized it was impossible to know the best future projection for any particular area (e.g., hydrology and vegetation), so adaptation strategies must be robust. Adding scenario planning to the exercise would be a useful next step. However, we used several other approaches to work with or around uncertainty to develop tangible adaptation strategies. First, in assessing sensitivity to climate change in each focus area, we considered ecological changes that have been observed with climatic variability in the past or that have already been observed with recent warming. When assessing projected effects of climate change, we focused on similarities between the various future climate and effects scenarios, and the most likely trends. We used local knowledge of ONF and ONP staff and regional scientists to help predict species

and system response to changing climate on the Olympic Peninsula. Finally, in developing adaptation strategies, we always focused on no-regrets approaches, or strategies that will increase ecosystem function and resilience regardless of the exact nature of future climate. Additional work will be needed to build on these results, and to integrate with neighboring lands.

Rethinking Management Goals

Climate change challenges current precepts and guidelines, and determining management goals within what may be entirely new ecosystems will be needed.

In the long term, yet still within planning horizons for both agencies, ecosystem changes and disturbances may occur more quickly in systems that have been relatively stable for hundreds or thousands of years. Determining management goals within what may be entirely new ecosystems will be needed. When once we might have observed or monitored, we may now need to undertake manipulative experiments that are different from any current management practices, particularly in the park. Goals that will be appropriate for fire management in environments modified by climate change are unclear. Similarly unclear are goals for wilderness management in potentially highly altered environments of the future. These and other questions indicate the limits of current understanding.

The case study exercise highlighted other situations that challenge our precepts and current guidelines. For example, although specialists may readily accept new concepts of ecosystem change, imagining how to address anticipated new conditions within current guidelines and definitions was sometimes a challenge. This was particularly evident at the wildlife workshop in which participants readily acknowledged that communities will be disrupted, that there will likely be different species assemblages in the future, and that managing for processes may be more important than managing for particular species. In this context, the question of whether the definition of exotic species will be altered with climate-induced changes in species distributions is, as yet, unanswered by ecologists and policymakers. For example, the barred owl arrived relatively recently on the peninsula and scientists have hypothesized

that human-caused landscape changes or even recent climate change enabled its population expansion to the west coast of the United States (Kelly et al. 2003). Under current policies, biologists view the barred owl as an invader as opposed to a member of a new faunal assemblage. Climate change, like human structural development, is a human-caused modifier of habitats and ecosystems. As species move in response to habitat loss or gain caused by climate change, new management goals and a new definition for exotics will be needed.

Capacity

The climate change adaptation process benefits from having an individual or individuals dedicated to facilitating the process and also requires focused time from staff specialists.

This case study project had the benefit of full-time assistance from a research ecologist associated with the University of Washington's School of Forest Resources who organized and facilitated the workshops, invited and scheduled speakers, took notes, synthesized literature, provided presentations of projected climate change effects, and prepared draft manuscript chapters for the case study report. This effort was essential for developing science-based adaptation strategies with sufficient depth for clear application to agency management.

In addition to managing the workload associated with organizing a planning process, focused time from staff specialists is essential. Adaptation or scenario planning added to existing workloads is challenging to implement. To fully develop robust, place-based adaptation strategies, either the responsibilities of staff specialists' day jobs must be temporarily relieved, or a process established and funded much like watershed analysis conducted under the Northwest Forest Plan (USDA and USDI 1994) to develop adaptation strategies. Climate change could also be incorporated into other appropriate planning efforts. Appropriate facilitation and strong commitments by all parties are essential. Lack of funding or support may hinder progress, but in the face of potential effects of climate change, postponing discussions on adaptation may reduce options for managing potentially adverse conditions in some ecosystems.

Raising Awareness

The workshops helped foster a cultural shift needed to incorporate climate change considerations into thoughts, plans, and actions for managers. This will be an ongoing, continually evolving process.

In some respects, at this early stage, it is less about developing the best adaptation plans and more about raising awareness, engaging a full range of participants, and enabling federal land managers to collectively think in new ways.

Themes in Climate Change Adaptation Strategies at Olympic National Forest and Olympic National Park

Several themes in adaptation strategies and actions emerged during the case study. In all four focus areas, contemplating the projected effects of climate change made the new management paradigm obvious—decisions can no longer assume a future that mirrors historical ecosystem conditions. Given the dynamic nature of climate and ecosystems, maintaining ecosystem function and biodiversity and increasing ecosystem resilience are often cited as suitable goals for adaptation in a changing climate (e.g., Baron et al. 2008, Blate et al. 2009, Dale et al. 2001, Joyce et al. 2009, Millar et al. 2007, Spittlehouse and Stewart 2003). The case study identified numerous ways to maintain ecosystem function and biodiversity and increase resilience to climate change at ONF and ONP. However, the looming questions of determining conditions for considering assisted migration, or redefining exotics, remain for discussion across broader spatial scales.

Workshop participants frequently remarked on the importance of monitoring as a critical element in tracking ecosystem change, and in serving adaptive management efforts to determine effects of management actions. Monitoring, restoration, and protection were often proposed for the most climate-sensitive habitats on the peninsula, including headwater streams and high-elevation ecosystems.

Assessment of current management activities revealed that management strategies at ONF and ONP are generally consistent with those that are likely to increase species and ecosystem resilience to climate change. The case study

also helped identify new potential actions, and actions that could be increased or reprioritized, or both. For example, an adaptation strategy for both agencies is to plan for larger and additional culverts on roads. A new strategy for ONF, where managers currently conduct forest thinning to promote late-successional conditions, may be to alter the nature and increase the extent of thinning activities to further increase forest resilience to drought. Prioritization of thinning activities around existing late-successional forest could also help to increase habitat quality for some wildlife species. And although ONF does not currently place large wood in headwater channels to restore natural sediment routing, this will be considered as a way to help restore and protect headwater streams and the species that depend on them. These and other ideas will require more indepth and integrated analysis before implementation.

Next Steps

Collaboration between land and resource management agencies in response to climate change is critical. The Olympic Climate Change Case Study illustrated the utility and success of agency collaboration in climate change adaptation planning. Although differences in mandates and management approaches exist between the forest and park, many ideas were developed about ways that ONF and ONP can work together to adapt to climate change.

Some adaptation ideas can be implemented right away, whereas others may be inappropriate until some of the projected effects of climate change are realized. Alternatively, small-scale experiments can be considered in the near term as a hedging strategy. Scenario planning to describe plausible futures, associated management strategies, and conditions that would trigger one decision over another, is a next logical step to build on this case study. Continual evaluation of the realized and projected effects of climate change will help determine appropriate triggers for specific actions. Future iterations of a process such as the one used in this case study will also likely lead to better informed adaptation actions by natural resource agencies.

Agency policies may either help or hinder collaboration and the adaptation process in general. Except for actions proposed in small areas, or for species that have very

limited range, many adaptation strategies may fail unless managers of large landscapes concur on goals and objectives more broadly than at present. Although it is uncertain exactly how regulations, agency policies, or guidelines may change in the future, they may need to evolve to encourage greater agency collaboration in addressing climate change. Climate change adaptation is a process that requires continued awareness and attention by managers. Staying abreast of available information on potential climate change effects is essential to determine additional ways to incorporate climate change adaptation into management. This case study is a beginning; in the future, we plan to expand its scope and create additional partnerships that will improve the process and products from this work.

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English Equivalents

When you know:	Multiply by:	To find:
Millimeters (mm)	0.039	Inches
Centimeters(cm)	.394	Inches
Meters (m)	3.28	Feet
Kilometers (km)	.621	Miles
Hectares (ha)	2.47	Acres
Square meters (m ²)	10.76	Square feet (ft ²)
Square kilometers (km ²)	.386	Square miles
Cubic meters per second (m ³ /sec)	35.3	Cubic feet per second (cfs)
Degrees Celsius	1.8 °C + 32	Degrees Fahrenheit

Common and Scientific Names

American kestrel	<i>Falco sparverius</i> L.	Chum salmon	<i>Oncorhynchus keta</i> Wolbaum
American marten	<i>Martes americana</i> Turton	Clark's nutcracker	<i>Nucifraga columbiana</i>
American pika	<i>Ochotona princeps</i> Richardson	Coho salmon	<i>Oncorhynchus kisutch</i> Wolbaum
American shad	<i>Alosa sapidissima</i> Wilson	Columbia black-tailed deer	<i>Odocoileus hemionus columbianus</i> (Richardson)
Bald eagle	<i>Haliaeetus leucocephalus</i> L.	Cope's giant salamander	<i>Dicamptodon copei</i>
Balsam woolly adelgid	<i>Adelges picea</i> Ratzeburg	Coyote	<i>Canis latrans</i> Say
Barred owl	<i>Strix varia</i> Barton	Cutthroat trout	<i>Salmo clarki</i> Richardson
Bass	<i>Micropterus</i> spp.	Dog star skipper butterfly	<i>Polites sonora siris</i> (W.H. Edwards, 1881)
Beargrass	<i>Xerophyllum tenax</i> (Pursh) Nutt.	Douglas-fir	<i>Pseudotsuga menziesii</i> (Mirb.) Franco
Bighorn sheep	<i>Ovis canadensis</i> Shaw	Douglas-fir beetle	<i>Dendroctonus pseudotsugae</i> Hopkins
Bigleaf maple	<i>Acer macrophyllum</i>	Garter snake	<i>Thamnophis</i> spp.
Pursh		Giant chinquapin	<i>Chrysopsis chrysophylla</i> (Douglas ex Hook.) Hjelmqvist
Bobcat	<i>Lynx rufus</i> Schreber	Grand fir	<i>Abies grandis</i> (Douglas ex D. Don) Lindl.
Bracken fern	<i>Pteridium aquilinum</i> (L.) Kuhn	Gray wolf	<i>Canis lupus</i> L.
Bull trout	<i>Salvelinus confluentus</i> Suckley	Gray-crowned rosy finch	<i>Leucosticte tephrocotis</i>
Bushy-tailed woodrat	<i>Neotoma cinerea</i> Ord	Grizzly bear	<i>Ursus arctos horribilis</i> Ord
Camas	<i>Camassia quamash</i> (Pursh) Greene	Ground squirrel	<i>Spermophilus</i> spp.
Canada lynx	<i>Lynx canadensis</i> Kerr	Huckleberries	<i>Vaccinium</i> spp.
Cascades frog	<i>Rana cascadae</i> Slater		
Cattail	<i>Typha latifolia</i> L.		
Channel catfish	<i>Ictalurus punctatus</i> Rafinesque		
Chinook salmon	<i>Oncorhynchus tshawytscha</i> Wolbaum		

Japanese knotweed	<i>Polygonum cuspidatum</i> Siebold & Zucc.	Oregon white oak	<i>Quercus garryana</i> Douglas ex Hook.
Keen's myotis bat	<i>Myotis keenii</i> (Merriam)	Pacific chorus frog	<i>Pseudacris regilla</i> Baird & Girard
Little brown bat	<i>Myotis lucifugus</i> LeConte	Pacific fisher	<i>Martes pennanti</i> (Erxleben, 1777)
Lodgepole pine	<i>Pinus contorta</i> Dougl. ex Laud.	Pacific madrone	<i>Arbutus menziesii</i> Pursh
Long-legged bat	<i>Myotis evotis</i> (H. Allen)	Pacific silver fir	<i>Abies amabilis</i> (Douglas ex Louden) Douglas ex Forbes
Long-toed salamander	<i>Ambystoma</i> <i>macrodactylum</i> (Baird, 1889)	Pallid horned lark	<i>Otocoris alpestris</i> <i>arcticola</i> Orberholser
Makah copper butterfly	<i>Lycaina mariposa</i>	Perch	<i>Perca</i> spp.
Marbled murrelet	<i>Brachyramphus</i> (Reakirt, 1866) <i>marmoratus</i> Gmelin	Pileated woodpecker	<i>Dryocopus pileatu</i> L.
Mountain beaver	<i>Aplodontia rufa</i> Rafinesque	Pink salmon	<i>Oncorhynchus gorbuscha</i> Wolbaum
Mountain goat	<i>Oreamnos americanus</i> de Blainville	Ponderosa pine	<i>Pinus ponderosa</i> Dougl. ex C. Laws.
Mountain hemlock	<i>Tsuga mertensiana</i> (Bong) Carr.	Pygmy nuthatch	<i>Sitta pygmaea</i> Vigors
Mountain pine beetle	<i>Dendroctonus</i> <i>ponderosae</i> Hopkins	Rainbow trout	<i>Oncorhynchus mykiss</i> Wolbaum
Nettle	<i>Urtica dioica</i> L.	Red alder	<i>Alnus rubra</i> Bong.
New Zealand mud snail	<i>Potamopyrgus</i> <i>antipodarm</i> J.E. Gray	Red fox	<i>Vulpes vulpes</i> L.
North American black bear	<i>Ursus americanus</i> Pallas	Red osier dogwood	<i>Cornus sericea</i> L.
North American Porcupine	<i>Erethizon dorsatus</i> (L.)	Red-legged frog	<i>Rana aurora</i> Baird & Girard
Northern alligator lizard	<i>Elgaria coerulea</i> Wiegmann	Redwood	<i>Sequoia sempervirens</i> (Lamb. ex D. Don) Endl.
Northern flying squirrel	<i>Glaucomys sabrinus</i> Shaw	Roosevelt elk	<i>Cervus canadensis</i> <i>roosevelti</i> T
Northern goshawk	<i>Accipiter gentilis</i> L.	Salal	<i>Gaultheria shallon</i> Pursh
Northern spotted owl	<i>Strix occidentalis</i> <i>caurina</i> Merriam	Salmonberry	<i>Rubus spectabilis</i> Pursh
Northwestern salamander	<i>Ambystoma gracile</i> Baird	Snowshoe hare	<i>Lepus americanus</i> Erxleben
Olympic marmot	<i>Marmota olympus</i> Merriam	Sockeye salmon	<i>Oncorhynchus nerka</i> Wolbaum
Olympic mudminnow	<i>Novumbra hubbsi</i> Schultz	Steelhead	<i>Oncorhynchus mykiss</i> Wolbaum
Olympic pocket gopher	<i>Thomomys mazama</i> <i>melanops</i> Merriam, 1899	Subalpine fir	<i>Abies lasiocarpa</i> (Hook.) Nutt.
Olympic torrent salamander	<i>Rhyacotriton olympicus</i> (Gage, 1917)	Tailed frog	<i>Ascaphus truei</i> Stejneger
		Taylor's checkerspot butterfly	<i>Euphydryas editha</i> <i>taylori</i> (Edwards)
		Townsend big-eared bat	<i>Plecotus townsendii</i> (Cooper, 1837)

Van Dyke's salamander	<i>Plethodon vandykei</i> (Van Denburgh, 1906)
Vaux's swift	<i>Chaetura vauxi</i> (J.K.Townsend, 1839)
Violet-green swallow	<i>Tachycineta thalassina</i> Swainson
Virginia Opossum	<i>Didelphis Virginiana</i> Kerr
Warty jumping slug	<i>Hemphillia glandulosa</i> Bland & Binney
Western heather vole	<i>Phenacomys intermedius</i> Merriam
Western hemlock	<i>Tsuga heterophylla</i> (Raf.) Sarg.
Western redcedar	<i>Thuja plicata</i> Donn ex D. Don.
Western toad	<i>Bufo boreas</i> Baird & Girard
Western white pine	<i>Pinus monticola</i> Douglas ex D. Don
White-tailed ptarmigan	<i>Lagopus leucura</i> Richardson
Willow	<i>Salix</i> spp. L.
Wolverine	<i>Gulo gulo</i> L.
Yellow-bellied marmot	<i>Marmota flaviventris</i> Audubon & Bachman
Zebra mussel	<i>Dreissena polymorpha</i> Pallas

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Glossary

Adaptation—(1) An adjustment in ecological, social, or economic systems in response to climate stimuli and their effects, which moderates harm or exploits beneficial opportunities; (2) a process, action, or outcome in a system (household, community, organization, sector, region, country) in order for the system to better cope with, manage, or adjust to some changing condition, stress, hazard, risk, or opportunity.

Adaptive capacity—The ability of a system to adjust to changes in climate (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Biodiversity—The sum of species, ecosystem, and genetic diversity. Average conditions (mean and variability) in the atmosphere, ocean, and ice sheets and sea ice over a period of time, ranging from months to thousands or millions of years.

Climate change—Change in climate (in mean state or variability) over time. Climate change can occur as a result of changes in the Earth's orbit around the sun, cyclical patterns in circulation of the oceans and atmosphere, cycles in the ocean-atmosphere system, or human-caused activities.

Climate envelope models—Statistical models that predict future species distribution based on the relationship between current species distribution and climate variables (and sometimes other variables).

Climate forcing—A mechanism that affects climate (e.g., changes in the composition of the Earth's atmosphere through greenhouse gas emissions).

Dynamic global vegetation model—Model that is based on soil and climate information that simulate key physiological processes in plant communities to infer vegetation type over time.

Ecosystem—A system of interacting living organisms together with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study, and thus, the extent of an ecosystem may range from very small spatial scales to the entire Earth.

Ecosystem management—(1) Management that integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term; (2) any land-management system that seeks to protect viable populations of all native species, perpetuate natural disturbance regimes on the regional scale, adopt a planning timeline of centuries, and allow human use at levels that do not result in long-term ecological degradation.

Ecosystem resilience—The amount of change or disturbance that can be absorbed by an ecosystem before the ecosystem is redefined by a different set of processes and structures (e.g., the ecosystem recovers from the disturbance without a major phase shift).

Ecosystem services—Ecological processes or functions that have value to individuals or society.

Exotic species—Also referred to as “alien,” “nonnative,” and “introduced” species. These terms refer to any species that is not native to a particular ecosystem. Nonnative species may or may not be invasive.

Exposure—The character, magnitude, and rate of climate change and variation to which a system is exposed.

Gap model—Model that simulates forest interactions and dynamics on a small, gap-sized patch of land (usually 0.02 acre [0.01 hectare] and larger). Gap models can be used to project potential forest response to climate change.

Global climate models—Global climate models (GCMs) are coupled global climate models of the Earth's atmosphere, oceans, sea ice, and terrestrial biosphere. These computationally intensive numerical models have been under development for many decades and are based on the integration of fluid dynamics, chemical, and sometimes biological equations. They spontaneously exhibit interannual and interdecadal oscillations like those observed in the real Earth system. They are run under different starting conditions and using different amounts of solar, volcanic, and greenhouse gas forcing of the atmospheric dynamics. Using this ensemble approach, various GCMs have successfully simulated the Earth's climate over the past 1,000 years.

Greenhouse gases—Gases that trap heat in the atmosphere. The main greenhouse gases in the Earth’s atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Invasive species—A species, usually exotic, with the potential to spread rapidly and cause economic or environmental harm.

Intergovernmental Panel on Climate Change (IPCC)—A scientific intergovernmental body that evaluates the risks associated with human-caused climate change. The United Nations established the panel in 1988. The IPCC has published a series of special reports and periodic assessment reports (approximately every 5 years since 1990).

Native species—A species that historically occurred or currently occurs in a given ecosystem and that has not been introduced through human activities.

Phenology—The timing of an organism’s life history events (e.g., flowering in plants) that are cued by the organism’s environment.

Rain-dominant watershed—A watershed that receives most precipitation as rain. Climate change will likely have minimal impact on timing of streamflow in rain-dominant watersheds.

Restoration—Manipulation of the physical and biological environment in order to restore a desired ecological state or set of ecological processes.

Sensitivity—The degree to which a system will respond to a given stimulus.

Snowmelt-dominant watershed—A watershed that stores most winter precipitation in snowpack. This snowpack melts in the spring and early summer, resulting in peak streamflow in the late spring or early summer and lower streamflow during the winter months. Both increased winter rain (as opposed to snow) and shifts to earlier spring snowmelt with climate change will result in higher winter and spring streamflows and lower summer streamflows in snowmelt dominant watersheds.

Snow water equivalent—The depth of water in the snowpack, if the snowpack were melted.

Special Report on Emissions Scenarios (SRES) emissions scenarios—The SRES was published by the Intergovernmental Panel on Climate Change for their third assessment report in 2001. The report gave details on potential future greenhouse gas emissions scenarios, which are dependent on current and future human activities, to drive global climate models. There are 40 emissions scenarios, all making different assumptions about technological and economic development. Of these 40, the three most commonly used scenarios are the B1 (relatively low future emissions), A1B (moderate future emissions), and A2 (relatively high future emissions).

Stressor—An agent, condition, or other stimulus that can reduce the vigor or functionality of biological entities ranging from species to ecosystems.

Transient watershed—Watersheds located primarily at mid elevations that receive some snow and some rain. Streams and rivers draining transient watersheds often have one streamflow peak in fall or early winter owing to runoff generated by precipitation falling as rain, and another peak in late spring when the snowpack accumulated in midwinter melts. Both increased winter rain (as opposed to snow) and shifts to earlier spring snowmelt with climate change will result in higher winter and spring streamflows and lower summer streamflows in transient watersheds.

Vulnerability—The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climatic variability and extreme.

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ATTACHMENT C



Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Introduction to Snowmobile Management and Policy*

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ABSTRACT: Wintertime backcountry recreation, including snowmobiles, is a large and rapidly growing use on National Forest System lands. As the number of participants increase, so does the potential for conflict between motorized and non-motorized uses, as well as impacts to natural resources such as wildlife, water quality, soils, and vegetation. The USDA Forest Service has started travel analysis across forests in the snow-belt region, which will determine where motorized use is allowed, restricted and prohibited for decades to come. For planning to be effective, managers and conservationists must have access to the most recent data on the impacts of snowmobiles and need to be aware of successful management strategies for mitigating those impacts. The next four articles review the environmental and social impacts of winter motorized recreation and present a set of best management practices (BMPs). Article 1 provides context and describes the current state of management and policy governing snowmobiles. Article 2 reviews water quality, soils, and vegetation research and presents BMPs to reduce the impacts to these resources. Article 3 reviews research on the impact of snowmobiles on wildlife and presents BMPs to address those impacts. Article 4 reviews the growing conflict between non-motorized users and snowmobile users and presents BMPs to mitigate this conflict. Applying these BMPs will lead to a more socially and environmentally sustainable system of motorized and non-motorized routes and areas on National Forest lands.

Keywords: *Travel planning, snowmobiles, best management practices, BMPs, winter recreational use conflict, wildlife, water quality, soils, vegetation, USDA Forest Service*

INTRODUCTION

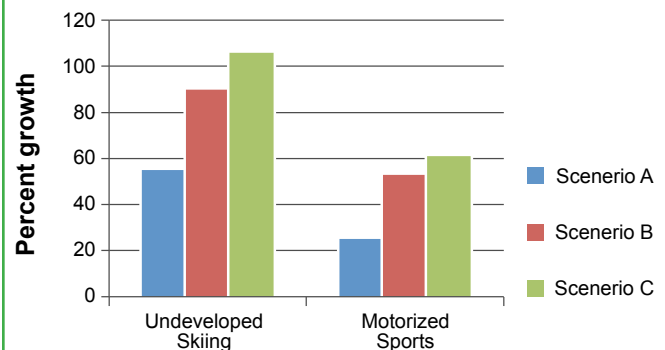
Winter backcountry recreation is a popular and steadily growing activity on USDA Forest Service (Forest Service) lands. Undeveloped skiing (including backcountry skiing, cross country skiing, and snowshoeing) is projected to be one of the top five fastest growing activities on Forest Service lands within 50 years (Figure 1). In one scenario, the number of participants in undeveloped skiing is predicted to double – reaching 16 million participants by 2060 (Cordell 2012). Motorized snow activities, including snowmobiling, are forecasted to grow as well, albeit at a slower rate. Overall, more than 20 million people participate in some form of backcountry winter recreation on National Forest lands each year (Cordell 2012).

Snowmobilers and skiers often seek out the same winter backcountry setting, looking for similar experiences such as solitude, fun, and the enjoyment of the natural beauty of the mountains. As motorized and non-motorized winter recreation grows on Forest Service lands, so does the potential for conflicts between the two user groups and impacts on natural resources. In terms of recreation opportunity, snowmobile use adversely impacts the recreation experience sought by many non-motorized users, while the reverse is rarely true. Motorized recreation will displace non-motorized users where use is heavy. This has occurred in numerous places. Where actual displacement does not occur, conflicts among users still arise from snowmobile use; the associated noise and fumes often creates annoyance for non-motorized users – especially if they are seeking quite solitude.

Additionally, advancements in technology and changes in use patterns of both user groups have increased the need for proactive management. In the early years, snowmobiles were relatively slow and limited to groomed trails; today's snowmobiles can go off-trail and up very steep slopes. "High marking" steep alpine bowls is now a popular riding technique, and modified motorcycles with a tread and ski allow riders to negotiate even heavily wooded areas. Backcountry skiers and snowboarders also have seen their sports evolve through technological changes in gear, making it easier for skiers and snowshoers to climb and descend mountains in the deepest of winter, thus accelerating the trend of increased user participation and demand.

These advancements and changes in use patterns have led to increased user conflicts and negative impacts on natural resources. Snowmobiles can impact wildlife, resulting in declines in animal health, fragmentation, and potential population declines (Gaines et al. 2003). Water quality, vegetation, and soils can also be greatly affected – especially in more sensitive alpine environments. Hundreds of research papers and monitoring reports have quantified these impacts and have been summarized in a number of recent literature reviews (e.g., Stokowski and LaPointe 2000, Gaines et al. 2003, Baker and Bithmann 2005, Davenport and Switalski 2006, Ouren et al. 2007, USDI NPS 2011, WWA 2014).

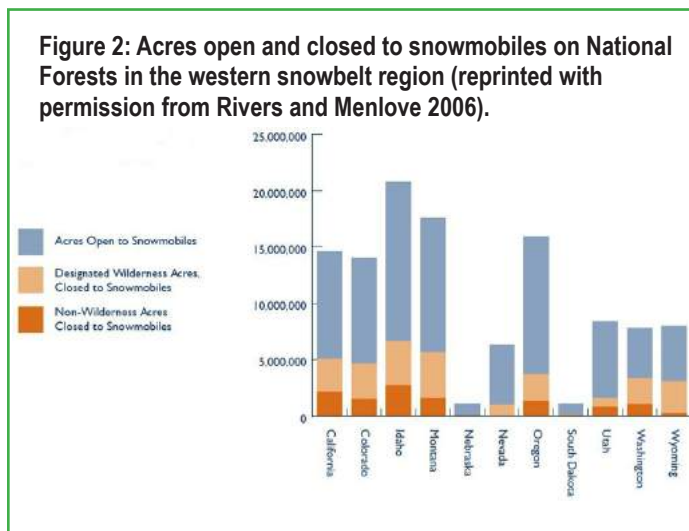
Figure 1: Percent growth in projected number of participants in undeveloped skiing and motorized snowsports on Forest Service lands in three model scenarios, 2008-2060 (adapted from Cordell 2012).



Snowmobile Management

In recent years, the Forest Service identified “unmanaged recreation” as one of the four threats to the health of National Forests (Bosworth 2003). On most forests, snowmobile activity was never formally planned or expected, but resulted from a default policy of allowing motorized use. This stance arose primarily due to the absence of a compelling reason to close or restrict motorized access, as it was already deemed self-limiting due to extreme terrain challenges and limitations of current technologies of the time. As a result, more than 70 percent or 81 million acres in the western snowbelt forests are open to potential snowmobile use (Rivers and Menlove 2006, Figure 2). While skiers (including cross country, backcountry, and snowshoers) outnumber snowmobiles on National Forest System lands (USDA FS 2014a), significantly more

acreage and trail miles are available for winter motorized recreation (Rivers and Menlove 2006, Figure 2). Of the 30 percent or 35 million acres closed to snowmobiles, two-thirds are in designated Wilderness Areas where all motorized use is legally prohibited, but where human-powered winter recreation opportunities are often difficult or impossible to access. Furthermore, numerous existing trailheads are weighted towards snowmobile recreation. The legacy of this *unplanned* “allocation” is widespread *open* allocation for winter motorized use that is often not based on historical use patterns or any specific rationale. Furthermore, significant displacement of non-motorized users has occurred as snowmobiles expand their reach, aided by ever-increasing technological advancements (e.g., Stokowski and LaPointe 2000, Manning and Valliere 2001, Adams and McCool 2010). Addressing this allocation disparity is critical to addressing recreational use conflict (Adams and McCool 2010).



Main Authorities Governing the Management of Snowmobiles in the National Forest System

In the early 1970s, management of snowmobiles and other motorized uses on public lands was inconsistent. However, after a series of ecological research findings and a rising need for conflict management, President Nixon signed Executive Order 11644 on February 8, 1972. This order charged federal land managers with developing and issuing regulations to manage off-road vehicles, including snowmobiles, specifically to *minimize* damage to natural

resources and *minimize* conflicts between motorized and non-motorized communities. The Executive Order continues to be the primary legal authority guiding off-road vehicle designations on public lands.

Executive Order 11644

Section 3. Zones of Use. (a) Each respective agency head shall develop and issue regulations and administrative instructions, within six months of the date of this order, to provide for administrative designation of the specific areas and trails on public lands on which the use of off-road vehicles may be permitted, and areas in which the use of off-road vehicles may not be permitted, and set a date by which such designation of all public lands shall be completed. Those regulations shall direct that the designation of such areas and trails will be based upon the protection of the resources of the public lands, promotion of the safety of all users of those lands, and minimization of conflicts among the various uses of those lands. The regulations shall further require that the designation of such areas and trails shall be in accordance with the following—

(1) Areas and trails shall be located to minimize damage to soil, watershed, vegetation, or other resources of the public lands.

(2) Areas and trails shall be located to minimize harassment of wildlife or significant disruption of wildlife habitats.

(3) Areas and trails shall be located to minimize conflicts between off-road vehicle use and other existing or proposed recreational uses of the same or neighboring public lands, and to ensure the compatibility of such uses with existing conditions in populated areas, taking into account noise and other factors.

(4) Areas and trails shall not be located in officially designated Wilderness Areas or Primitive Areas. Areas and trails shall be located in areas of the National Park system, Natural Areas, or National Wildlife Refuges and Game Ranges only if the respective agency head determines that off-road vehicle use in such locations will not adversely affect their natural, aesthetic, or scenic values.

In 1977, President Carter signed Executive Order 11989, which amended and strengthened EO 11644 by giving

federal public land managers the authority to close a motorized route or area if current access “will cause or is causing considerable adverse effects” to natural resources:

Executive Order 11989

Section 9. Special Protection of the Public Lands.

(a) Notwithstanding the provisions of Section 3 of this Order, the respective agency head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close such areas or trails to the type of off-road vehicle causing such effects, until such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence.

(b) Each respective agency head is authorized to adopt the policy that portions of the public lands within his jurisdiction shall be closed to use by off-road vehicles except those areas or trails which are suitable and specifically designated as open to such use pursuant to Section 3 of this Order.

Travel Management Rule (TMR)

Over the last few decades, impacts resulting from unmanaged off-road vehicle use and the growth of non-motorized backcountry recreation on National Forest System lands have led to a renewed effort to comply with the Executive Order direction. In 2005, the Forest Service promulgated the Travel Management Rule (TMR) to govern the management of summer and winter off-road vehicle systems. Subpart B of the TMR requires the Forest Service to have a designated summertime off-road vehicle system, while subpart C allows *but does not require* the Forest Service to designate a wintertime off-road vehicle system.

In 2013, a Federal court found that subpart C failed to comply with the direction in the Executive Order to designate a system of trails and areas that minimize impacts to natural resources and conflicts. In response, the Forest Service in 2014 issued a draft amendment to the TMR requiring

the designation of roads, trails, and areas where over-snow vehicle (OSV) use is allowed, restricted, or prohibited. A final winter travel rule is expected in the near future. In the coming years, areas that receive enough snow to support winter recreation will be required to have a system of designated routes and areas for winter motorized use, providing opportunity for public input as they do so. The BMPs presented in the next three articles are designed specifically to aid in the process of OSV route and area designation, and to improve management and monitoring on Forest Service lands.

Best management practices (BMPs) for minimizing impacts from snowmobiles

Best management practices provide science-based criteria and standards that land managers follow in making and implementing decisions that affect natural resources and human uses. BMPs are usually developed for a particular land use (e.g., road building and maintenance) and are based on the best available science, legal obligations, and pragmatic experience (Switalski and Jones 2012).

While some BMPs currently exist for snowmobile use, they are presented in a piecemeal, resource-specific fashion, or only provide guidelines for trail building and maintenance. For example, the Forest Service has created BMPs for protecting water quality on its lands and gives some guidance on how to minimize impacts related to snowmobile route planning (USDA FS 2012). The Forest Service – as well as other land management agencies – also has guidance to pursue environmental collaboration and conflict resolution in addressing land management challenges generally (OMB CEQ 2012). The practice of collaboration and conflict resolution has been an increasing trend in recent years. For environmental collaboration to be successful, several key aspects have been identified, including: balanced stakeholder representation, clear goals and objectives, information exchange, and shared decision-making (Schuett et al. 2001). As the Forest Service begins travel planning, a comprehensive framework is essential to help managers implement the mandate to minimize social and environmental impacts in designating winter motorized routes and areas.

The next three articles present the best available science for studying the impacts of snowmobiles on recreation use conflict and natural resources including water quality, soils, vegetation, and wildlife. Building off of the literature and existing recommendations from researchers and managers, a framework is outlined for the minimization of snowmobile impacts. These best management practices (BMPs) provide guidelines to help Forest Service managers designate appropriate routes and areas as *open*, and to close inappropriate routes and areas. Additionally, these practices provide guidance on managing snowmobile use to be consistent with the Executive Orders minimization criteria and the Forest Service Travel Management Rule.

Monitoring, enforcement, and funding

Implementing the BMPs presented here will help create a more sustainable and manageable system of routes and areas that will limit impacts to natural resources and use conflicts. Key to any management action is monitoring the success or failure of a project or program and adapting the management strategy to reach the goal or objectives. Accordingly, the BMPs rely heavily on monitoring to ensure they are indeed reducing negative social and environmental impacts. Once management actions are implemented, enforcement is essential for the success of any management plan (Adams and McCool 2010). It is also very important that the Forest Service allocates adequate funding and resources to undertake travel planning efforts (Yankoviak 2005, Adams and McCool 2010). Education and outreach programs that reduce conflict between uses and increase compliance have also been implemented (Lindberg et al. 2009, USDI NPS 2013). However, data is limited on the success of these programs, and such efforts may need to be supplemented with monitoring and enforcement of existing regulations.

Yellowstone National Park has developed an extensive adaptive management program following the implementation of its winter use plan (USDI NPS 2013). Land managers identified key resources affected by motorized recreation, indicators for measuring their effects, and the most appropriate monitoring methods (Table 1). Using this framework, they are able to revisit management decisions to determine if they are effectively mitigating use conflicts and environmental concerns in the Park.

Table 1: Examples of adaptive management monitoring: affected resource, indicator, and monitoring method identification in Yellowstone National Park (reprinted from USDI NPS 2013).

Affected Resource	Indicator	Preliminary Monitoring Methods
Air Quality at the West Entrance and Old Faithful	Levels of: CO, PM10, and NO2	Fixed site monitoring for CO, PM10, and NO2
Soundscape directly adjacent to park roads	Audibility: decibel levels (dBA) in terms of magnitude and duration (constant sound level or Leq) sound is audible over an 8-hour period	Could include audibility logging, digital recordings, and sound pressure level measurement
Visitor Experience	Satisfaction	Visitor survey (pending OMB approval)
Wildlife on or near roads	Wildlife behavioral responses to OSV	Observational studies

Climate Change

Today's land managers have to plan in the context of a rapidly changing climate. This includes addressing rising temperatures, thinner snow packs, more intense storms, increased number of freeze/thaw cycles, and more rain-on-snow events which can damage trail systems and add additional management challenges (IPCC 2013). These changes in snow conditions as well as a receding snowpack and earlier spring run-off will alter future winter backcountry recreation use patterns.

With fewer or smaller areas available (and possibly a shortened timeframe with good snow conditions), use will be concentrated, which may lead to increased crowding, recreational conflict, and resource damage. For example, it is becoming more commonplace for snowmobiles to travel on dry roadbeds or snow-free trails to access the

receding snowline. This direct contact with the ground can cause soil compaction, erosion, and water quality issues and lead to a whole new set of management concerns. In another example, grizzly bears may leave their dens earlier as climate changes, making previous seasonal management decisions obsolete. The trails themselves will need increased maintenance such as grading and clearing obstacles during snow-free months, upgrading culverts, building larger bridges, and moving routes from areas prone to flooding or rapid melting. The quality of snow, the number of days with good snow conditions, and quality of recreation experience may also be altered in some regions as there are more freeze-thaw cycles. To preserve quality recreation opportunities and minimize natural resource damage, land managers should consider the impacts of a changing climate when developing management direction.

CONCLUSION

The growing number of winter backcountry users has increased recreational use conflicts and negative impacts on natural resources. Climate change may also restrict where winter recreation takes place, further concentrating use and associated impacts. As the Forest Service begins formally addressing winter recreation through OSV travel planning and determines where motorized use is allowed, restricted, and prohibited, it is essential that land managers have the best available science to guide their important decisions. Furthermore, several management strategies have already been found to successfully mitigate these impacts.

This series of articles presents the best available science on the impacts of snowmobiles. Based upon this research and the recommendations of researchers and managers, and professional experience, a list of best management practices has been developed. If these BMPs are followed, they will help mitigate recreational use conflicts and minimize impacts to natural resources. Once a system of routes is established and special use areas are designated, effective enforcement and monitoring will be critical to the long-term success of any management plan.

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Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Water Quality, Soils, and Vegetation*

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ABSTRACT: Since the seminal research of Wallace Wanek and his colleagues in the 1970s, it has been well established that snowmobiles can negatively impact water quality, soils, and vegetation. However, while early researchers focused on localized impacts of snowmobiles on groomed trails, today's machines also travel off-trail and into many sensitive habitats such as alpine cirques, meadows, and wetlands. Water quality can also be affected when spring runoff releases pollutants stored in the snowpack – especially at staging areas. Furthermore, as snowmobiles become increasingly powerful, their increased torque and reach creates a potential for greater impact on those resources. Based on this research and existing management strategies, we present best management practices (BMPs) which will help protect water quality, soils, and vegetation.

Keywords: *Travel planning, snowmobiles, best management practices, BMPs, water quality, soils, vegetation, USDA Forest Service*

Water Quality Research

Protecting and enhancing water supply is a key mandate of the USDA Forest Service (Forest Service), and a number of aquatic species and municipal watersheds depend on National Forests – especially in the West. For example, most National Forest acres west of the Cascade Mountains in Oregon and Washington are municipal watersheds and provide water to local communities (USDA FS 2000). During the winter, snowmobiles release toxins such as ammonium, nitrate, sulfate, benzene, and toluene which accumulate in the snowpack (Ingersol 1999) and increase acidity (Musselman and Kormacher 2007). In the spring runoff, accumulated pollutants are released as a pulse into the soil, groundwater, and surrounding waterbodies.

A recent study found snowmobiles are polluting a tributary of Lake Tahoe, CA. Examining 168 different semi-volatile organic compounds (SVOC), McDaniel (2013) found eight to 20 times greater loadings on snowmobile trails than background levels. He further reported that highly toxic and persistent polycyclic aromatic hydrocarbons (PAHs) had increased two to six times the background level in a nearby stream (McDaniel 2013). Impacts on water quality can be especially pronounced at trailheads and staging areas where snowmobiles congregate (USDA FS 2012). Lakes can also be vulnerable because snow melts directly into the waterbody without any vegetative buffer, and there is a risk of snowmobiles falling through thin ice and spilling toxins directly into the water (USDA FS 2012).

Soils Research

Snowmobiles can directly impact soils in a number of ways including soil compaction, erosion, and contamination. When traveling in areas of low or no snow – such as wind-swept ridges, snow-free access points, or during periods of thin snowpack – snowmobiles can be particularly damaging. This may also be an increasingly common situation as climate change leaves low-elevation access points snow-free for longer periods of time. Snowmobiles can also indirectly impact soils through snow compaction (Wanek 1971). Weighing several hundred pounds, snowmobiles easily compact the snow, which can increase snowpack density, reduce soil temperatures, increase soil freezing, and result in a later melt-out (Gage and Cooper 2009).

In areas of low or no snowpack, direct soil compaction can occur from snowmobiles leading to erosion (Gage and Cooper 2009). On steep slopes – especially south facing, or wind-swept slopes – vegetation and snow can be mechanically removed from snowmobile tracks resulting in exposed bare ground (Stagl 1999). Soil compaction impacts nearly all properties and functions of soil including increased bulk density and reduced pore space leading to reduced permeability of water and air (Batey 2009). This results in surface erosion, especially on steep slopes (Batey 2009). Soil erosion when located near streams can also lead to localized stream sedimentation and increased turbidity. As climate change increases the number of snow-free days, erosion from snowmobiles will be an increasing management concern.

Soils can also be contaminated when pollutants enter the soil from a melting snowpack. With inefficient engines, snowmobiles release much of their oil gas mixture into the snow unburned. Several pollutants have been recorded in the snowpack along snowmobile trails including ammonium, nitrate, sulfate, benzene, and toluene (Ingersol 1999). In the spring, these pollutants are released into the soil, creating local contamination and associated impacts.

Vegetation Research

Snowmobiles impact vegetation either through directly crushing and breaking vegetation, or through a number of indirect mechanisms. When traveling off-trail, snowmobiles often run over trees and shrubs causing damage or death – often with minimal snowmobile traffic. Although these impacts may not be environmentally significant when they occur in robust forest environments, they can be very significant when they occur in sensitive forest habitat, such as high mountain slopes or meadows.

A recent study on the Gallatin National Forest (MT) found 366 acres of trees damaged by snowmobiles on timber sale units – slowing forest regeneration (WWA 2009, Table 1). Trees such as white-bark pine (*Pinus albicaulis*), found only at high elevations and declining across its range, may be vulnerable to snowmobile damage. Trampling has also been found to result in a reduction in plant productivity, changes in the plant community, and a reduction in plant diversity (Masyk 1973, Wanek 1973, Wanek and Schumacher 1975).

Compaction of the snow reduces the insulating air spaces and conducts cold air to the ground (Wanek 1973). These lower temperatures can reduce plant density and composition (Neumann and Merriam 1972), reduce productivity and growth (Wanek and Potter 1974), delay seed germination and flowering (Rongstad 1980), as well as affect decomposition rates, hummus formation and microbial activity (Neumann & Merriam 1972, Rongstad 1980). These impacts ultimately can change community structure and reduce the availability and duration of spring wildlife foods (Stagl 1999).

to protect the underlying vegetative cover and soil or trail surface; use and enforce closure orders to mitigate effects when adverse effects to soil, water quality, or riparian resources are occurring; use suitable measures to trap and treat pollutants from over-snow vehicle emissions in snowmelt runoff or locate the staging area at a sufficient distance from nearby waterbodies to provide adequate pollutant filtering” (USDA FS 2012, p. 96-97).

Some Forest Service policy has also recommended restricting snowmobile use to protect water quality.

Table 1. Summary of snowmobile damaged trees on the Gallatin National Forest (MT) reported during regeneration transect surveys of previously logged timber stands (reprinted from WWA 2009).

Area name	Year logged	Year inventoried	Acres	Average # damaged trees per acre	Total number of trees damaged
Little Teepee Creek Drainage	1969	1995	122	140	17,080
Horse Butte Road*	1992	1995	15	514*	7710*
Madison Arm	1991	1995	12	5	60
Unknown	1960s	1983	68	23	1564
Unknown*	1960s	1983	100	652*	65,200*
Cream Creek*	1986	1995	60	725*	43,500*
Total damaged trees:					135,114

*surveys note the presence of a snowmobile trail in this stand

Water Quality, Soils, and Vegetation Management

The most common strategy for protecting water quality, soils, and vegetation from snowmobile impacts is to ensure that there is adequate snow cover and create a buffer around waterways. For example, the Forest Service has developed best management practices (BMPs) to protect water resources on Forest Service lands from snowmobile pollution (USDA FS 2012). This document recommends, “Allow over-snow vehicle use cross-country or on trails when snow depths are sufficient

The Uinta-Wasatch-Cache National Forest (UT) does not allow recreational snowmobiling in Salt Lake City’s municipal watershed (USDA FS 2003). The Inyo, Sequoia, and Sierra National Forests are proposing a minimum of 18” of snowpack before allowing snowmobiling in their revised Forest Plan to protect forest resources (USDA FS 2014). Restricting snowmobile use in sensitive habitats such as riparian areas and wetlands can be helpful in mitigating these impacts as well.

Best Management Practices for Water Quality, Soils, and Vegetation

Designating motorized use

1. Set dates for snowmobile season opening and closure, and adjust based upon adequate snow depth.
2. Require a minimum snow depth of at least 0.3m (12 in), or sufficient depth to protect water quality, soils, and vegetation before a contingency plan and implement emergency closures if snowpack goes below this threshold.
3. Require a minimum snow depth of at least 0.45 m (18 in), or sufficient depth to protect water quality, soils, and vegetation before allowing snowmobiling off-trail. Have a contingency plan and implement emergency closures if snowpack goes below this threshold.
4. Avoid locating snowmobile routes or areas in municipal watersheds.
5. Restrict snowmobile use on wetlands, riparian areas, and sensitive meadows and buffer snowmobile trailheads and routes 45 m (150 ft) from these areas.

Minimizing impacts of motorized use

1. Develop public information, educational programs, and signage about the impacts of snowmobiles on water quality, soils, and vegetation and how to minimize those impacts.
2. Ensure adequate maintenance of bridges and culverts on routes to help prevent erosion during the spring run-off.
3. If roads are only used for snowmobile use, scarify the roadbed to restore hydrology.
4. Encourage or require the use of best available technology (BAT) where necessary to minimize the impacts water quality, soils, and vegetation.
5. Close routes and areas when excessive damage to soils and vegetation has occurred, and/or erosion has been documented.

6. Monitor closed routes and areas to ensure the measures taken are effectively mitigating impacts to water quality, soils, and vegetation.
7. Establish an adaptive management framework using monitoring to determine efficacy of current management.
8. Revisit plan decisions as necessary to ensure impacts to water quality, soils, and vegetation are being minimized and motorized impacts are below accepted thresholds.

CONCLUSION

It has been well documented that snowmobiles can impact water quality, soils, and vegetation. Alpine environments are particularly sensitive to disturbance, and snowmobiles can pollute waterways, cause localized soil erosion, and crush and break vegetation. Many of these impacts are compounded by climate change which is leaving many “historic” access points snow-free for much of the winter. Ensuring that there is adequate snow cover and buffered waterways are key mitigation strategies. Restricting use in sensitive habitats such as riparian areas and wetlands is also an important mitigation step. Applying BMPs in the development of a system of snowmobile routes and areas will protect water quality, soils, and vegetation on Forest Service lands.

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Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Wildlife*

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ABSTRACT: Snowmobiles can have a number of impacts on wildlife including physiological responses such as increased heart rate and elevated stress level, behavioral responses such as displacement and avoidance, as well as facilitating sources of competition, and/or increasing hunting, trapping, and poaching mortality. This article highlights the impacts of snowmobiles on three species of special concern because their populations are in decline or vulnerable, and they have state and/or federal legal protections: grizzly bears (*Ursus arctos*), wolverine (*Gulo gulo*), and Canada lynx (*Lynx canadensis*). As supported below, these three species are highly susceptible to snowmobile noise and disturbance, and need additional management actions to ensure winter recreation does not compromise their recovery. We also highlight research on the impact of snowmobiles on ungulates which are managed as game species and also need special management considerations. Based on this research and current management strategies, we present a set of best management practices (BMPs) which will help these sensitive species recover on National Forest lands.

Keywords: *Travel planning, snowmobiles, best management practices, BMPs, wildlife, grizzly bear, wolverine, Canada lynx, ungulates, USDA Forest Service*

INTRODUCTION

While many animals are well adapted for survival in the winter, deep snow and cold temperatures can limit foraging opportunities and increase metabolic demands. Snowmobiles can add to animals' vulnerability during this critical time by eliciting physiological responses such as increased heart rate and elevated stress level; eliciting behavioral responses including displacement and avoidance; facilitating sources of competition; and/or increasing hunting, trapping, and poaching mortality (for a review see Gaines et al. 2003, Figure 1, Table 1). These impacts can result in declines in animal health, fragmented wildlife populations, and potential population declines (Gaines et al. 2003). In this article, we focus on snowmobile impacts on three species that are in decline or vulnerable and have special legal protections. Additionally, we present research and management strategies for reducing the impacts of snowmobiles on ungulates. The increased popularity of winter recreation and the potential for climate change concentrating their use makes mitigating the impacts of snowmobiles very timely.

Figure 1. Interactions between the 29 focal wildlife species and snowmobile routes documented from a comprehensive literature review (reprinted from Gaines et al. 2003).

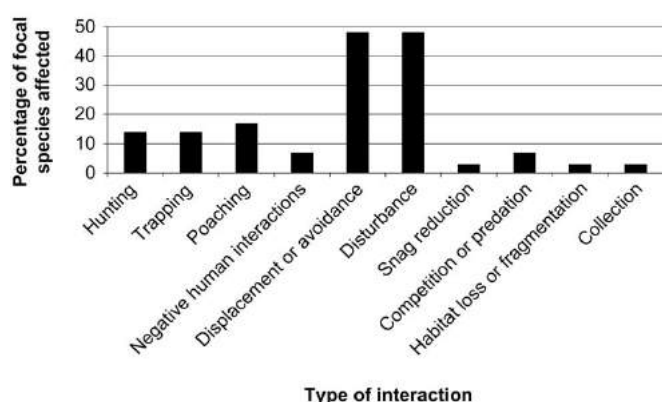


Table 1. Snowmobile route associated factors for wide-ranging carnivores and ungulate focal species (adapted from Gaines et al. 2003).

Focal species	Scientific name	Snowmobile route associated factors
Grizzly bear	<i>Ursus arctos</i>	Disturbance at a specific site
Wolverine	<i>Gulo gulo</i>	Trapping Disturbance at a specific site
Lynx	<i>Lynx canadensis</i>	Route for competitors or predators Trapping Disturbance at a specific site
Gray wolf	<i>Canis lupus</i>	Trapping Physiological response
American marten	<i>Martes americana</i>	Trapping
Fisher	<i>Martes pennanti</i>	Trapping Displacement or avoidance
Mule deer	<i>Odocoileus hemionus</i>	Displacement or avoidance Disturbance at a specific site
Elk	<i>Cervus canadensis</i>	Displacement or avoidance Disturbance at a specific site Physiological response
Bighorn sheep	<i>Ovis canadensis</i>	Displacement or avoidance Disturbance at a specific site Physiological response

Grizzly Bear

Grizzly bears (*Ursus arctos*) are a Threatened Species under the U.S. Endangered Species Act and protected from harm across their range in the continental United States. Their denning habitat often overlaps with winter recreation areas, making them susceptible to disturbance, thus increasing energy expenditures and the potential of den abandonment (Linnell et al. 2000). Direct mortality is

also possible if an avalanche is triggered on a slope where the bears are hibernating (Hilderbrand 2000).

Grizzly bears typically den in relatively high elevation areas with more stable snow conditions and steep slopes (Linnell et al. 2000). In general, grizzlies avoid roads (Mace et al. 1996) and typically select den sites one to two kilometers from human activity (Linnell et al. 2000). However, snowmobiles can easily access these remote sites, posing the potential for disturbance. No systematic data set exists on how denning bears react to snowmobile disturbance, but a comprehensive review on the topic found that human disturbance within one kilometer of a den site has a significant risk of abandonment, especially early in the denning season (Linnell et al. 2000).

Grizzly Bear Management

Although grizzly bears can be susceptible to disturbance and the risk of den abandonment, careful management of winter recreation can help avoid this conflict. Linnell et al. (2000) recommended that “winter activities should be minimized in suitable or traditional denning areas; if winter activity is unavoidable, it should begin around the time bears naturally enter dens, so that they can choose to avoid disturbed areas; and winter activity should be confined to regular routes as much as possible” (Linnell et al. 2000, pgs. 409-410). Podrunzney et al. (2000) modeled the overlap of potential grizzly bear denning habitat and potential snowmobile use areas on the Gallatin National Forest (MT). This model was used in USDA Forest Service (Forest Service) travel planning and allowed managers to plan snowmobile routes and areas to avoid conflict with grizzly bears. Similar modeling efforts have been conducted in Alaska incorporating both motorized and non-motorized recreation with bear denning habitat (see Goldstein et al. 2010).

Because the grizzly bear is a federally protected Threatened Species, the U.S. Fish and Wildlife Service (USFWS) considers snowmobile disturbance as a potential “take,” thus requiring management actions. In a recent Biological Opinion for snowmobiling on the Flathead National Forest (MT), the USFWS required Forest land managers to “quantify and monitor snowmobile use... and ensure adequate protection to known and discovered grizzly bear den sites and post-emergent females with cubs” (USDI FWS 2008, p. 57). In 2014, the Flathead National Forest closed

the Skyland / Challenge snowmobile play area due to the emergence of a grizzly bear in the area. As climate change results in bears leaving dens earlier, agency authority and flexibility to close areas will become increasingly important.

Limiting open motorized route density is a key management action to increase grizzly bear habitat security. For example, USDA FS (2011) recommends limiting open motorized route density to less than 1 mile per square mile in much of the Cabinet-Yaak Recovery Area (MT). State-level management plans also address management of snowmobiles in grizzly bear habitat. For example, The Montana Forested State Trust Lands Habitat Conservation Plan calls for minimizing road miles and restricting public access (including snowmobiles) on roads in important grizzly bear habitat areas and seasons (MT DNRC 2011).

Wolverine

Wolverine (*Gulo gulo*) are rare, long-ranging carnivores that spend most of their lives in high elevation areas (Aubry et al. 2007). While they roam hundreds, sometimes thousands of miles seeking food and mates, in the heart of the winter females dig dens in the snowpack and give birth. Little has been known about this elusive carnivore until recently when it was petitioned for listing under the Endangered Species Act, resulting in a flurry of research studies. Wolverine are a Species of Special Concern in Montana, classified as a Sensitive Species by the Forest Service, and trapping has been banned across their range in the continental United States.

In general, wolverine are sensitive to human disturbance. Studies in Canada reveal that wolverine have been found to be much more common in protected areas than in multiple-use landscapes (Fisher et al. 2013, Whittington et al. 2014). Snowmobile use commonly overlaps with wolverine denning habitat, and the noise may cause female wolverine to abandon their denning sites, potentially reducing reproductive success.

One on-going, five-year study examines the impact of winter recreation on wolverine in multiple mountain ranges in Montana and Idaho (Heinemeyer and Squires 2013). Preliminary results suggest that in areas with winter backcountry use, denning female wolverine move more frequently, move at higher rates when in higher intensity recreation areas, and move more during the weekend when

there is more human use (Heinemeyer and Squires 2013). These impacts are creating “significant additive energetic effects on wolverine during the critical winter and denning periods” (Heinemeyer and Squires 2013, p. 5). While the majority of the research sites studied are snowmobile use areas, the ongoing study is adding more sites where non-motorized backcountry skiers recreate as well. However, researchers have noted that limitations on the distance that skiers can travel often allows for core denning habitat to be available beyond the reach of backcountry skiers (Heinemeyer et al. 2014).

Wolverine Management

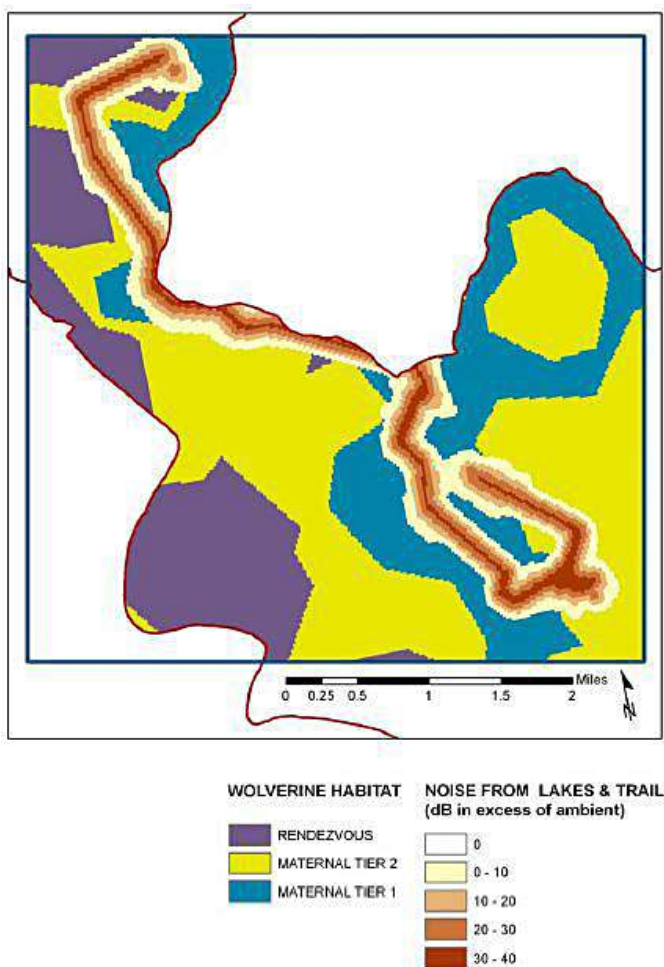
Wolverine have very large home ranges and need large blocks of interconnected habitat. Key management schemes for protecting wolverine include limiting disturbance, and retaining and restoring habitat connectivity. Managers can reduce the potential conflict between snowmobiles and wolverine by identifying areas of overlap and managing accordingly. For example, The Wilderness Society developed the SPreAD-GIS model that can model snowmobile sound propagation overlap with wolverine denning habitat (Reed et al. 2009, Figure 2). Two other sound propagation models, the Integrated Noise Model and the Noise Simulation Model (USDI NPS 2013), have also been used by Yellowstone National Park to model over-snow vehicle audibility.

In the face of climate change, wolverine may lose much of their denning habitat as persistent snowfields disappear (Fisher et al. 2013), and connectivity among remaining habitat patches will become increasingly important (Schwartz et al. 2009). The 2014 Management Plan for the Conservation of Wolverines in Idaho calls for identifying wolverine linkage areas at local and regional scales and pro-actively conserving them (IDFG 2014).

Canada Lynx

Canada lynx (*Lynx canadensis*) is a Threatened Species under the U.S. Endangered Species Act. They are adapted to deep snow conditions, allowing them to thrive in habitats where potential competitors and predators such as coyotes (*Canis latrans*) cannot easily survive. However, compacted snow trails and snowmobile play areas help facilitate coyote movement into Canada lynx habitat. While one study in Montana found limited use of snowmobile trails by coyotes (Kolbe et al. 2007), studies in Utah and Wyoming documented coyotes using compacted trails extensively, resulting in potential competition and displacement of Canada lynx (Bunnell et al. 2006, Gese et al. 2013, Dowd et al. 2014). The differences in results are probably due to distinct regional snow characteristics, predator communities, and snowmobile use (Bunnell et al. 2006). While both snowmobiles and skis create trails that coyotes could exploit, snowmobiles can travel an order of magnitude farther in a day than non-motorized users.

Figure 2. An example of using the SPreAD model to identify the overlap of snowmobile noise emissions and wolverine habitat types (Reed et al. 2009).



Canada Lynx Management

Both researchers and managers have recommended limiting snowmobile routes in Canada lynx habitat. Following their research on coyotes' use of snowmobile trails, Dowd et al. (2014) suggest that "limiting the expanse of groomed trail systems may minimize coyote encroachment into these deep snow environments" (p.39). The Canada Lynx Assessment and Conservation Strategy set planning standards on Forest Service lands that include, "Consider not expanding designated over-the-snow routes or designated play areas in lynx habitat, unless the designation serves to consolidate use" (ILBT 2013, p.94).

Ungulates

Ungulates are hoofed animals including deer (*Odocoileus spp.*), elk (*Cervus canadensis*), moose (*Alces alces*), mountain goat (*Oreamnos americanus*), and bighorn sheep (*Ovis canadensis*). All of these animals are highly prized game species. Bighorn sheep are classified as a Sensitive Species by the Forest Service, and two subspecies – Nelson's Peninsular and Sierra Nevada bighorn sheep – are listed as Endangered Species. It has been well established that undisturbed "winter range" is essential for ungulates survival (Canfield et al. 1999).

Studies have found that snowmobiles can exhibit both a physiological and behavioral response on a number of ungulate species (Gaines et al. 2003, Table 1). Recent studies in Yellowstone National Park found elk experienced increased stress (Creel et al. 2002) and actively responded (Borkowski et al. 2006) when approached by snowmobiles. A recent study on moose in Scandinavia also found disturbance and displacement following snowmobile activity (Neumann et al. 2011). Bighorn sheep and mountain goats are particularly susceptible to the effects of disturbance because they are limited to relatively small areas of suitable habitat with very steep and rocky slopes (Canfield et al. 1999).

Ungulate Management

Limiting disturbance on ungulates, especially in winter range, is a key management strategy. For example, in their review of the impact of recreation on Rocky Mountain ungulates, Canfield et al. (1999) suggest keeping motorized

routes and trails away from wintering areas, and they recommend establishing designated travel routes to make human use as predictable as possible. Further, Harris et al. (2014) recently reviewed the impacts of winter recreation on northern ungulates and highlighted the importance of limiting the duration and spatial footprint of disturbance.

Yellowstone National Park has implemented a number of policies to reduce disturbance from snowmobiles. Some of these practices include: limiting the number of snowmobiles, requiring best available technology (BAT), setting speed limits of 56 kph (35mph), and establishing open and closure dates (USDI NPS 2013). These practices have been coupled with monitoring and complementary research projects which can measure the effectiveness of the management plan. For example, Borkowski et al. (2006) stated that snowmobile regulations in Yellowstone, including intensities and travel routes, "were effective at reducing disturbances to bison and elk below a level that would cause measurable fitness effects" (p.1).

Best Management Practices for Wildlife

Designating motorized use

Based on the best available scientific research and successful management strategies, a set of best management practices (BMPs) has been created to guide effective and timely land management decisions and actions so that sensitive species will recover on National Forest lands.

1. Identify routes and areas where there is the potential for snowmobile disturbance of key wildlife including grizzly bear, wolverine, lynx, and ungulate winter range using survey data or GIS modeling. Survey information should be catalogued and regularly updated in a GIS database.
2. Locate motorized routes and areas:
 - a. where disturbance is unlikely to significantly affect viability or recovery of listed or petitioned threatened or endangered species:
 - i. limit snowmobile routes and areas in grizzly bear suitable denning habitat, wolverine denning habitat, and Canada lynx Critical Habitat.

- ii. reduce snowmobile route density to below 0.6 km/km² (1 mi/mi²) in occupied habitat.
 - b. outside proposed Wilderness Areas, Wilderness Study Areas and Research Natural Areas.
 - c. in discrete, specified areas bounded by natural features (topography and vegetative cover) to provide visual and acoustic barriers and to ensure that secure habitat is maintained for wildlife.
 - d. outside critical ungulate wintering habitat.
3. Set dates for snowmobile season opening and closure, and adjust based upon seasonal wildlife needs including:
 - a. critical ungulate wintering habitat/winter concentration areas (e.g., December through March in Rockies).
 - b. grizzly bear denning season (mid-November), and emergence time (mid-April).
 4. Limit or close routes and play areas with known bighorn sheep and mountain goat populations.
 5. Limit or close areas to off-road and over-snow vehicle use in areas where antler shed hunting is prevalent.
 6. Limit the number of routes and restrict off-trail use in key wildlife corridors.
 7. Maintain large unfragmented, undisturbed, and connected blocks of forestland and alpine habitat where no snowmobile routes are designated.
3. Close snowmobile routes and areas if a grizzly bear emerges from its den in the area.
 4. Monitor closed and open areas to ensure they are effectively mitigating impacts to wildlife, and not being used illegally.
 5. Establish an adaptive management framework using monitoring to determine efficacy of current management.
 6. Revisit plan decisions as necessary to ensure wildlife impacts are being minimized and motorized impacts are below accepted thresholds.

CONCLUSION

The growing number of winter backcountry users has increased the negative impacts on wildlife. Snowmobiles in particular can impact sensitive and hunted species. Grizzly bears' denning habitat overlaps with winter recreation areas, and snowmobiles can increase bears' energy expenditures and the risk of den abandonment. Wolverine can be disturbed by snowmobiles with significant additive energetic effects during critical denning periods. Canada lynx are also impacted by snowmobiles by introducing competitors into their habitat. Furthermore, ungulates, in response to snowmobile activity, exhibit both physiological and behavioral responses. Climate change may alter the behavior of wildlife as well, and most likely will concentrate snowmobile use – resulting in a need to pro-actively address the management of affected species. Identifying routes and areas where snowmobile activity and sensitive species habitat overlap is a necessary first step, and limiting snowmobiles in these areas is a key management action. Seasonal closures and use of best available technology can also limit impacts to these species.

Minimizing impacts of motorized use

1. Implement outreach programs to raise public awareness of winter wildlife habitat, wildlife behavior, and ways to minimize user impacts.
2. Encourage or require the use of best available technology (BAT) where necessary to limit disturbance on sensitive species.

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Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Winter Recreational Use Conflict*

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ABSTRACT: Winter wildlands are becoming increasingly crowded, and use conflicts are on the rise. To address use conflict and other resource impacts, the USDA Forest Service has begun Travel Planning in the snow-belt region. To assist in this process, this article presents recent research on how snowmobile use and associated noise and fumes impact non-motorized use. Motorized use often creates annoyance non-motorized users that has been documented to lead to displacement. However, a well-planned and enforced system of routes and areas, as well as improved management tools and technologies, has been shown to help reduce or eliminate conflict. Based on research and existing management strategies, we present a set of best management practices (BMPs) to address winter recreational use conflict and to create a more socially and environmentally sustainable system of motorized and non-motorized designations on National Forest lands.

Keywords: *Travel planning, snowmobiles, best management practices, BMPs, winter recreational use conflict, USDA Forest Service*

INTRODUCTION

As more people recreate in the backcountry, winter wildlands are becoming increasingly crowded, and conflicts are on the rise. Backcountry skiers and other non-motorized users seek solitude, quiet, and undisturbed natural areas. Desirable terrain, snow conditions and access are also key components of their recreational experience. Snowmobiles change the quality of this experience and create conflict with other winter recreationists (Adams and McCool 2012). Conflict among motorized and non-motorized use is typically “asymmetrical;” skiers experience conflict; snowmobilers do not (Knopp and Tyger 1973, Jackson and Wong 1982, Gibbons and Ruddell 1995). Quiet, non-motorized recreationists can have the quality of their experience dramatically altered by snowmobiles, while motorized users often don’t even notice skiers using the same landscape. This article reviews how snowmobile use affects the soundscape, airshed, and viewshed of non-motorized users and presents management strategies for mitigating these impacts.

Soundscape

Protecting quiet soundscapes has become an increasingly important management issue in winter landscapes. Snowmobile noise is one of the biggest sources of use conflict, as an increasing number of winter recreationists seek the peace and quiet found in the backcountry as a way to escape the sounds of modern busy life (Abraham et al. 2010). Noise from motorized recreation is a particular problem in winter because all use becomes restricted to a relatively small number of plowed trailheads, thus significantly reducing access to wilderness for non-motorized users.

Research shows that natural soundscapes assist “in providing a deep connection to nature that is restorative and even spiritual for some visitors” (Freimund et al. 2009, pg. 4). When recreationists have these expectations, the mechanical noise of snowmobiles in otherwise quiet areas can result in a substantial diminution in non-motorized users’ recreation experience. This often negatively impacts the experience of the recreationist, creates conflict, and ultimately leads to displacement (Gibbons and Ruddell 1995, Manning and Valliere 2001, Vittersø et al. 2004, Adams and McCool 2010).

In “multiple-use” backcountry areas, snowmobile noise can be difficult to escape. While dependent on speed, type of machine, and direction of wind, snowmobile noise can travel up to 16 km (10 mi; Hastings et al. 2006, Burson 2008) – a distance farther than most non-motorized recreationists travel in a day. Additionally, considering that most forest roads are not plowed in the winter, the ability of skiers to avoid motorized noises is very restricted. Often trails and areas that are considered “front-country” and easily drivable in the summer are much more difficult to access in the winter. Accordingly, the user expectation in these areas is more aligned with a backcountry experience including a quiet soundscape. This strong disconnect between available recreation settings and desired user experience is something the USDA Forest Service (Forest Service) primarily addresses in planning using the Recreation Opportunity Spectrum (ROS). However, ROS is a classification tool that describes physical, social, and managerial attributes – access, remoteness, size, user density, and level of development – in summer, but not winter. Addressing these front-country multiple-use areas, which span a variety of ROS settings and experience high user conflict, is a particularly important priority for travel planning strategies.

Many people also travel in the winter backcountry to view wildlife. However, it has been well established that noise has a widespread and profound impact on wildlife (Barber et al. 2010, Farina 2014), which limits opportunities for viewing and listening to birds and other wildlife. Most fundamentally, snowmobile noise creates annoyance for many non-motorized users that reduces the quality of backcountry experience and may lead to displacement (e.g., Stokowski and LaPointe 2000, Manning and Valliere 2001, Adams and McCool 2010).

Airshed

Motorized and non-motorized winter backcountry recreationists are often confined to the same plowed parking areas to prepare for their trips. However, in these “staging areas” snowmobile emissions can be concentrated and lead to an additional source of conflict and potential health concerns. While technological advances have produced cleaner four-stroke engines (and even zero emission electric snowmobile prototypes), the vast majority of snowmobiles still use highly polluting two-stroke

engine technology. Lubricating oil is mixed with the fuel, and 20 to 30 percent of this mixture is emitted unburned into the air and snowpack (Kado et al. 2001). Also, the combustion process itself is relatively inefficient and results in high emissions of air pollutants (USDI NPS 2000). As a result, two-stroke snowmobiles emit very large amounts of smoke which includes carbon monoxide (CO), unburned hydrocarbons (HC) and other toxins (Zhou et al. 2010).

Concerns over human health related to snowmobile emissions have led to extensive recent research on snowmobile pollution in Yellowstone National Park (e.g., USDI NPS 2000, Bishop et al. 2001, Kado et al. 2001, Bishop et al. 2006, Bishop et al. 2009, Ray 2010, Zhou 2010), and conclusions from these studies have led to a Park ban of 2-stroke engines (USDI NPS 2013). Emissions from snowmobiles release many carcinogens and can pose dangers to human health (Eriksson et al. 2003, Riemann et al. 2009). Several “known” or “probable” carcinogens are emitted including nitrogen oxides, carbon monoxide, ozone, aldehydes, butadiene, benzenes, and polycyclic aromatic hydrocarbons (PAH). While most of the acute toxic effects of snowmobiles are limited to staging areas and parking lots, the smoke and fumes from snowmobiles on trails can dramatically reduce the quality of the experiences of non-motorized users along the trail as well.

Viewshed and other impacts

In addition to the sounds and smells of snowmobiles, the mere presence of snowmobiles on the landscape can degrade the experience of many non-motorized users. In just a few hours, snowmobiles can access almost any basin in the west and disproportionately consume a limited resource, powder snow. Slopes displaying dozens of “high mark” tracks can take away the natural beauty of the landscape for some. The deep tracks of snowmobile can also create a hazard for skiers navigating a downward slope, or the tracks can quickly “track out” a slope, rendering it completely un-skiable. Safety is also a concern, as there is the possibility of collision with a snowmobile, or the risk of a snowmobile triggering an avalanche from above. Alternatively, a snowmobile can diminish the sense of risk or wildness because they effectively reduce the real and perceived distance from safety (Adams and McCool 2010).

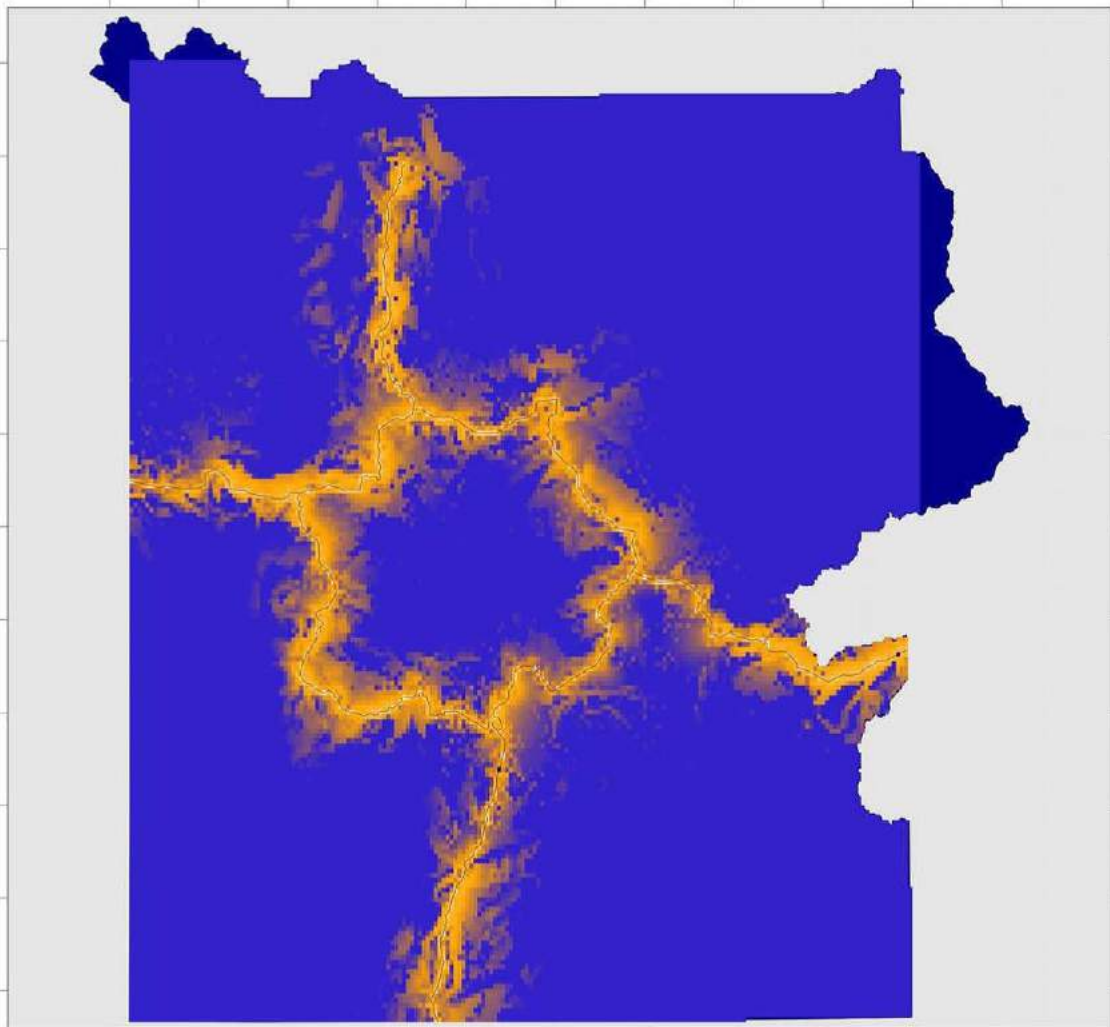
Winter recreational use conflict management

The most effective way to manage winter recreational use conflict is a well-planned and enforced system of routes and areas that separate motorized and non-motorized uses as much as possible (e.g., Andereck et al. 2001, Lindberg et al. 2009, Adams and McCool 2010, USDI NPS 2013). Simply reducing snowmobile noise and smells may not be sufficient to reduce conflict or deter displacement. However, limiting snowmobile use to best available technology (BAT) machines, as has been done at Yellowstone National Park, can substantially reduce use conflict. Closing or separating the non-compatible uses is the most effective way to reduce conflict. For example, an analysis of conflict reduction strategies in Sweden found that closing access to snowmobiles – a change from seeing, hearing, and smelling snowmobiles – led to significant skier welfare gains (Lindberg et al. 2009).

Another strategy employed by the Forest Service is to separate motorized and non-motorized temporally, thereby granting all users some opportunity for use while minimizing conflict. On the Chugach National Forest (AK), for example, one section of the forest is closed to motorized use on alternating years (USDA FS 2007a). On the Humboldt-Toiyabe National Forest (NV, CA), a high-elevation trailhead designated as shared use until lower elevation access receives enough snow for OSV use at which point it becomes non-motorized (USDA FS 2007b). In more popular areas, shorter alternating closure periods, such as biweekly, may be more appropriate.

Mitigating snowmobile noise can also help address use conflict. Snowmobile noise can travel long distances in the winter, and noise models have been used to identify areas of recreational use conflict for management planning. For example, noise modeling has been used extensively in Yellowstone National Park to estimate the area affected by noise under a range of management alternatives (Hastings et al. 2006, Hastings et al. 2010, USDI NPS 2013, Figure 1).

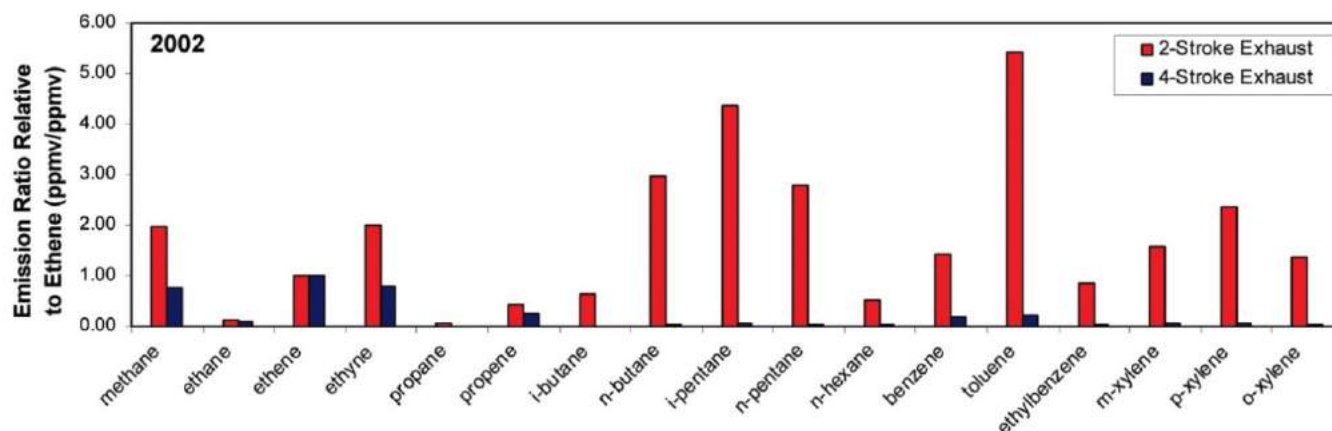
Figure 1. Example of noise simulation modeling used in Yellowstone National Park to identify where disturbance and conflict may be a management issue. Orange is the distance snowmobile and snow coach noise travels beyond the groomed roads. Model inputs include temperature, relative humidity, snow cover, and natural ambient sound levels. The modeling also accounts for the acoustic effects of topography, vehicle speeds, and vehicle group size (USDI NPS 2013).



Several studies recommend replacing two-stroke engines with four-stroke engines to significantly reduce emissions and noise (e.g., Miers et al. 2000, Kado et al. 2001, Eriksson et al. 2003). Four-stroke engines are significantly less polluting (Zhau et al. 2010, Figure 2), and have improved fuel efficiency,

as well as a reduction in visible exhaust plumes, odor, and noise (Bishop et al. 2006). A study of using best available technology (BAT) machines in Yellowstone has resulted in a 60% reduction in carbon monoxide (CO) and a 96% reduction in hydrocarbon (HC) emissions (Bishop et al. 2006).

Figure 2. Average non-methane hydrocarbons exhaust emission ratios relative to ethene (ppmv/ppmv) for two-stroke and four-stroke engines in 2002 (Reprinted with permission from (Zhou, Y., D. Shively, H. Mao, R.S. Russo, B. Pape, R.N. Mower, R. Talbot, and B.C. Sive. 2010. Air toxic emissions from snowmobiles in Yellowstone National Park. *Environmental Science and Technology* 44(1): 222-228. Copyright 2010 American Chemical Society).



However, if motorized use of a route or area has been identified as having an unacceptable impact on other user groups, that route or area should be closed (Lindberg et al. 2009, Adams and McCool 2010, and NYSDEC 2011). Furthermore, some National Forest lands have limited non-motorized recreation opportunities, so creating non-motorized areas may be needed. For example, a snowmobile plan for Adirondack Park (NY) calls for closing routes if the “opportunities for quiet, non-motorized use of trails are rare or nonexistent;” (NYSDEC 2011, p.244). Finally, in some areas—regardless of conflict—snowmobiling should not be allowed. For example, Adams and McCool (2010) argue that roadless areas should be protected from motorized use because “roadless areas are exceptional for their wild and quiet recreational opportunities, their habitat for threatened and endangered species, and other values. Their character and values derive from their lack of accessibility by motor vehicles” (p. 109).

To identify routes and areas that are sources of conflict, working groups have been established. However, for this collaboration to be successful, several key aspects have been identified, including: balanced stakeholder representation, clear goals and objectives, information exchange, and shared decision making (Schuett et al. 2001).

Best Management Practices for Winter Recreational Use Conflicts

Designating motorized use

1. When necessary elements for successful collaboration exist, establish a working group with motorized and non-motorized users, conservation interests, land managers, and other stakeholders to develop concepts for minimizing recreational conflict.
2. Identify routes and areas where conflict is ongoing among motorized and non-motorized winter recreational use utilizing existing information, surveys, GIS modeling, and community outreach.
3. Identify routes and areas of particularly high value or demand for motorized and non-motorized use.
4. To the degree possible, allocate separate trails, trailheads, and areas.
5. Ensure that non-motorized trails and areas are available:
 - a. close to plowed access points, groomed trails, and other access portals.
 - b. in contiguous non-motorized blocks.

- c. in areas where there are few non-motorized opportunities.
 - d. in both frontcountry and backcountry settings.
 - e. in areas with scenic beauty.
 - f. in areas sheltered from noise emanating from motorized areas.
 - g. cross a variety of Recreational Opportunity Spectrum (ROS) categories.
6. Ensure that a fair balance of unplowed roads is set aside for non-motorized use.
7. Locate motorized routes and areas:
- a. away from popular or historically used backcountry ski areas, or areas of growing use.
 - b. outside proposed Wilderness Areas, Wilderness Study Areas, and Research Natural Areas.
 - c. with easily enforceable boundaries using topographic or geographic features. (e.g., a ridge top or highway) - use boundary signage to provide additional clarity, or where unauthorized use is occurring.
 - d. where they do not bisect non-motorized areas.
8. Consider temporal restrictions in areas of high-use or high-value to both motorized and non-motorized use. This includes both early/late season restrictions, as well as alternating access.
9. Where necessary to designate a motorized route through a non-motorized area, locate and manage such route (such as speed and idling limits) to minimize disturbance to the non-motorized area.
10. In areas of shared use, consider requiring best available technology (BAT) to reduce conflict and impacts between uses.

Minimizing impacts of motorized use

1. Undertake proactive and systematic outreach programs in order to facilitate increased compliance of closures and reduce user conflicts.
2. Provide free digital and paper maps that clearly show routes, areas, and watersheds open and closed to snowmobiles.
3. Encourage or require the use of best available technology (BAT) snowmobiles to reduce noise and local air quality impacts.
4. Implement significant penalties and consequences for violating snowmobile regulations that will dissuade users from such violations.
5. Monitor closed routes and areas to ensure that snowmobile intrusion is not occurring.
6. Establish an adaptive management framework using monitoring to determine efficacy of current management.
7. Revisit plan decisions as necessary to ensure use conflicts are being minimized and motorized impacts are below accepted thresholds. Close snowmobile routes and areas when motorized use is leading to trespass onto non-motorized trails or areas.

CONCLUSION

The growing number of winter backcountry users has increased recreational use conflicts and negative impacts on natural resources. As the Forest Service begins formally addressing winter recreation and determining where motorized use is allowed, restricted, and prohibited, it is essential that managers have the best available science to guide their decisions. Snowmobiles can negatively affect the soundscape, airshed, and viewshed of non-motorized users. The most effective way to mitigate winter recreational use conflict is a well-planned and enforced system of routes and areas. Simply reducing snowmobile noise or smells can limit snowmobile impacts to non-motorized users, but may not be sufficient in reducing conflict. Rather, closing or separating the non-compatible

users is the best way to reduce conflict. Collaboration among user groups can be successful, but there must be a balanced stakeholder representation, clear goals and objectives, information exchange, and shared decision making.

This document presented the best available science on the impacts of snowmobiles. Based upon this research and the recommendations of researchers and managers, and professional experience, we have developed a list of best management practices. These BMPs will help mitigate recreational use conflicts and minimize impacts to natural resources. Once a system of routes and special use areas is established, enforcement and monitoring will be critical to the success of any management plan.

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EXHIBIT 2



FOREST SERVICE HANDBOOK NATIONAL HEADQUARTERS (WO) WASHINGTON, DC

FSH 1909.15 – NATIONAL ENVIRONMENTAL POLICY ACT HANDBOOK

CHAPTER 20 – ENVIRONMENTAL IMPACT STATEMENTS AND RELATED DOCUMENTS

Amendment No.: 1909.15-2011-5

Effective Date: September 14, 2011

Duration: This amendment is effective until superseded or removed.

Approved: FAYE L. KRUEGER
Associate Deputy Chief, NFS

Date Approved: 09/09/2011

Posting Instructions: Amendments are numbered consecutively by handbook number and calendar year. Post by document; remove the entire document and replace it with this amendment. Retain this transmittal as the first page(s) of this document. The last amendment to this handbook was 1909.15-2011-4 to 1909.15_zero_code.

New Document	1909.15_20	24 Pages
Superseded Document(s) by Issuance Number and Effective Date	1909.15_20 (Amendment 1909.15-2011-2, 04/01/2011)	25 Pages

Digest:

22.1 - Removes “Distribution” from the section title as it implies a requirement for distribution of notices of intent (NOI) that is not intended. Also, updates the hyperlink to *Field Unit Checklist for Processing Notices*.

22.2 - Changes “may” to “should” to encourage issuance of corrected NOIs when there are major changes and removes the unintended implied requirement for distribution of NOIs. Also, removes the requirement to distribute notices of intent.

22.3 - Removes the “Exhibit 01” heading and makes minor text edits and paragraph alignment for clarity.

24.1 - Adds a reminder that paper copies of environmental impact statements filed with EPA’s Office of Federal Activities must be bound.

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This chapter provides guidance on preparing the environmental impact statement (EIS) when the environmental analysis determines there may be significant environmental effects. Classes of actions that normally require preparation of an EIS are identified and guidance for preparing related documents, such as notices of intent (NOI) and records of decision (ROD), is also provided.

For ease of reference, [Council on Environmental Quality \(CEQ\) regulations](#) for implementing requirements of the [National Environmental Policy Act](#) (NEPA) are set out in boldface type and block-indented and [Forest Service regulations](#), that supplement the CEQ regulations are in **boldface** type, *italicized*, and block-indented.

21 - FACTORS TO CONSIDER

21.1 - Whether to Prepare an Environmental Impact Statement

In determining whether to prepare an environmental impact statement the Federal agency shall:

(a) Determine under its procedures supplementing these regulations (described in § 1507.3) whether the proposal is one which:

(1) Normally requires an environmental impact statement, or

(2) Normally does not require either an environmental impact statement or an environmental assessment (categorical exclusion).

(b) If the proposed action is not covered by paragraph (a) of this section, prepare an environmental assessment (§ 1508.9). The agency shall involve environmental agencies, applicants, and the public, to the extent practicable, in preparing assessments required by § 1508.9 (a)(1).

(c) Based on the environmental assessment make its determination whether to prepare an environmental impact statement.

(d) Commence the scoping process (§ 1501.7), if the agency will prepare an environmental impact statement.

(e) Prepare a finding of no significant impact (§ 1508.13), if the agency determines on the basis of the environmental assessment not to prepare a statement.

(1) The agency shall make the finding of no significant impact available to the affected public as specified in § 1506.6.

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(2) In certain limited circumstances, which the agency may cover in its procedures under § 1507.3, the agency shall make the finding of no significant impact available for public review (including State and area-wide clearinghouses) for 30 days before the agency makes its final determination whether to prepare an environmental impact statement and before the action may begin. The circumstances are:

(i) The proposed action is, or is closely similar to, one which normally requires the preparation of an environmental impact statement under the procedures adopted by the agency pursuant to § 1507.3, or

(ii) The nature of the proposed action is one without precedent. (40 CFR 1501.4)

In determining whether to prepare an EIS, consider the significance of effects. Use the criteria in the definition for “significantly,” found in the zero code, section 05, for determining whether the action will have a significant effect on the human environment.

21.2 - Classes of Actions Normally Requiring Environmental Impact Statements

Forest Service NEPA procedures identify the following classes of action which normally require preparation of an environmental impact statement. These classes of actions were identified because they normally result in significant effects. The EIS requirement may be met with a programmatic EIS.

(1) Class 1: Proposals to carry out or to approve aerial application of chemical pesticides on an operational basis. Examples include but are not limited to:

(i) Applying chemical insecticides by helicopter on an area infested with spruce budworm to prevent serious resource loss.

(ii) Authorizing the application of herbicides by helicopter on a major utility corridor to control unwanted vegetation.

(iii) Applying herbicides by fixed-wing aircraft on an area to release trees from competing vegetation.

(2) Class 2: Proposals that would substantially alter the undeveloped character of an inventoried roadless area or potential wilderness area. Examples include but are not limited to:

(i) Constructing roads and harvesting timber in an inventoried roadless area where the proposed road and harvest units impact a substantial part of the inventoried roadless area.

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(ii) Constructing or reconstructing water reservoir facilities in a potential wilderness area where flow regimens may be substantially altered.

(iii) Approving a plan of operations for a mine that would cause considerable surface disturbance in a potential wilderness area. (36 CFR 220.5(a))

The pesticides in Class 1 are conventional chemical pesticides, not those classified as [biopesticides by the US Environmental Protection Agency](#) (EPA). Operational applications do not include those applications regulated as Emergency Exemptions ([40 CFR part 166](#)) or Experimental Use Permits ([40 CFR part 172](#)).

If an action in one of these classes does not have significant effects, follow the CEQ regulations above ([40 CFR 1501.4](#)) and make the FONSI available for public review before the determination is made to not prepare an EIS.

22 - NOTICES OF INTENT

22.1 - Preparation of Notices of Intent (NOI)

Normally a notice of intent to prepare an EIS shall be published in the Federal Register as soon as practicable after deciding that an EIS will be prepared. Where there is a lengthy period between the agency's decision to prepare an environmental impact statement and the time of actual preparation, the notice of intent may be published at a reasonable time in advance of preparation of the draft statement. (36 CFR 220.5(b))

The NOI begins the formal scoping process, but is not intended to be the sole method of scoping. Policy on scoping is provided in chapter 10, section 11.

CEQ regulations require that:

The notice shall briefly:

- (a) Describe the proposed action and possible alternatives.**
- (b) Describe the agency's proposed scoping process including whether, when, and where any scoping meetings will be held.**
- (c) State the name and address of a person within the agency who can answer questions about the proposed action and the environmental impact statement. (40 CFR 1508.22)**

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Forest Service regulations further require that:

A notice must meet the requirements of 40 CFR 1508.22, and in addition, include the following:

- (1) Title of the responsible official(s);***
- (2) Any permits or licenses required to implement the proposed action and the issuing authority;***
- (3) Lead, joint lead, or cooperating agencies if identified; and***
- (4) Address(es) to which comments may be sent. (36 CFR 220.5(b))***

Follow the [Federal Register Document Drafting Handbook](#) direction for preparing a NOI or use the [notice of intent template](#) found on the Forest Service [NEPA website](#). See also the Office of Regulatory and Management Services [Field Unit Checklist for Processing Notices](#).

When the Chief or the Secretary is the responsible official, the appropriate field unit or Washington Office staff prepares the NOI and sends it to the Washington Office Director of Ecosystem Management Coordination for review and submission.

The title of the EIS used in the NOI should be used on the cover of the draft and final EIS.

The following paragraph is recommended for inclusion in an NOI:

Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the Agency with the ability to provide the respondent with subsequent environmental documents.

22.2 - Correction of Notices of Intent

A corrected NOI should be published in the *Federal Register* (sec. 22.1) if there are major changes.

Examples of major changes include:

1. A delay of more than a year in filing either the draft or final EIS.
2. Dramatic changes in the proposed action or the decision to be made.
3. Designation of a different responsible official by title.

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A corrected NOI refers to the date and page number of all prior notices relevant to the proposed action that were published in the *Federal Register*. Prepare a corrected NOI in the same way as the original (sec. 22.1).

22.3 - Withdrawal of a Notice of Intent

A withdrawal notice must be published in the Federal Register if, after publication of the notice of intent or notice of availability, an EIS is no longer necessary. A withdrawal notice must refer to the date and Federal Register page number of the previously published notice(s). (36 CFR 220.5(c))

Prepare and distribute a withdrawal notice in the same way as the NOI (sec. 22.1). In addition, send a copy of the withdrawal notice to the Environmental Protection Agency's Office of Federal Activities (sec. 25.2).

When the Chief or the Secretary is the responsible official, the appropriate field unit or Washington Office staff prepares the withdrawal notice as soon as there is a decision to terminate the process. Then the notice is sent to the Director of Ecosystem Management Coordination for review and submission to Office of Regulatory and Management Services (ORMS) and the Environmental Protection Agency's Office of Federal Activities.

23 - UNIFORM REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS

As required by [section 102\(2\)\(C\) of NEPA](#), EISs are to be included in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment ([40 CFR 1502.3](#)). For guidance on classes of actions normally requiring an EIS, refer to section 21 and [36 CFR 220.5\(a\)](#).

23.1 - Page Limits

The text of final environmental impact statements (paragraphs (d) through (g) of § 1502.10) shall normally be less than 150 pages and for proposals of unusual scope or complexity shall normally be less than 300 pages. (40 CFR 1502.7)

23.2 - Writing

Environmental impact statements shall be written in plain language and may use appropriate graphics so that decision makers and the public can readily understand them. (40 CFR 1502.8)

The form and style of writing in an EIS should follow the [U.S. Government Printing Office Style Manual](#). [NEPA document templates](#) can be useful to get started. A variety of clear writing resources are also available through the [plain language in government](#) website.

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23.3 - Content and Format

The responsible official may use any EIS format and design as long as the statement is in accordance with 40 CFR 1502.10. (36 CFR 220.5(d))

The recommended format found in the CEQ regulations is outlined below.

Agencies shall use a format for environmental impact statements which will encourage good analysis and clear presentation of the alternatives including the proposed action. The following standard format for environmental impact statements should be followed unless the agency determines that there is a compelling reason to do otherwise:

- (a) Cover sheet.**
- (b) Summary.**
- (c) Table of contents.**
- (d) Purpose of and need for action.**
- (e) Alternatives including proposed action (sections 102(2)(C)(iii) and 102(2)(E) of the Act).**
- (f) Affected environment.**
- (g) Environmental consequences (especially sections 102(2)(C)(i), (ii), (iv), and (v) of the Act).**
- (h) List of preparers.**
- (i) List of Agencies, Organizations, and persons to whom copies of the statement are sent.**
- (j) Index.**
- (k) Appendices (if any).**

If a different format is used, it shall include paragraphs (a), (b), (c), (h), (i), and (j), of this section and shall include the substance of paragraphs (d), (e), (f), (g), and (k) of this section, as further described in §§ 1502.11 through 1502.188, in any appropriate format. (40 CFR 1502.10)

A variety of [formatting resources for an EIS including templates, references and examples](#) for each of the paragraphs listed above is available on line.

1. Cover Sheet. The cover sheet details the agencies involved in the development of the statement, contact information, and a brief abstract describing the contents of the document. The CEQ requires the following form and content for a cover sheet. (40 CFR 1502.10).

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The cover sheet shall not exceed one page. It shall include:

- (a) A list of the responsible agencies including the lead agency and any cooperating agencies.**
- (b) The title of the proposed action that is the subject of the statement (and if appropriate the titles of related cooperating agency actions), together with the State(s) and county(ies) (or other jurisdiction if applicable) where the action is located.**
- (c) The name, address, and telephone number of the person at the agency who can supply further information.**
- (d) A designation of the statement as a draft, final, or draft or final supplement.**
- (e) A one paragraph abstract of the statement. (40 CFR 1502.11)**
- (f) The date by which comments must be received (computed in cooperation with EPA under § 1506.10). (40 CFR 1502.11)**

The abstract of the EIS should include the alternatives considered and identification of the preferred alternative(s), if one or more exists.

In addition, the cover sheet should include the name, title, and address of the responsible official.

If the EIS is a draft, the cover sheet must include the deadline by which comments must be received. Subject to [40 CFR 1506.10\(d\)](#), agencies must allow a minimum of 45 days from the date the EPA notice of availability is published in the *Federal Register* for comments on draft EISs. See sec. 24.2 for calculation of comment period closing date.

The cover sheet for a draft EIS should also include the following two standard paragraphs about the reviewer's obligation to comment during the review period and the public nature of comments. If space is not available on the cover sheet, these statements may be included in the cover letter soliciting comments on the draft EIS.

- a. It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review.
- b. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action.

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Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

2. Summary.

Each environmental impact statement shall contain a summary which adequately and accurately summarizes the statement. The summary shall stress the major conclusions, areas of controversy (including issues raised by agencies and the public), and the issues to be resolved (including the choice among alternatives). The summary will normally not exceed 15 pages. (40 CFR 1502.12)

3. Table of Contents. The table of contents should list major chapters and sections of the EIS, as well as a list of tables and exhibits. The table of contents should provide a mechanism for locating these sections by page number. The complexity of the table of contents will depend on the length and complexity of the EIS.

4. Purpose and Need.

The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action. (40 CFR 1502.13)

The purpose and need statement defines the scope and objectives of the proposal. A well-defined purpose and need statement narrows the range of alternatives that may need to be developed in the "alternatives" section. It describes in detail why action is being proposed at that location and at that time. In this way, the purpose and need reflects the difference between the existing condition and the desired condition.

The analysis may be tiered to other EISs that influence the scope of the analysis or support the rationale for the need for action (40 CFR 1502.20). If a forest plan amendment is included, it should also describe why there is a need for this project to vary from the forest plan to move toward the desired condition.

Other information that is useful to have early in the document, but is not directly purpose and need, includes any Federal permits or licenses necessary to implement the project (40 CFR 1502.25) and a location map.

5. Alternatives Including the Proposed Action.

This section is the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment (§1502.15) and the Environmental Consequences (§1502.16), it should present the

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environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public. In this section agencies shall:

- (a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.**
- (b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.**
- (c) Include reasonable alternatives not within the jurisdiction of the lead agency.**
- (d) Include the alternative of no action.**
- (e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.**
- (f) Include appropriate mitigation measures not already included in the proposed action or alternatives. (40 CFR 1502.14)**

Forest Service regulations specify the following in developing and analyzing alternatives.

The EIS shall document the examination of reasonable alternatives to the proposed action. An alternative should meet the purpose and need and address one or more significant issues related to the proposed action. Since an alternative may be developed to address more than one significant issue, no specific number of alternatives is required or prescribed. The following procedures are available to the responsible official to develop and analyze alternatives. (36 CFR 220.5(e))

For additional guidance on the development of alternatives, see chapter 10, section 14 and questions 1-7 of “NEPA’s [40 Most Asked Questions](#)”.

6. Affected Environment.

The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced.

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Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement.
(40 CFR 1502.15)

The affected environment section can be organized by resource topic or by issue. In either case, discussions of the affected environment should describe the physical, biological, social and economic components for each potentially affected resource. It is important to limit the discussion of affected environment to topics relevant to the significant issues and to the decision being made. See chapter 10, section 15.1, for additional guidance on the consideration of past actions.

The affected environment and environmental consequences sections may be combined for efficiency and clarity. Combining the sections focuses the documentation on what is relevant and reduces redundancies and inconsistencies.

7. Environmental Consequences.

This section forms the scientific and analytic basis for the comparisons under §1502.14. It shall consolidate the discussions of those elements required by sections 102(2)(C) (i), (ii), (iv), and (v) of NEPA which are within the scope of the statement and as much of section 102(2)(C)(iii) as is necessary to support the comparisons. The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. This section should not duplicate discussions in §1502.14. It shall include discussions of:

- (a) Direct effects and their significance (§1508.8).**
- (b) Indirect effects and their significance (§1508.8).**
- (c) Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned. (See §1506.2(d).)**
- (d) The environmental effects of alternatives including the proposed action. The comparisons under §1502.14 will be based on this discussion.**
- (e) Energy requirements and conservation potential of various alternatives and mitigation measures.**

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(f) Natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures.

(g) Urban quality, historic and cultural resources, and the design of the built environment, including the reuse and conservation potential of various alternatives and mitigation measures.

(h) Means to mitigate adverse environmental impacts (if not fully covered under §1502.14(f)). (40 CFR 1502.16)

This section also discloses cumulative effects germane to each issue. For guidance on cumulative effects analysis see chapter 10, section 15.1.

In the case that the EIS includes an adaptive management strategy, the following Forest Service regulations would apply.

...The EIS must disclose not only the effect of the action but also the effect of the adjustment. Such proposal or alternative must also describe the monitoring that would take place to inform the responsible official whether the action is having its intended effect. (36 CFR 220.5(e))

8. List of Preparers.

The environmental impact statement shall list the names, together with their qualifications (expertise, experience, professional disciplines), of the persons who were primarily responsible for preparing the environmental impact statement or significant background papers, including basic components of the statement (§1502.6 and 1502.8). Where possible the persons who are responsible for a particular analysis, including analyses in background papers, shall be identified. . . (40 CFR 1502.17)

This section also lists all Federal, State, and local agencies, tribes, and non-Forest Service persons who helped prepare or contribute to the development of the EIS.

9. List of Agencies, Organizations, and Persons to Whom Copies of the Statement Are Sent. The list should include names only and not addresses of those to whom a statement was sent. In addition, the EIS may note the total number of individuals and groups that were notified of the availability of the EIS in a library, on the World-Wide Web, or at other locations.

10. Index. An index is required in all EISs by the CEQ regulations (see sec. 23.3, [40 CFR 1502.10](#)). The purpose of an index is to make the information in the EIS fully available to the reader without delay. See chapter 60, section 62, for preparation of indexes.

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11. Appendix.

If an agency prepares an appendix to an environmental impact statement the appendix shall:

- (a) Consist of material prepared in connection with an environmental impact statement (as distinct from material which is not so prepared and which is incorporated by reference (§1502.21)).**
- (b) Normally consist of material which substantiates any analysis fundamental to the impact statement.**
- (c) Normally be analytic and relevant to the decision to be made.**
- (d) Be circulated with the environmental impact statement or be readily available on request. (40 CFR 1502.18)**

For a final EIS, the response to comments is often included as an appendix.

23.31 - Incomplete or Unavailable Information

Refer to chapter 10, section 13, for guidance on addressing incomplete or unavailable information.

23.32 - Documentation of Cost-Benefit Analysis

If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with section 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision. (40 CFR 1502.23)

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23.33 - Identification of Methodology and Scientific Accuracy

Agencies shall insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements. They shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement. An agency may place discussion of methodology in an appendix. (40 CFR 1502.24)

23.34 - Identification of Permits Necessary to Implement the Proposal

The draft environmental impact statement shall list all Federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. If it is uncertain whether a Federal permit, license, or other entitlement is necessary, the draft environmental impact statement shall so indicate. (40 CFR 1502.25(b))

This information should be included in chapter 1 of the EIS.

24 - REQUIREMENTS SPECIFIC TO DRAFT ENVIRONMENTAL IMPACT STATEMENTS

24.1 - Circulating and Filing a Draft Environmental Impact Statement

Circulate a draft EIS to agencies and to the public prior to or at the same time of transmittal to the Environmental Protection Agency (EPA) in Washington, DC. If a statement is unusually long, the summary may be circulated instead, except that the entire statement must be circulated as required by the CEQ regulations:

... if the statement is unusually long, the agency may circulate the summary instead, except that the entire statement shall be furnished to:

(a) Any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved and any appropriate Federal, State or local agency authorized to develop and enforce environmental standards.

(b) The applicant, if any.

(c) Any person, organization, or agency requesting the entire environmental impact statement.

(d) In the case of a final environmental impact statement any person, organization, or agency which submitted substantive comments on the draft.

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If the agency circulates the summary and thereafter receives a timely request for the entire statement and for additional time to comment, the time for that requestor only shall be extended by at least 15 days beyond the minimum period. (40 CFR 1502.19)

In addition, Forest Service regulations specify that:

(1) The draft and final EISs shall be filed with the Environmental Protection Agency's Office of Federal Activities in Washington, DC (40 CFR 1506.9).

(2) Requirements at 40 CFR 1506.9 "Filing requirements", 40 CFR 1506.10 "Timing of agency action" and 40 CFR 1502.19 "Circulation of the environmental impact statement" shall only apply to the last draft and final EIS and not apply to material produced prior to the draft EIS or between the draft and final EIS which are filed with EPA. (36 CFR 220.5(f))

File four copies of a draft EIS with the EPA. At least one copy must be a paper copy; the remaining three copies may be on appropriate electronic storage devices, such as compact discs (CDs), USB flash drives, or memory cards. The EPA requires paper copies to be "bound." (If documents are 3-hole punched and shrink-wrapped, they need to be placed in a 3-ring binder.) Addresses, phone numbers and instructions are on [the EPA website](#). EPA will then publish the notice of availability in the *Federal Register*.

Distribute EISs prepared for the Forest Service to Federal agencies as instructed on the [current EIS distribution list](#).

Calculate the review period from the day after EPA's notice of availability appears in the *Federal Register* as per the appeal regulation [\(36 CFR 215.6\(a\)\(1\)\(ii\)\)](#).

(a) The Environmental Protection Agency shall publish a notice in the FEDERAL REGISTER each week of the environmental impact statements filed during the preceding week. The minimum time periods set forth in this section shall be calculated from the date of publication of this notice. (40 CFR 1506.10)

(d) The lead agency may extend prescribed periods. The Environmental Protection Agency may upon a showing by the lead agency of compelling reasons of national policy reduce the prescribed periods and may upon a showing by any other Federal agency of compelling reasons of national policy also extend prescribed periods, but only after consultation with the lead agency (Also see § 1507.3(d).) Failure to file timely comments shall not be a sufficient reason for extending a period. If the lead agency does not concur with the extension of time, EPA may not extend it for more than 30 days. (40 CFR 1506.10)

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Allow a minimum of 45 days for comments on a draft EIS unless a different time period is required by law or regulation. If the prescribed period must be reduced for compelling reasons of national policy, contact the Washington Office Director of Ecosystem Management Coordination prior to issuing a draft EIS.

Determine the comment period closing date by adding 45 days to the date that EPA's notice of availability is expected to be published. Use an express delivery service or hand deliver the draft EIS to ensure when EPA receives the document. The notice of availability will be published in the *Federal Register* on Friday of the week following EPA's receipt of the draft EIS. If the Friday is a Federal holiday the publication will be on Thursday. Add 45 days to the expected date of the notice of availability, with the day after the notice (Saturday) being day 1. Since notices of availability are normally published on Fridays, 45-day comment periods will normally close on a Monday. If the closing date is a holiday, the comment period is extended to the next business day.

Agency notice and comment regulations also require that a legal notice be published in the newspaper of record ([36 CFR 215](#)) (See FSH 1509.12, sec. 06, ex. 02).

24.2 - Solicit Comments on a Draft Environmental Impact Statement

The CEQ regulations require the following:

Inviting comments.

(a) After preparing a draft environmental impact statement and before preparing a final environmental impact statement the agency shall:

(1) Obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards.

(2) Request the comments of:

(i) Appropriate State and local agencies which are authorized to develop and enforce environmental standards;

(ii) Indian tribes, when the effects may be on a reservation; and

(iii) Any agency which has requested that it receive statements on actions of the kind proposed . . .

(3) Request comments from the applicant, if any.

(4) Request comments from the public, affirmatively soliciting comments from those persons or organizations who may be interested or affected. (40 CFR 1503.1)

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The following items are appropriate to include in your solicitation of comments on a draft EIS:

1. The availability of the draft EIS and timing for comments.
2. The date, time, and location of public meetings, if any.
3. How to obtain any additional information.
4. How and to whom to submit your comments. Include e-mail and street addresses and FAX and telephone numbers.
5. Refer to section 23.3, exhibit 01, for language regarding how to instruct reviewers on their duties relative to commenting.
6. Where and how to review comments submitted on the draft EIS.

24.3 - Extending the Comment Period on a Draft Environmental Impact Statement

When the responsible official determines that an extension of the review period on a draft EIS is appropriate, notice shall be given in the same manner used for inviting comments on the draft. (36 CFR 220.5(f)(3))

Forward one copy of the notice to EPA's Management Information Unit, [Office of Federal Activities](#). EPA will publish the notice of the extension of the comment period in the Federal Register on the Friday following the week the notice is received.

25 - REQUIREMENTS SPECIFIC TO A FINAL ENVIRONMENTAL IMPACT STATEMENT

25.1 - Use of Comments on a Draft Environmental Impact Statement in a Final Environmental Impact Statement

Review, analyze, evaluate, and respond to substantive comments on the draft EIS.

(a) An agency preparing a final environmental impact statement shall assess and consider comments both individually and collectively, and shall respond by one or more of the means listed below, stating its response in the final statement. Possible responses are to:

- (1) Modify alternatives including the proposed action.**
- (2) Develop and evaluate alternatives not previously given serious consideration by the agency.**
- (3) Supplement, improve, or modify its analyses.**

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(4) Make factual corrections.

(5) Explain why the comments do not warrant further agency response, citing the sources, authorities, or reasons which support the agency's position and, if appropriate, indicate those circumstances which would trigger agency reappraisal or further response.

(b) All substantive comments received on the draft statement (or summaries thereof where the response has been exceptionally voluminous), should be attached to the final statement whether or not the comment is thought to merit individual discussion by the agency in the text of the statement.

(c) If changes in response to comments are minor and are confined to the responses described in paragraphs (a) (4) and (5) of this section, agencies may write them on errata sheets and attach them to the statement instead of rewriting the draft statement. In such cases only the comments, the responses, and the changes and not the final statement need be circulated (§1502.19). The entire document with a new cover sheet shall be filed as the final statement (§1506.9). (40 CFR 1503.4)

When the responsible official determines that a summary of responses is appropriate, the summary should reflect accurately all substantive comments received on the draft EIS. Comments that are pertinent to the same subject may be aggregated by categories. As a minimum, include in an appendix of a final EIS copies of all comments received on the draft EIS from Federal, State, and local agencies and elected officials. This will satisfy the requirement in Section 102 (c) of NEPA, which states, "...comments and views of the appropriate Federal, State and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public..."

25.2 - Circulating and Filing a Final Environmental Impact Statement

Distribute a final EIS to other agencies and to the public prior to or at the same time of filing it with EPA ([40 CFR 1506.9](#)). If the statement is unusually long, a summary may be circulated instead ([40 CFR 1502.19](#)). However, the responsible official shall file the entire document, including appendices, with EPA as well as other persons or agencies specified in section 24.1. In addition to the persons or agencies specified in section 24.1, the entire final EIS must also be circulated to "any person, organization, or agency which submitted substantive comments on the draft EIS" ([40 CFR 1502.19\(d\)](#)).

If changes resulting from comments to a draft EIS are minor, they may be written on an errata sheet and attached to the draft EIS. In this case only the comments, the responses, and the changes need to be circulated. However, file the entire document with a new cover sheet as the final EIS ([40 CFR 1503.4\(c\)](#)).

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File a final EIS with the EPA as shown in section 24.1 along with all substantive comments or a summary of the comments on the draft EIS. The Washington Office Director of Ecosystem Management Coordination files with EPA the statements for which the Chief or the Secretary is the responsible official.

Refer to [40 CFR 1506.10\(b\)\(2\)](#) for the timing of publishing a final EIS and issuing a ROD (see sec. 26.1). Because the Forest Service has formally established appeal processes which allow other agencies or the public to appeal a decision after publication of the final EIS, an exception to the timing rules at [40 CFR 1506.10\(b\)\(2\)](#) is made for the Forest Service. This means that a decision can be made and recorded at the same time the final EIS is published. In this case, the final EIS must explain the timing and the public's right to appeal ([40 CFR 1506.10\(b\)](#)). In addition, at the time of filing the final EIS, EPA should be informed of this exception so that the notice of availability accurately reflects this information. Additional decision timing requirements follow in section 26.1.

After filing a final EIS with the EPA, ensure that a reasonable number of copies of the statement are available free of charge.

26 - DOCUMENTING DECISIONS

26.1 - Decision Timing

The following time limits apply to decisions supported by an EIS.

Timing of agency action.

(a) The Environmental Protection Agency shall publish a notice in the Federal Register each week of the environmental impact statements filed during the preceding week. The minimum time periods set forth in this section shall be calculated from the date of publication of this notice.

(b) No decision on the proposed action shall be made or recorded under §1505.2 by a Federal agency until the later of the following dates:

(1) Ninety (90) days after publication of the notice described above in paragraph (a) of this section for a draft environmental impact statement.

(2) Thirty (30) days after publication of the notice described above in paragraph (a) of this section for a final environmental impact statement.

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An exception to the rules on timing may be made in the case of an agency decision which is subject to a formal internal appeal. ... In such cases, where a real opportunity exists to alter the decision, the decision may be made and recorded at the same time the environmental impact statement is published. (40 CFR 1506.10)

Because the Forest Service has formally established appeal processes, the 30-day delay provision at [40 CFR 1506.10\(b\)\(2\)](#) seldom applies unless a decision is not subject to appeal or unless implementation will be allowed to proceed during an appeal filing period. Occasionally, an EIS on a fast-track bumps up against the requirement that a decision cannot be made until 90 days after the notice of availability of the draft EIS is published by EPA, as shown in (1) above.

26.2 - Record of Decision

If an EIS has been prepared, the responsible official documents the decision in a ROD (sec. 11.6, ex. 01). CEQ requirements for a ROD are as follows:

At the time of its decision (§1506.10) or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public record of decision. The record, which may be integrated into any other record prepared by the agency, shall:

(a) State what the decision was.

(b) Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives which were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.

(c) State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation. (40 CFR 1505.2)

Forest Service requirements for decisionmaking are as follows:

Responsible Official. The Agency employee who has the authority to make and implement a decision on a proposed action. (36 CFR 220.3)

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For each Forest Service proposal (§ 220.4(a)), the responsible official shall coordinate and integrate NEPA review and relevant environmental documents with Agency decisionmaking by:

- (1) Completing the environmental document review before making a decision on the proposal;***
- (2) Considering environmental documents, public and agency comments (if any) on those documents, and agency responses to those comments;***
- (3) Including environmental documents, comments, and responses in the administrative record;***
- (4) Considering the alternatives analyzed in environmental document(s) before rendering a decision on the proposal; and***
- (5) Making a decision encompassed within the range of alternatives analyzed in the environmental documents. (36 CFR 220.4(c)).***

26.21 - Format and Content

Records of decision should generally conform to the following format. Sections of the format may be combined or rearranged in the interest of clarity and brevity. Records of decision should reflect the analysis documented in the EIS and contain the following elements.

1. Heading. The heading identifies:
 - a. Agency.
 - b. Type of decision document, that is, ROD.
 - c. The title of the proposed action.
 - d. The location of the proposed action, including administrative unit, county, and State.
2. Decision and Reasons for the Decision. Describe the decision being made, including the permits, licenses, grants, or authorizations needed to implement the decision. Identify the specific location of the alternative selected, including the legal land subdivision if pertinent. Refer to or include any mitigation and monitoring program related to the decision. This section also identifies:
 - a. Applicable laws, regulations, and policies;
 - b. How the selected alternative best meets the purpose and need;

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- c. How environmental issues were considered and addressed;
 - d. Factors other than environmental consequences considered in making the decision; and
 - e. Identification of environmental document(s) considered in making the decision.
3. Public involvement conducted. Identify the issues which determined the scope of the analysis. Provide a brief summary of the public participation that relates to the decision. Agencies, organizations, or persons raising issues or asserting opposing viewpoints may be identified and their positions discussed.
 4. Alternatives considered. All alternatives considered (including the no-action) should be briefly discussed with specific references to the EIS. Mitigation measures, management requirements, and monitoring provisions that are pertinent to environmental concerns should be discussed with specific citations to pages of the EIS.
 5. Findings required by other laws. Include any findings required by any other laws. For example, findings of consistency with the forest plan, suitability, and vegetation management required by the National Forest Management Act.
 6. Identify the Environmentally Preferable Alternative. Based on the definition in 36 CFR 220.3, state which alternative(s) is environmentally preferable.
 7. State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program must be adopted and summarized where applicable for any mitigation 40 CFR 1505.
 8. Implementation date. Identify the date when the responsible official intends to implement the decision (ch. 50, sec. 51).
 9. Administrative review or appeal opportunities. Clearly state whether the decision is subject to review or appeal (citing the applicable regulations), and identify when and where to file a request for review or appeal.
 10. Contact Person. Identify the name, address, and phone number of a contact person who can supply further information.
 11. Signature and Date. The responsible official signs and dates the ROD on the date the decision is made.

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- a. For decisions subject to review under Forest Service appeal regulations, the responsible official may sign and date the ROD on the date that it is transmitted with the final EIS to the EPA and made available to the public.
- b. For decisions not subject to review, the responsible official may not sign and date the ROD sooner than 30 days after EPA's notice of availability of the final EIS is published in the *Federal Register* (see sec. 25.2).

When an EIS identifies joint lead agencies (ch. 10, sec. 11.31a) or cooperating agencies with jurisdiction by law, the responsible official from each agency shall sign and date a ROD for those actions within the authority of each agency.

When the Chief or Secretary is the responsible official, the appropriate field unit or Washington Office staff prepares the record of decision with assistance from the Washington Office Ecosystem Management Coordination staff. The Washington Office Director of Ecosystem Management Coordination coordinates the review and signing of the ROD, involving the appropriate Washington Office staff(s), deputy chief, Chief, or Secretary, as necessary. The signed original is then filed in Washington Office Ecosystem Management Coordination staff office files and the Washington Office Ecosystem Management Coordination staff forwards a copy to the appropriate field unit or Washington Office staff for necessary distribution.

27 - NOTICE OF THE RECORD OF DECISION

The responsible official shall notify interested or affected parties of the availability of the record of decision as soon as practical after signing. (36 CFR 220.5(g))

Appeal and objections regulations require specific notifications. The responsible official may provide additional forms of notice appropriate to the importance of the decision such as sending paper or electronic copies of the ROD or notifying interested or affected parties by paper or electronic means of a website containing the ROD. Remember to enter the date of the ROD as soon as practical in the Planning, Appeals and Litigation System (PALS). In addition to the decision itself, the ability of the decision to be implemented is also tracked in the PALS. The voluntary withdrawal of a decision, the reversal of a decision in appeal, or a court case directing constraint of a decision all require notation (action) in PALS.

EXHIBIT 3

Federal Outdoor Recreation Trends: Effects on Economic Opportunities

**National Center for Natural Resources Economic Research (NCNRER)
NCNRER Working Paper Number 1
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Introduction

Outdoor recreation plays a significant role in American lives. It provides physical challenges and well-being, helps develop lifelong skills, provokes interest and inquiry, inspires wonder and awe of the natural world, and often provides an alternative to daily routines. Recreation contributes greatly to the physical, mental, and spiritual health of individuals, bonds family and friends, and instills pride in natural and cultural heritage. Federal lands contribute significantly, and in many cases uniquely, to the provision of nature-based outdoor recreation opportunities.

This paper, prepared for the Federal Interagency Council on Outdoor Recreation (FICOR), focuses on the potential future role of federal lands in supplying outdoor recreation opportunities and therefore supporting associated jobs and income. FICOR is a seven-agency council that promotes better coordination and collaboration among Federal agencies whose missions or programs include providing outdoor recreation and conserving or managing natural and cultural resources. The FICOR agencies are the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), Forest Service (FS), National Oceanic and Atmospheric Administration (NOAA), National Park Service (NPS), U.S. Army Corps of Engineers (USACE), and the Fish and Wildlife Service (FWS).

We begin with an overview of recent trends in outdoor recreation activity participation in the United States and projected recreation participation to 2030. The primary driving forces for participation are reviewed, and their effects on future recreation use are discussed. The federal land base for outdoor recreation and expectations for future availability are also described. Recreation visitation in 2012 on lands and waters managed by the FICOR agencies and the associated jobs provide the baseline for considering how projected recreation use might influence future economic effects.

The “future” look takes into account 1) the key factors that determine the level of economic activity in and around federal lands, 2) potential changes in recreation activities and associated spending patterns, and 3) other factors that influence spending. Finally, we discuss other contributions to local economies that may be influenced by federal recreation opportunities, including amenity migration, business relocation, and natural backdrops.

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Outdoor Recreation Participation

Measuring outdoor recreation participation in the United States

National trends in outdoor recreation participation are based primarily on the National Survey on Recreation and the Environment (NSRE). The NSRE is a general population telephone survey of people 16 years of age and older designed to measure participation in outdoor recreation activities and people's environmental behaviors and attitudes (Cordell 2012). NSRE sampling is population-based occurring across both rural and urban areas of the country and includes all activity participation whether on public or private land and water.

Historical outdoor recreation trends

Choices for outdoor recreation today are different from choices made by previous generations of Americans, both in the mix of activities and relative popularity. Outdoor recreation participation grew through the 1960s and 1980s. Activities such as camping, canoeing, kayaking, and bicycling grew rapidly, influenced partly by improving equipment technology. New activities appeared, while a few activities declined in participation (Cordell 2012).

Between 1999 and 2009, nature-based outdoor recreation generally increased, although trends vary across individual activities. The number of U.S. participants⁶ in 50 nature-based outdoor recreation activities increased 7.1 percent between 1999 and 2009, while the number of activity days⁷ increased at least that much (Table 1). Activities oriented toward viewing and photographing nature have been among the fastest growing activities, both in terms of number of participants and activity days of participation. Off-highway vehicle driving realized a 34 percent increase in participants. Several physically challenging activities, such as kayaking, snowboarding, and surfing also had relatively large increases in this time frame (Cordell 2012).

While there were increases in the number of participants for the majority of activities from 1999-2009, there were declines in some activities. Most of the traditional winter recreation activities experienced decreasing participation rates and days of activity, with the exception of snowboarding. In addition, several activities that had increased numbers of participants experienced a drop in total days of activity, indicating that the average number of days per participant declined. Examples included day hiking and horseback riding on trails. While more people recreate in the eastern United States because of the U.S. population distribution, participation rates are uniformly higher in the west for all activities except hunting and fishing (Cordell 2012).

⁶ A participant is any individual 16 years of age or older that engaged in one or more recreation activities during the 12 months prior to the survey interview date.

⁷ An activity day is any amount of time during the course of a calendar day in which an individual participates in a given activity. Thus, an individual may report multiple activity days for a given calendar day.

Table 1. Percent change between 1999-2001 and 2005-2009 in total participants and total days for people age 16 and older participating in nature-based outdoor activities (Cordell 2012).

	Percent Change in Total Participants	Percent Change in Total Days ¹
Activity Groups	1999-2009	1999-2009
Visiting Developed Sites		
Developed site use		
Family gathering	10.5	21.5
Picnicking	2.8	-5.8
Developed camping	1.1	0.5
Visiting interpretive sites		
Visit outdoor nature center/zoo	10.2	18.6
Visit historic sites	8.1	7.0
Visit prehistoric sites	11.1	9.4
Viewing & Photographing Nature		
Birding		
View or photograph birds	22.8	36.7
Viewing		
View/ photograph natural scenery	17.9	62.6
View/ photograph flowers, etc.	29.4	83.5
View/ photograph other wildlife	25.4	51.8
View or photograph birds	22.8	36.7
Gather mushrooms, berries, etc.	28.6	30.1
Backcountry Activities		
Challenge		
Mountain climbing	-5.9	-4.3
Caving	18.4	14.0
Rock climbing	9.5	12.3
Equestrian		
Horseback riding on trails	1.6	-9.7
Hiking		
Day hiking	15.4	-4.9
Visiting primitive areas		
Backpacking	7.9	26.6
Primitive camping	3.2	6.6
Visit a wilderness	17.7	31.8
Motorized Activities		
Motorized off-road use		
Off-highway vehicle driving	34.5	47.6
Motorized water		
Motorboating	8.6	12.3
Waterskiing	33.1	20.0
Use personal watercraft	10.9	12.7
Motorized snow		
Snowmobiling	-5.5	-23.7
Hunting and Fishing		

Hunting		
Small game hunting	11.4	-0.7
Big game hunting	17.1	22.2
Migratory bird hunting	-1.1	0.4
Fishing		
Anadromous fishing	24.1	9.7
Coldwater fishing	8.7	1.4
Saltwater fishing	17.2	-0.7
Warmwater fishing	17.1	13.1
Non-motorized Winter Activities		
Developed Skiing		
Downhill skiing	-8.5	-19.4
Snowboarding	33.7	32.6
Undeveloped skiing		
Cross-country skiing	-21.7	-32.9
Snowshoeing	-9.4	-25.1
Non-motorized Water Activities		
Swimming		
Swimming in lakes, streams, etc.	14.0	16.0
Snorkeling	11.8	-0.6
Surfing	46.3	18.6
Scuba diving	-5.6	-15.6
Visit a beach	20.7	28.2
Visit waterside besides beach	6.3	28.1
Windsurfing	-10.1	-24.7
Floating		
Canoeing	18.2	8.0
Kayaking	103.8	86.3
Rafting	-2.8	7.9

¹Since individual may report multiple activity days for a given calendar day, these increases are not additive across activities.

Recreation Participation in the Future

Past and recent outdoor recreation trends are important indicators of what might happen in the near future. However, simple trends do not address the underlying factors and associations that may be driving these trends. Thus, a trend may be of limited value as an indicator if the time horizon is long or if the trend's driving factors are expected to deviate substantially from historical patterns. Therefore, projection models developed for the 2010 Resources Planning Act (RPA) Assessment⁸ (USDA Forest Service 2012a) are used in conjunction with external projections of relevant factors, including demographic, economic, land use, and climate factors, to simulate future recreation participation (Bowker et al. 2012). Outdoor recreation participation was projected for 17 recreation activity composites that were organized into seven activity groups that either occur in similar recreation settings

⁸ See <http://www.fs.fed.us/research/rpa/> for additional information about the RPA Assessment.

or have a similar focus (Table 2). These projections are based on the NSRE data described above, and include nature-based recreation on all ownerships of land and water.

Table 2. Outdoor recreation activity groups and associated activity composites.

Activity Group	Modeled Activity Composite	Activities Included in Modeled Activity Composite
Visiting Developed Sites		
	Developed site use	Family gathering; picnicking; developed camping
	Visiting interpretive sites	Visiting nature centers, zoos, historic sites, and prehistoric sites
Viewing & Photographing Nature		
	Birding	View or photograph birds
	Viewing	View/ photograph natural scenery, flowers, birds, other wildlife; gather mushrooms, berries, etc.
Backcountry Activities		
	Challenge activities	Caving; mountain climbing; rock climbing
	Day hiking	Day hiking
	Equestrian	Horseback riding on trails
	Visiting primitive areas	Backpacking; primitive camping; visiting wilderness
Motorized Activities		
	Motorized off-road use	Off-road driving
	Motorized snow use	Snowmobiling
	Motorized water use	Motorboating; waterskiing; personal watercraft use
Hunting and Fishing		
	Hunting	Big game; small game; migratory birds
	Fishing	Anadromous; coldwater; warmwater; saltwater
Non-motorized Winter Activities		
	Developed skiing	Downhill skiing; snowboarding
	Undeveloped skiing	Cross-country skiing; snowshoeing
Non-motorized Water Activities		
	Swimming	Swimming in lakes, streams; snorkeling; surfing; scuba diving; visit a beach; visit waterside besides beach; windsurfing
	Floating	Canoeing; kayaking; rafting

The 2010 RPA Assessment used multiple scenarios to explore a range of possible futures that account for uncertainties about future political, economic, social, and environmental change. A detailed description of these scenarios can be found in USDA Forest Service (2012b). Projections to 2060, at 10-year intervals, associated with these scenarios incorporate changing population, socioeconomic characteristics, land availability and the potential effects of climate change. For this report, we chose to use projected recreation participation through 2030 to focus on the time frame most consistent with federal land management planning. We also chose to focus on the results from one socioeconomic scenario and its associated climate projections – the scenario referred to as RPA A1B in the 2010 RPA Assessment. Since population growth is an important determinant of recreation demand in the future, we chose the RPA A1B scenario because it is the most consistent with the Census Bureau’s projected population growth in the United States at the time the RPA scenarios were developed.

The outdoor recreation projections resulted in estimates of per capita participation and average annual days per participant. Total participants and total annual days of participation were calculated by multiplying the RPA population projections by the participation rate and average days per participant

(Bowker et al. 2012). Table 3 summarizes projected participation and use for the activity groups shown in Table 2.

Visiting Developed Sites

The activities associated with developed site use include venues popular with all age groups. Per capita participation in this activity group is currently highest among the 17 activity groups and is projected to remain the most popular through 2030. The number of potential developed site users increases from over 190 million to 246 million participants over the projection period, driven primarily by increasing population. While the total number of participants is projected to increase, those participants are projected to have slightly fewer numbers of days recreating at developed sites each year, on average, compared to the current pattern.

Visiting interpretive sites is also popular across all ages and occurs primarily in developed settings. The projections indicate participation rates of the population could increase by more than three percent, translating into a gain of more than 30 percent in the total number of participants by 2030. Two factors might influence the greater participation rate growth in this activity group compared to developed site use. First, developed site use is negatively correlated with age which is expected to rise by 2030, and positively correlated with available federal land per capita, which is expected to decline. Those variables are less important in interpretive site participation. Secondly, in comparison to the other activity groups, visiting interpretive sites has one of the higher percentage increases in both average days per participant and total days of participation.

Viewing and Photographing Nature

This category is comprised of birding and nature viewing, that includes viewing wildlife and nature, gathering, and nature study. Adult participation in birding averaged 35 percent in 2008. Nearly 81 percent of adults participated in the more broadly defined nature viewing during the same period. The participation rate for nature viewing is projected to increase by slightly more than one percent through 2030, whereas the participation rate for birding could increase by four percent. The viewing days per participant are anticipated to decline by over three percent. This decline is influenced by projected increases in population density and minority populations, as well as projected decreases in both forest and rangeland and national park acres per capita. The average annual days of participation exceed 160 and contribute to an estimate of total days nearly 10 times higher than any other non-viewing activity group. However, given the broad definition of viewing, much of this activity occurs in close proximity to home, in-transit to other recreation activities, or while participating in another activity.

Table 3. Projected participation and use for activity groups between 2008 and 2030.

Activity Groups	Per Capita Participation			Adult Participants (millions)			Days per Participant			Total Days (millions)		
	2008	2030	Percent	2008	2030	Percent	2008	2030	Percent	2008	2030	Percent
	Rate	Rate	Change	Number	Number	Change	Rate	Rate	Change	Number	Number	Change
Visiting Developed Sites												
Developed site use	0.819	0.825	0.7	192.7	245.9	27.6	11.67	11.58	-0.8	2,235	2,830	26.6
Visiting interpretive sites	0.669	0.690	3.2	157.4	205.7	30.7	7.81	8.02	2.6	1,243	1,666	34.1
Viewing & Photographing Nature												
Birding	0.346	0.361	4.4	81.4	107.7	32.3	97.71	97.91	0.2	8,215	10,889	32.5
Viewing	0.805	0.814	1.2	189.4	242.7	28.1	169.59	163.96	-3.3	32,303	40,019	23.9
Backcountry Activities												
Challenge	0.107	0.111	3.6	25.1	33.0	31.3	4.77	4.74	-0.6	120	156	30.5
Equestrian	0.070	0.072	2.7	16.4	21.3	30.1	16.28	16.48	1.2	262	345	31.7
Hiking	0.333	0.343	3.1	78.3	102.2	30.5	22.89	23.41	2.3	1,826	2,437	33.5
Visiting primitive areas	0.383	0.375	-2.1	90.2	111.8	24.0	13.22	13.08	-1.1	1,233	1,512	22.6
Motorized Activities												
Motorized off-road use	0.204	0.194	-4.7	47.9	57.8	20.7	21.65	21.04	-2.8	1,048	1,229	17.3
Motorized water use	0.263	0.270	2.5	62.0	80.5	29.9	15.27	15.35	0.5	953	1,244	30.6
Motorized snow use	0.040	0.036	-10.4	9.4	10.7	13.6	7.25	7.16	-1.3	68	77	12.1
Hunting and Fishing												
Hunting	0.119	0.105	-11.6	27.9	31.3	12.0	19.13	18.17	-5.0	535	570	6.4
Fishing	0.309	0.301	-2.6	72.7	89.7	23.4	18.48	18.15	-1.8	1,363	1,651	21.1
Non-motorized Winter Activities												
Developed skiing	0.101	0.108	6.7	23.7	32.1	35.1	7.19	7.42	3.2	171	238	39.5
Undeveloped skiing	0.033	0.033	-0.6	7.8	9.8	25.9	6.58	6.72	2.1	51	66	28.6
Non-motorized Water Activities												
Swimming	0.609	0.630	3.4	143.2	187.5	31.0	23.98	24.12	0.6	3,459	4,558	31.7
Floating	0.169	0.162	-3.9	39.8	48.4	21.7	6.50	6.53	0.3	261	318	22.1

Backcountry Activities

Backcountry activities are pursued in undeveloped, but accessible lands. This activity group includes challenge activities, equestrian, hiking, and visiting primitive areas. Challenge activities are often associated with young and affluent adults and include caving, mountain climbing, and rock climbing. Over 11 percent of adults are expected to participate in challenge activities by 2030; an increase of about 3.5 percent from 2008. The growth in the rate of participation is driven mostly by projected increases in income. The projected days per participant are almost unchanged through 2030. Participants in challenge activities report less than five days of participation per year, which is the lowest among all activity groups.

Participation in equestrian or trail riding per capita is projected to increase about 2.5 percent by 2030. As with the challenge activities, income also has a strong positive influence on the participation rate for trail riding. However, the days per participant change very little, perhaps suggesting higher income participants have more competing uses for their time.

Hiking is the most popular single backcountry activity with 33 percent adult participation in 2008. By 2030, the participation rate is projected to increase about three percent with the number of projected participants exceeding 100 million. Total days of hiking are projected to increase by about 33 percent, which is slightly more than participation (30 percent). The increase in hiking days is among the highest for all activity groups.

The final backcountry activity is visiting primitive areas. It is a composite activity consisting of people who backpack, primitive camp, or visit wilderness areas. The participation rate is projected to decline by over two percent by 2030. Increased population density and projected decreases in wilderness, forest, and rangeland acres per capita appear to correlate with the participation rate decline. Activity days per participant are projected to decline slightly less than participation rates.

Motorized Activities

Three categories of motorized activities were considered: off-road driving, motorized water use, and motorized snow use. Participation in off-road driving averaged a little more than 20 percent among the adult population in 2008. An expected decrease in the participation rate between four and five percent will lower participation below 20 percent by 2030. The decrease is correlated with expected increases in the average age and the increasing proportion of Hispanics in the population. Annual days per participant are also projected to decline by almost three percent. The declines in both the participation rate and days per participant imply that the overall increases in total days will be less than the respective increase in population.

Motorized water use has the highest participation rate of the motorized activities. More than 80 million adults or 27 percent of the adult population are projected to participate in 2030. It is the only motorized activity with positive percentage increases in both participation rate and days per participant. Income growth appears to be a significant factor in the positive growth rates. Both total participants and total days grow by about 30 percent between 2008 and 2030.

Motorized snow use (snowmobiling) has one of the largest projected declines in participation rates across all activities. Snowmobiling is geographically limited to areas with adequate recreation opportunities and snow conditions and is undertaken by only about 4 percent of the population. By

2030, rates are projected to decline over 10 percent. Similar to off-road driving, these declines are correlated with increasing average age and increasing proportion of Hispanics in the population. Days per participant also decline, but at a much lower percentage than the participation rate. Snowmobilers will still average about seven days per year on the snow.

Hunting and Fishing

The traditional wildlife pursuits of hunting and fishing remain popular outdoor activities with about 28 million and 73 million annual adult participants, respectively, in 2008. However, on a per capita basis, these activities continue a decline from levels of past decades. The adult hunting participation rate is projected to decline by 11 to 12 percent by 2030. Increased education levels, increased population density, diminishing availability of private and public land, and strong negative relationships between growing minority populations and hunting appear to be influencing the decline in participation rate. Days per hunter are also projected to decline by about five percent. Total participants and total days of hunting continue to grow because of population growth, but at small increases of about 12 and 6.4 percent respectively. Hunting exhibits the largest drop in the rates of participation and days per participant and the smallest increases in the number of participants and total days.

The overall rate of decline in per capita participation and days per participant are not as drastic for fishing as hunting. The participation rate for fishing is projected to decline between two and three percent. The number of adult participants is still expected to increase by about 23 percent to over 89 million anglers. Average annual fishing days per participant are projected to fall a little less than two percent.

Non-Motorized Winter Activities

Developed skiing (downhill skiing and snowboarding) is the only winter activity with projected percentage increases in both per capita participation and days per participant. The participation rates increase by six to seven percent by 2030, the largest increase among all activity groups. Income growth is a strong driver in skiing participation. Days per participant also increase but at a more modest rate of three percent. The total days of 238 million in 2030 reflect an almost 40 percent increase above the 2008 levels.

Undeveloped skiing (cross-country skiing and snowshoeing) has the lowest participation rate for any of the activity groups. About three percent of the population participates with the number of adult participants expected to remain below 10 million in 2030. Although per capita participation is expected to change little, the days per participant are projected to increase slightly due to a positive correlation with mean population age. However, given this small increase and a static participation rate, the annual undeveloped skiing days per year will most likely track population growth at about 29 percent.

Non-Motorized Water Activities

This category consists of floating and various kinds of outdoor swimming activities, including snorkeling, surfing, diving, and visiting beaches or watersides. Swimming is the fourth most popular outdoor activity, with a 63 percent adult participation rate and 187 million participants projected for 2030. Although the projected percentage increase in days per participant is relatively flat, the projected total days will exceed 4,500 million by 2030. This is driven by the popularity of swimming and the relatively high number of days people swim each year.

Floating activities include canoeing, kayaking, and rafting. By 2030, the participation rate is projected to decrease by almost four percent. The days per participant are projected to be virtually unchanged between 2008 and 2030 at about 6.5 days per year. Both the total adult participants and total days increase in future decades, but at levels less than the expected increase in population.

Climate change and recreation trends and projections

The results shown in Table 3 were estimated without incorporating climate change into the projections. Climate variables were added to the projection models to assess whether participation and participation intensity were sensitive to climate effects (see Bowker et al. 2012 for details about the climate variables).

Except for a few activities, adding climate variables to the projection models does not greatly change projected future participation (Bowker et al. 2012). Generally, the effect of the climate variables is a minor change in both per capita participation and average days per year compared to the “no climate change” projection. The effect of climate is easier to understand when expressed as changes in total participation or total days. Table 4 shows the percentage change between 2008 and 2030 for activity projections with and without climate effects in the model. It also displays the net difference between the no climate change (No CC) vs. climate change (CC) estimates as increases or decreases from the percentage for the no climate change projection. Overall, 14 of 17 activities showed average declines in total days of participation when accounting for climate change. Most of those reductions lower future projected percentage increases in total days by five percent or less. The percent decline was greatest for three activities: snowmobiling, undeveloped skiing (cross country skiing, snowshoeing), and floating (canoeing, kayaking, rafting), accounting for average net decreases of 39 percent, 36 percent, and 9 percent, respectively. The effect of climate change on snowmobiling and undeveloped skiing actually reduced the projected days of participation in 2030 to levels lower than those observed in 2008. The effects of climate change surpassed the gains in participant days resulting from population growth. Activities that could show a slight increase in total days under projected climate changes include interpretive site use, challenge sports, and off-road driving.

The general effects of climate change on projected percentage change in the number of total participants for 2030 is also shown and has similar results to the climate effect on total days. The direction (increase or decrease) of the climate effect is often the same, but the magnitude of the difference is more muted for the analysis of participants. The primary exception is for equestrian, where the climate change models reduced the estimate of days by 4.5 percent and increased the number of participants by 4.9 percent. The opposite effect was evident for visiting interpretive sites, as climate change had a negative effect on the number of participants and a positive effect on days. The magnitude of the effect was relatively low at -.6 percent and 1.4 percent respectively. Thirteen of 17 activities are expected to experience fewer participants when climate change is included into the projection estimates.

However, the small percentage increases or decreases from incorporating climate change can have a noticeable impact on total participants and days if the activity has high levels of participation and average days. For example, climate change effects associated with developed site use could result in two million fewer participants and 52 million fewer activity days in 2030, on average, than would be expected with no climate change. The overall decline is 1.1 percent for total participants and 2.3 percent for days. In contrast, the 36 percent drop in days for winter activities only reduces the total activity days by 18 million because participants only engage in 6 to 7 days annually.

The effects of climate change on outdoor recreation activities vary across alternative climate projections. In the set of climate projections used in the 2010 RPA Assessment (USDA Forest Service 2012a), the most pronounced effects of climate were associated with the climate projections with the greatest increases in average temperature and greatest decreases in precipitation (Bowker et al. 2012).

Table 4. Projected percent change in participants and days to 2030 with (CC) and without (No CC) the effects of climate change (Scenario RPA A1B), by recreation activity.						
Activity Groups	Adult Participants (millions)			Total Days (millions)		
	Average % Change 2008 to 2030		Effects of CC	Average % Change 2008 to 2030		Effects of CC
	No CC	CC	% Difference	No CC	CC	% Difference
Visiting Developed Sites						
Developed site use	27.6	26.5	-1.1	26.6	24.3	-2.3
Visiting interpretive sites	30.7	30.0	-0.6	34.1	35.4	1.4
Viewing & Photographing Nature						
Birding	32.3	28.8	-3.5	32.5	28.3	-4.3
Viewing	28.1	27.8	-0.4	23.9	22.2	-1.6
Backcountry Activities						
Challenge	31.3	32.6	1.4	30.5	32.9	2.5
Equestrian	30.1	35.0	4.9	31.7	27.2	-4.5
Hiking	30.5	27.7	-2.8	33.5	31.0	-2.5
Visiting primitive areas	24.0	22.3	-1.6	22.6	18.8	-3.8
Motorized Activities						
Motorized off-road use	20.7	21.2	0.5	17.3	19.3	2.1
Motorized water use	29.9	26.3	-3.5	30.6	25.5	-5.1
Motorized snow use	13.6	-18.4	-32.0	12.1	-26.8	-38.9
Hunting and Fishing						
Hunting	12.0	10.5	-1.5	6.4	4.0	-2.4
Fishing	23.4	19.1	-4.2	21.1	16.1	-5.0
Non-motorized Winter Activities						
Developed skiing	35.1	34.7	-0.4	39.5	38.7	-0.8
Undeveloped skiing	25.9	-5.9	-31.8	28.6	-6.9	-35.5
Non-motorized Water Activities						
Swimming	31.0	31.0	0.0	31.7	29.8	-1.9
Floating	21.7	13.1	-8.5	22.1	13.1	-9.0

CC = climate change

Dominant factors in recreation projections

Previous research (e.g. Cordell 2012) has established that population size, gender, race, ethnicity, education, income, and supply of and proximity to recreation settings can be highly correlated with the rate of outdoor recreation participation as well as age, place of residence, and participation intensity. The results of the recreation projections (Bowker et al. 2012) reinforce those findings, as summarized below.

Key differences in the model variables drive the projections of recreation participation. Population growth often is the most important factor. Income growth also has differential effects on projected participation, particularly for those activities that require more capital or income for effective participation, such as developed skiing, challenge activities, equestrian activities, hunting, and motorized activities. The effects of population growth were often offset by more indirect effects. For example, increased population density in the vicinity of recreation sites can cause crowding onsite, which has been shown to reduce the quality of many nature-based recreation experiences. In most cases, population growth is sufficient to result in overall growth in total participants and total days of participation, even when participation rates and/or average days of participation are projected to decline.

Males are more apt to participate in backcountry activities, hunting and fishing, motorized activities, non-motorized winter activities, and floating than are females, while the latter are more likely to participate in the viewing activities, swimming, equestrian, and visiting developed sites.

Ethnicity is still an important influence on the decision to participate. However, it has little influence on the annual days of participation, once the individual chooses to participate. Minorities including African Americans, Hispanics, and Asians, are almost always less likely than Whites to participate in the various activities examined in this report. A notable exception occurs with hiking where, controlling for other socioeconomic and supply factors, Hispanics are more likely than Whites to participate. Respondents claiming American Indian, non-Hispanic identity are often more likely than Whites to participate in remote activities like hunting and fishing, motorized off-road, motorized snow, hiking, equestrian, and viewing. In absolute numbers, 70-75 percent of total participants across all activity groups are non-Hispanic Whites with Hispanic participants the next highest, averaging about 14 percent.

Education beyond high school generally results in higher participation rates for most activities. However, the level of education attained can influence participation somewhat. For example, the greater the education level, the more likely one would participate in birding, non-motorized winter activities, backcountry activities, and viewing activities. More than a high school education lowers the probability of participation for fishing and hunting, motorized off-road use, and motorized snow activities. While participation rate generally increases with education, around 50 percent (+ or – 5 percent) of participants across all activity groups have maximum education attainment of either a high school education or some college.

Income is positively associated with participation and use across all activities. However, for some activities such as birding, hiking, and hunting, the effect is small, while for others such as developed skiing and motorized water use, the effect is large. An important aspect of income growth, omitted from the analysis in this report, is that RPA Assessment scenarios used in this study accounted only for aggregate income growth and omitted any consideration of changing income distribution. This omission is serious and likely overlooks the fact that recreation access will probably become more partitioned by income class.

Generally, land and water available per capita positively influence activity participation. Population growth combined with a stable public land base and declining private natural land base (from urbanization) resulted in a decline in per capita recreation opportunities over the projection period. This decline is likely to reduce participation rates for activities that require large spatial extents, such as hunting, off-road driving, and visiting primitive areas. Similarly, participation in water-based activities such as swimming, motorized boating, and non-motorized boating are all positively correlated with the per capita water area. Fishing is positively correlated with both per capita water area and forest and rangeland area. A seemingly counterintuitive result occurred with the variable indicating whether the respondent lived in a coastal community. Here, participation in fishing, hunting, and viewing are negatively correlated with residence in a coastal county. Such a result could be driven by the fact that coastal population in the country is dominated by highly urban areas. Finally, it should be noted that these results and projections do not account for factors outside the range of available data such as climate change effects on recreation resources, new technology, changes in relative costs, new infrastructure, and changes in tastes and preferences.

Federal Land Base for Outdoor Recreation

The United States has extensive land and water resources. Public lands held in trust by local, state, and federal governments, are critical resources for nature-based outdoor recreation. While focusing on the federal land base, we briefly describe the role of state, and local lands in providing recreation opportunities, based on Cordell et al. (2013). The distribution of federal land is uneven between the eastern and western United States, which influences the role of federal lands in providing outdoor recreation opportunities in different regions of the United States. Some of the information is provided by regions used in the RPA Assessment (Figure 1).

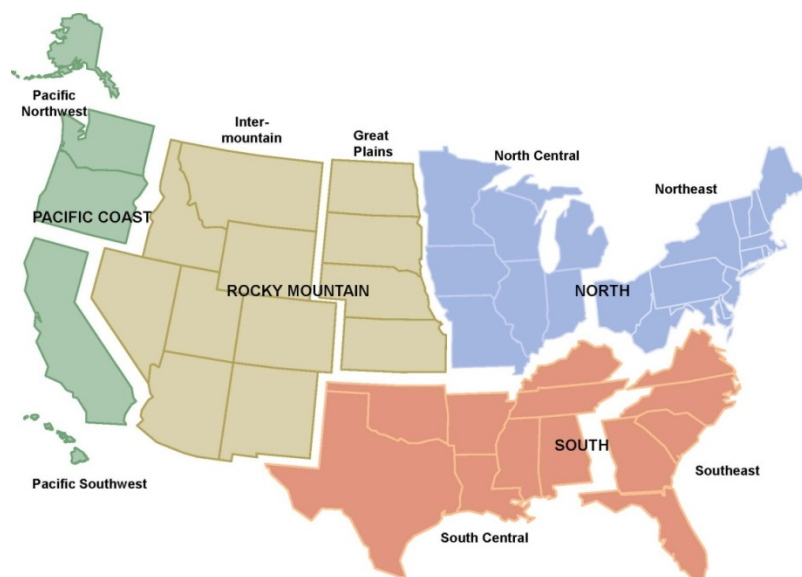


Figure 1. Resources Planning Act (RPA) Assessment regions of the United States.

Local and State government lands

Local governments own a small percentage of total public lands, but these holdings are highly important because they tend to be located close to population centers. Urban parklands are an important resource in areas of high population density. These resources typically fill a key recreation niche, providing places for activities such as team sports and daily exercise such as walking or jogging. Generally, these resources are designed and managed to accommodate frequent and heavy density of use.

States manage a variety of lands that can provide recreation opportunities, including state parks, state forests, state wildlife areas, and other designations. State lands tend to occupy a niche between the more undeveloped and dispersed recreation opportunities of federal lands and the much more facility and development-oriented local lands. Similar to local government lands, state resources tend to occur in close proximity to populated areas, especially in the eastern United States where state lands play a much more significant role in providing outdoor recreation opportunities than in the West. Still, because of the lower population in the West, there are more state park system acres per capita in the West than in the East (Cordell et al 2013).

States manage more than 6500 individual parks and other categories of areas (e.g. natural areas, historic sites) that account for about 14 million acres. The North and Pacific Coast regions have the largest areas (about 5.2 million acres each), while the South has about 2.2 million acres, and the Rocky Mountain region about 1.4 million acres. About 25 million acres of U.S. forest land are managed by state forestry agencies. These lands are often available for recreation purposes, especially fishing, hunting, and wildlife watching. The largest proportion (64 percent) is in the North region, followed by the Pacific Coast region (20 percent). State forests and State wildlife and fish areas provide additional outdoor recreation opportunities (Cordell et al. 2013).

Federal lands

Federal lands cover about 640 million acres in the United States⁹, about 28 percent of the total land area. Nearly all Federal land is open and available to the public for recreation. More than 92 percent of Federal land is located in the West, with about 36 percent of all Federal land in Alaska. The FS and BLM manage the majority of Federal land. The acres of land managed by six of the seven FICOR agencies are shown in Table 5, as well as the distribution by RPA region. Since the Pacific Coast includes large Federal holdings in Alaska, Table 5 shows acreage for Alaska separately. NOAA manages 14 marine protected areas encompassing more than 170,000 square miles of marine and Great Lakes water from Washington State to the Florida Keys, and from Lake Huron to American Samoa. The network includes a system of 13 national marine sanctuaries and one marine national monument.¹⁰

⁹ The 640 million acres does not include land managed by the Department of Defense.

¹⁰ <http://sanctuaries.noaa.gov/>

Table 5. Acres of federal land¹ in the United States by FICOR agency and RPA region (thousand acres).

Federal agency	North	South	Rocky Mountain	Pacific Coast ²	Alaska	United States
Forest Service	12,161	13,396	100,096	45,101	22,207	192,961
National Park Service	1,225	5,129	10,763	9,954	52,621	79,691
Fish & Wildlife Service	1,568	4,522	10,496	1,767	76,886	95,239
Bureau of Reclamation	0	197	5,470	854	0	6,522
Bureau of Land Management	4	25	142,956	31,906	72,423	247,314
Army Corps of Engineers	2,557	7,104	3,540	526	19	13,746
Total	17,515	30,373	273,321	90,108	224,156	635,473

¹ Acres reported by the Bureau of Reclamation and Army Corps of Engineers include water area

² Pacific Coast acreage in this column does not include Alaska.

Sources:

USDA Forest Service: http://www.fs.fed.us/land/staff/lar/LAR2013/Table_03.pdf (2013 data)

USDI National Park Service. 2010 Data as reported in Gorte et al (2012)

U.S. Fish & Wildlife Service http://www.fws.gov/refuges/realty/archives/pdf/2013_Annual_Report_of_LandsDataTables.pdf (2013 data)

USDI Bureau of Reclamation. Recreation Fast Facts. www.usbr.gov/recreation.

USDI Bureau of Land Management. http://www.blm.gov/public_land_statistics/pls12/pls2012-web.pdf (2012 data)

U.S. Army Corps of Engineers. Institute for Water Resources in partnership with the Engineer Research and Development Center and Natural Resources Management. Value to the Nation website: www.CorpsResults.us. Last updated 2006.

Congressional designations offer additional direction to the management of Federal lands that often affect the recreation opportunities available on those lands. The National Wilderness Preservation (NWPS) System includes more than 109 million acres of Wilderness Areas that represent the most pristine and protected of federal lands. More than half of the NWPS area is in Alaska, while the remainder is almost entirely in the western United States. Other Congressionally designated acres provide unique recreation resources: National Recreation Areas (NRAs), National Wild and Scenic Rivers (NWSRs), and the National Trail System. NRAs are intended to serve primarily as a recreation resource and be accessible to population centers. In 2008, 41 NRAs covered 7.4 million acres, with 90 percent of that acreage in the western United States. The NWSR designation requires qualifying rivers to have outstanding scenic, wild, and/or recreation values. Almost 12,600 miles of 203 rivers in 39 states and Puerto Rico were designated as of April 2012;¹¹ the Pacific Coast region contained more than half of the designated areas in 2009 (Cordell et al. 2013). The National Trails System includes national scenic trails, national historic trails, and national recreation trails. Currently, the National Trails System totals over 60,000 miles in all 50 states and is comprised of 11 National Scenic Trails and 19 National Historic Trails authorized by Congress, and more than 1000 National Recreation Trails (NRT) designated by the Departments of the Interior or Agriculture. The NRT system is unique in that it can be managed by any government agency at any level of government. In 2009 there were slightly more than 20,000 miles in the system, with the East accounting for almost 70 percent of the total trail miles (Cordell et al. 2013).

¹¹ <http://www.rivers.gov/national-system.php>

Federal land availability and facilities

The seven FICOR agencies are critical providers of outdoor recreation opportunities to the American public as well as foreign tourists. The key activities for each agency focus on connecting the visiting public with the resources under their stewardship. All of the FICOR agencies balance recreation activity with resource management, where ‘management’ can be construed as either preserving a specific resource or balancing joint production of several outputs from one resource unit. All of the FICOR agencies have goals that include some combination of providing public access to the resource base, promoting health benefits, and improving connections with our nation’s natural and cultural heritage.

The recreation resources managed by the FICOR agencies are extensive. If the area of federal lands and waters are assumed to remain stable, per capita availability can only decline over time as population increases. The ability of Federal resources to meet future recreation participation depends on future recreation participation rates, the distribution of recreation participants in relation to recreation resources, and substitutes for Federal opportunities. Transportation systems will continue to be critical for providing access to recreation opportunities. Figure 2 overlays the current land base of six of the FICOR agencies (excluding NOAA) in the United States on a map of county-level projected population change to 2030, following the population projections of the RPA A1B scenario from the 2010 RPA Assessment.

While the federal land base may remain relatively static, legislative and executive designations, along with Agency regulations and rules can alter the mix of recreation opportunities available. Changes in designations can affect the mix between recreation activities (e.g., a change from motorized to non-motorized use) or the mix between recreation and other uses (e.g., recreation and logging or mineral extraction). These types of changes can effectively increase or decrease federal acreage available for recreation.

The NPS, FWS, BLM, and FS provide a wide range of recreation opportunities, with dominant activities including sightseeing (including auto touring or pleasure driving), viewing nature and wildlife (including birds), and hiking and walking. Top activities across all NPS units are sightseeing, day hiking, visitor center use, and creative arts (photography, writing, painting, drawing, etc.).¹² The greatest participation rates on FWS lands are for wildlife observation and birding, photography, hiking/walking, auto-tour driving, and fresh water fishing, although other popular activities are hunting, bicycling, and non-motorized boating (Kevin Kilcuillen, personal communication). BLM officials indicated the activities with the highest recreational visitation on BLM lands are camping and picnicking; non-motorized travel; off-highway travel; water-based activities; and hunting (USDI BLM 2012). The most common activities in which people participate on FS lands include viewing scenery/natural features; hiking/walking; relaxing/ hanging out; and viewing wildlife.¹³

¹² <https://irma.nps.gov/Stats/Reports/National>

¹³ <http://www.fs.fed.us/recreation/programs/nvum/>

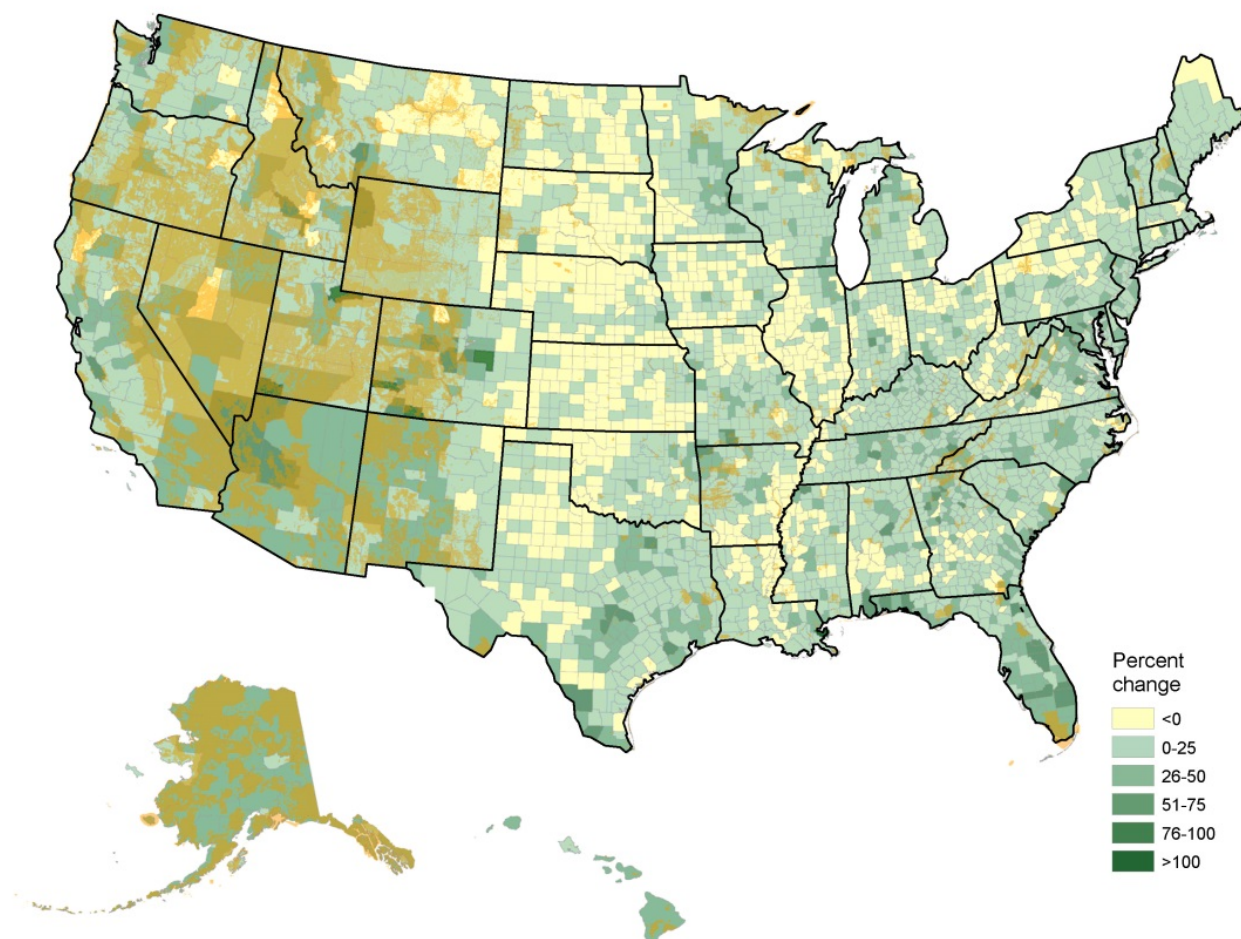


Figure 2. Federal lands (brown shading) overlaid on population change by county in the United States projected from 2010-2030, RPA A1B scenario. (Source of federal ownership overlay for six FICOR agencies: Protected Area Database-United States (PAD-US))

The USACE, BOR, and NOAA are more focused on opportunities associated with water recreation. The USACE sites host 33% of all U.S. freshwater lake fishing; provide other water-based activities, and camping and hiking/walking opportunities.¹⁴ Similarly, the BOR provides extensive water-based opportunities. BOR's day use and dispersed opportunities areas also accommodate activities such as camping, picnicking, hiking, wildlife viewing, and photography. The most common activities at NOAA marine sanctuaries are fishing, SCUBA, and snorkeling.

¹⁴ <http://www.usace.army.mil/Missions/CivilWorks/Recreation.aspx>

Proximity is important for many recreation visitors. For several agencies, including BLM, FS, FWS, and USACE, at least half of the visits come from people who live within 50 miles.¹⁵ Thus, population growth and/or change in the communities in those proximate zones can have large effects on the volume and nature of visitation. Even so, these agencies all have resources that can have regional, national, or international markets. While there is considerable overlap in the recreation opportunities across the FICOR agencies, they could be segmented into dominant niches. The BLM and FS offer a range of opportunities from “big backyard” to backcountry; the FWS opportunities emphasize wildlife, fish, and birds, while the NPS is often associated with iconic natural and cultural resources. The USACE, BOR, and NOAA tend to focus on water and underwater resources.

Economic Contributions from Recreation on Federal Lands

Federal recreation resources offer opportunities for individuals to interact with forests and other natural resources. Federally-managed public areas supply places individuals can use to recreate or exercise, landscapes that are aesthetically pleasing and provide desirable backdrops for living or working nearby. Through these interactions with federal recreation resources, a number of positive economic effects accrue to people, individually and as communities. The most commonly recognized economic outcomes from federal recreation resources include business activity generated from the spending made by recreation visitors, increased property values and business attraction because of natural amenities those resources provide, and health benefits from physical activity and stress reduction.

Of the economic outcomes associated with federal recreation resources noted above, the most attention is typically given to the business activity created when visitors spend money to recreate. This economic outcome is often a key consideration in federal natural resource planning, is a focus of local, regional, and national business groups, and is a primary interest of local and state community leaders. Americans spend an estimated \$646 billion annually on recreation equipment and the goods and services connected with outdoor recreation (Outdoor Industry Association 2013). The majority of that spending—\$525 billion—is made while recreating for purchases of things like food, lodging, fuel, and entertainment. Recreation trip spending includes purchases at home in preparation for the trip, enroute, and at the recreation destination. In total, American spending for recreation supports about 6.1 million full and part-time jobs (Outdoor Industry Association 2012). How spending in support of recreation influences the economy in the future will be influenced, in large part, by future patterns of recreation participation.

People spend money at businesses while recreating on both public and private lands. But, from the standpoint of public lands management, there is substantial interest in how government provision of opportunities for recreation on public lands translates into economic activity in communities around federal recreation resources. Studies specific to federal lands indicate that those recreating on federal recreation resources spend at least \$51 billion in the local economies around their federal recreation destination (English et al. 2014). This provides a conservative estimate of overall spending relative to spending reported in national recreation industry analyses. Federal contribution analyses typically limit visitor expenditures to a geographic area in close proximity to the federal sites. The at-home and enroute spending of visitors traveling longer distances are not included. The intent is to attribute the spending to a single destination and a single trip and focus the effects in and around federal recreation opportunities. This limits the magnitude and scope of what is included in federal contributions, but links the spending to resources and opportunities provided.

¹⁵ http://www.fs.fed.us/recreation/programs/nvum/2012%20National_Summary_Report_061413.pdf

Factors Contributing to Economic Activity from Federal Recreation

The magnitude of business activity in local communities associated with outdoor recreation on federal lands is dependent on: 1) the presence of people recreating on federal recreation lands, 2) the existence of businesses where visitors can spend money, and 3) spending from recreation visitors.

Recreation Participation

Recreation occurring on federal lands results from individual visitor preferences for outdoor recreation as well as the quality and quantity of recreation opportunities supplied by federal agencies. The quality of opportunities for recreation activities such as camping, hiking, picnicking, observing nature, fishing, hunting, viewing wildlife, driving off-road, and others, federal recreation agencies will influence the amount and type of recreation on federal lands. Visitors to communities around federal recreation opportunities generate economic activity. A number of federal recreation destinations are unique, premier recreation destinations, i.e., “crown jewels,” that consistently attract large numbers of tourists who travel long distances to reach the site. The recreation activity at these sites often drives substantial economic activity in local communities. Tourism is the primary economic driver in many of these communities. Some other federal recreation destinations are in remote rural communities that tend to have few visitors, many of whom reside in the local area. Visitor spending in these locales is often relatively low with limited economic effects. The majority of federal recreation areas are likely somewhere in the middle, receiving moderate levels of visitation that drive an important component of local economic activity.

Opportunities for Visitor Spending

The amount of visitor spending stimulated by federal recreation opportunities depends, in large part, on the presence of private businesses in nearby communities. Communities that are able to capture the most spending from recreation visitors have businesses that offer services and goods desired by those engaged in outdoor recreation. On average, expenditures for lodging, food in restaurants/bars and grocery stores, and fuel account for the majority of recreation trip spending. Communities may increase the likelihood and magnitude of visitor spending by including complementary and other attractions/activities to lengthen visitor stays, or provide incentives for return visits.

The presence of private businesses operating as concessionaires or offering outfitter/guide services on federal lands often enhances the recreation opportunities accessible to visitors and leads to increased spending in local communities. Concessionaire and guide businesses are attracted to, and dependent on, the innate features of federal recreation resources and operate within guidelines set by federal agencies. Concessionaires and guides can provide key services and create access opportunities for a broader spectrum of recreation visitors. In some cases, concessionaires and guides may encourage longer stays and enhance the amount of spending in local communities by selling recreation packages that include services or products offered by other local businesses.

The primary effects of visitor purchases of goods and services are realized by businesses catering directly to visitor needs. However, the total economic activity is greatest when there are other local businesses that are intermediate suppliers to businesses selling directly to recreationists. For example, if a restaurant purchases meats, vegetables, or beverages from producers in the local area, money spent by recreationists accrues both to the restaurant serving recreationists as well as local food producers.

Alternately, if a restaurant must source food from outside the local area, the money spent by recreationists leaks out of the local economy more rapidly as restaurant supplies are purchased from elsewhere.

Recreation Visitor Spending

Spending from visitors in and around federal recreation opportunities creates economic activity in local communities. A variety of factors, including the size of the travel party, time spent in the local area, personal preferences and income, and shopping opportunities influence how much money people spend in local communities and the types of purchases. The specific recreation activity of the visitor has a secondary influence on spending.

Visitor spending is strongly influenced by the type of recreation trip, day use versus overnight trips and destinations far from or close to home. Those characteristics of trip type alter the array of items and services a visitor must purchase during the recreation visit. Those staying overnight away from home usually spend money for lodging in hotels/motels, B&Bs, or public or private campgrounds. An individual on a day trip does not need to purchase lodging. Visitors staying one or more nights in a community eat more meals in the area and often spend more money in local restaurants/bars and grocery stores. A day visitor may spend a relatively brief time in local communities and may eat meals at home before and after the trip. Finally, visitors staying more than one day in an area are more likely to spend money on entertainment, souvenirs and other retail items. A visitor traveling a long distance from home, whether on a day trip or overnight trip, often has greater spending because the trip length requires increased purchases of items such as fuel.

Generally, the specific recreation activity has a secondary influence on visitor spending. Some activities have greater or lesser spending, on average, because of the types of purchases (e.g., lift tickets, fuel, and guide services) required to complete the trip. For example, downhill skiers at sites on federal lands are among the highest recreation spenders. On a per night basis, these visitors spend significantly more than other visitors for recreation fees (i.e., lift tickets), restaurants and bars, and lodging. Conversely, some activities, such as backpacking and hiking have spending levels that are lower than visitors on the same type of trip but engaged in a different primary activity. Visitors on backpacking trips are likely to make purchases near their home and have limited or no opportunities to spend money while recreating in the backcountry. Despite lower than average spending, hiking is one of the most popular activities on federal lands. The aggregate total spending of hikers and backpackers can be an important contribution to the economies of many rural communities.

Classification of Trip Spending and Recreation Visits

The FICOR agencies each develop estimates of total recreation use, the amount of money visitors spend in local communities, and how that spending affects local economies. In many cases, agencies have implemented monitoring systems to update estimates of total recreation use, visitor characteristics and trip spending on a regular basis. For this discussion, we use spending estimates developed from the FS National Visitor Use Monitoring (NVUM) Program as an indicator of how projected future recreation participation could change the amount of recreation spending in local communities. NVUM data are a useful source for this analysis because they are collected throughout the U.S., represent visitors engaged in a broad range of recreation trips and activities, and come from surveys of users in a variety of settings near a diverse group of communities. The approach for estimating visitor spending through NVUM is generally consistent with that used by other FICOR agencies. Further, spending averages estimated

from the NVUM data are consistent with spending averages estimated from the monitoring programs of other agencies. For the purpose of economic contribution analysis, the FICOR agencies are consistent and only consider visitor spending within about 50 miles of federal recreation resources. The marine sanctuaries managed by NOAA are one notable exception.

Visitor spending attributed to recreation on federal lands is categorized by the type of recreation trip. At the most aggregate level, trips are classified by the proximity of their origin to the destination and if the trip lasted more than one day. Trip origin distinguishes trips to recreation sites close to home (local trips) from trips involving longer distance travel (non-local trips). The cutoff distance can vary based on the recreation market area, but local trips are often less than 50 miles from the visitor's home to the recreation destination. The length of the trip is classified as 1) recreation trips that start and finish at-home on the same day (day trips) or 2) trips that involve an overnight stay on federal lands or in local communities nearby (overnight trips). The combination of these trip types creates four separate categories and forms the core of trip types considered across all federal agencies. Most agencies refine the categories to explain more of the spending variation between trips. For example, the NPS classifies overnight trips into those staying in Agency campgrounds, Agency lodges, private hotels/motels outside the park, and private campgrounds (Cullinane-Thomas et al. 2014). Further, the FS partitions overnight stays into those that include stays at hotels, motels or campgrounds outside the national forest versus those in campgrounds or other lodging on national forest lands (White et al. 2013). Lastly, recreation visitors who do not consider the federal site to be the primary motivating reason for the trip are often grouped into a separate category. The spending of visitors in that category is typically fully or partially excluded from analysis of economic contribution, leading to a more conservative estimate of the economic contribution of federal lands. At the national level across all activities, the FS uses seven trip types to classify all recreation visits to national forests (Table 6). The FS visitor spending figures and the distribution of recreation visits across the trip types demonstrate the key features of classifying trips.

The type of recreation trip is the most important factor in explaining variation in visitor trip spending to federal recreation sites (White and Stynes 2008). Average spending figures estimated from NVUM data illustrate how recreation spending varies by trip type. Visitors traveling outside the local area of their home (non-local visitors) to recreate spend up to twice as much as visitors recreating near their homes (local visitors) (Table 6). Further, those visitors who take trips where they stay overnight away from home (whether local or non-local trips) have greater spending than visitors on day trips. The greatest spending comes from visitors who travel far from home and stay overnight in communities near federal lands. These visitors spend on average 15 times more than those on local day trips.

Table 6. Average spending in local communities and the distribution recreation visits across Forest Service trip type categories (Source: White et al. 2013)

	Non-local Day Trips	Non-local Overnight Trips (camping)	Non-local Overnight Trips (hotels or motels)	Local Day Trips	Local Overnight Trips (camping)	Local Overnight Trips (hotels or motels)	Not Primary¹
Average party spending within 50 miles of recreation destinations ²	\$ 63	\$233	\$514	\$33	\$162	\$213	NA
Percent of all trips ³	10	9	14	49	4	1	13

¹The Forest Service recognizes a group termed “not primary” travelers. Those visitors recreate on Forest Service land as part of a larger leisure or business trip that has some primary purpose other than Forest Service recreation. These visitors typically have high levels of spending, but only a portion of that spending is directly attributable to Forest Service land.

²Average spending by trip type in local communities of travel parties recreating on U.S. Forest Service land

³Percent distribution of U.S. Forest Service recreation trips across trip type categories

Communities often make a considerable effort to attract overnight visitors (who tend to have higher spending profiles). However, recreation visitors take a variety of trip types and total spending in communities is dependent on both the patterns of average spending and the distribution of visitation across trip types (Table 6). Most visits to FS lands are associated with people on day trips recreating locally (49%). Although day trips have relatively low levels of average spending, the high number of trips yields a significant amount of total spending. The second most common type of trip to FS lands is by nonlocal visitors staying overnight. The high spending of that group and the fairly large number of trips combine to generate high levels of total spending. Relatively small changes in the level of visitation can produce large swings in total spending.

Total spending in local communities is largely a function of the numbers of each trip type taken by visitors. The recreation activity can also play an important role if opportunities for expensive activities such as developed skiing and motorized vehicle use are available. Conversely, low spending activities, such as backcountry camping and hiking usually support less spending. However, lower spending for these activities may not hold for unique recreation opportunities or high quality environments that draw visitors for extended stays. The recreation activity can provide important information about visitor spending, but except for special cases, like developed skiing, it should be considered as a secondary attribute after trip type when evaluating recreation spending.

Economic Contribution from Federal Recreation Opportunities

A recently completed analysis by the FICOR agencies uses spending and reported recreation visitation to provide estimates of the economic contribution of federal recreation to the national economy (English et al. 2014). Outdoor recreationists made more than 938 million visits to federal lands in 2012, spending \$51 billion and supporting 880,000 jobs (English 2014). Table 7 provides a snapshot of the contributions that outdoor recreation had on jobs and the economy in 2012.

Table 7. 2012 Economic contributions of visitor spending for recreation on federal lands and waters (2012 dollars).			
Agency	Recreation Visitation (millions)	Visitor Spending (billion \$)	Jobs (thousands)
National Park Service	283	15	243
Bureau of Land Management	59	3	58
U.S. Fish and Wildlife Service	47	2	37
Bureau of Reclamation	28	1	26
Forest Service	161	11	194
National Oceanic and Atmospheric Administration	NR ¹	5	135
U.S. Army Corps of Engineers	360	13	187
All FICOR Agencies	938	51	880

¹ NR = not reported
Source: English 2014

Economic Activity Associated with Future Recreation Participation

The RPA Assessment projections described earlier are used in this section as a reasonable estimate of the overall patterns of future recreation participation on federal lands. Those projections do not differentiate recreation participation on public or private lands. Moreover, while the projections are not specific to federal lands, the set of nature-based activities considered are closely related to many federal opportunities. Because consideration of trip type is fundamental to understanding visitor spending in local communities, we separately discuss activity spending for day and overnight trips and the distribution of visitation by activity across trip types. The effects of climate change on future recreation participation are discussed at the end of this section.

Visitor Spending on Day trips

The level of average spending for day trips ranges from a low of \$21 dollars for local visitors to \$130 for visitors coming from longer distances (Table 8). At the high end of spending are visitors engaged in developed skiing (downhill, snowboarding), all motorized activities, undeveloped skiing (cross country, snowshoeing), and hunting. These activities often require a significant investment in recreation fees, fuel, and supplies for completing the trip. Of these activities, developed skiing and motorized water recreation are projected to see the greatest percentage increases in participant days by 2030. Motorized off-road use, snowmobiling, and hunting are projected to have the lowest increases in participant days, ranging from six percent to 17 percent. Motorized recreation activities on federal lands are typically restricted to specific areas. Snowmobiling is further limited to times and regions of the country where weather conditions are conducive. Changes in recreation participation in motorized activities (and the associated changes in visitor spending) will likely affect a select subset of communities near federal lands. Because hunting occurs across a broad range of recreation resources and is distributed across the United States, although seasonally restricted, the effects of slow growth in participation could influence a greater number of communities.

Hiking, birding, and interpretive site use occur across a broad spectrum of recreation environments and represent three of the top four projected percentage increases in participant days. Hiking is currently the most common recreation activity on FS lands. The average spending of day trip visitors engaged in these general activities is among the lowest and is significantly less than specialized activities like motorized recreation or skiing. However, recreation participation in general activities is so great that the total spending is substantial. Most federal lands offer opportunities for visitors to engage in these activities. Therefore, anticipated future participation increases in these generalized activities is likely to have positive economic effects on numerous communities located around federal recreation resources.

Table 8. Projected change in participant days¹ and average spending in local communities of parties on recreation trips to U.S. Forest Service lands.

Activity Groups	Projected change in participant days 2008-2030	Spending per party per trip in federal recreation communities (2007 \$) (White and Stynes 2010)			
		Non-local Day Trips	Non-local Overnight Trips	Local Day Trips	Local Overnight Trips
Visiting Developed Sites					
Developed site use	27%	\$72	\$206	\$40	\$171
Visiting interpretive sites	34%	\$65	\$473	\$37	\$195
Viewing & Photographing Nature					
Birding	33%	\$65	\$473	\$37	\$195
Viewing	24%	\$65	\$473	\$37	\$195
Backcountry Activities					
Challenge	30%	\$50	\$473	\$21	\$150
Equestrian	32%	\$50	\$473	\$21	\$150
Hiking	33%	\$50	\$473	\$21	\$150
Visiting primitive areas	23%	\$50	\$134	\$21	\$120
Motorized Activities					
Motorized off-road use	17%	\$109	\$277	\$58	\$134
Motorized water use	31%	\$109	\$277	\$58	\$134
Motorized snow use	12%	\$129	\$642	\$74	\$311
Hunting and Fishing					
Hunting	6%	\$88	\$368	\$51	\$248
Fishing	21%	\$55	\$331	\$38	\$161
Non-motorized Winter Activities					
Developed skiing	39%	\$130	\$798	\$64	\$386
Undeveloped skiing	29%	\$97	\$537	\$27	\$259
Non-motorized Water Activities					
Swimming	32%	\$72	\$330	\$40	\$187
Floating	22%	\$72	\$330	\$40	\$187

¹ Results do not include climate change effects see Table 3.

Visitor Spending on Overnight Trips

Visitors traveling on overnight trips have the highest per trip spending of any visitor type (Table 8). Spending ranges from about \$120 for locals visiting primitive areas to almost \$800 for nonlocal developed skiers. The pattern of high spending noted for day trip visitors engaged in developed and undeveloped skiing and snowmobiling continues for overnight visitors as all three groups exceed \$500 per trip. Motorized water and off-road use are generally on the lower end of the overnight spending spectrum in contrast to their high spending as day use activities. In many cases, visitors engaged in these activities are camping and spending less on lodging than other overnight visitors.

Visitors on overnight trips use a variety of lodging types and have varying patterns of visitor spending. Campers tend to have high levels of spending for groceries and fuel, although some visitors bring food purchased outside the local area. In many settings, these visitors also have relatively high spending on entertainment and souvenirs. Public or private area camping is split between developed site use (which includes developed campground camping) and visiting primitive areas (backcountry camping). Participation in both those activities is projected to increase (27% and 23%, respectively). Increased rates of camping will promote increased spending for groceries, fuel, souvenirs, and entertainment.

Those staying overnight in hotels/motels or lodges spend more in restaurants and bars and on entertainment than campers. Winter recreationists engaged in developed skiing or snowmobiling have some of the highest levels of overnight spending and use hotels/motels and lodges more than visitors engaged in other activities. Participation growth in developed skiing is projected to be very high, while motorized snow recreation is projected to see lower levels of growth. Visitors using cabins, seasonal homes, or staying with friends and relatives have spending patterns that are a mix of campers and those using hotels/motels or lodges. They often eat some meals at the cabin (leading to grocery spending) and some meals in restaurants (leading to restaurant spending). Like campers, some of these visitors may bring food purchased from outside the local area. Cabin and seasonal home users participate in a variety of activities, but have high levels of participation in winter recreation and general recreation activities like viewing and photographing nature, hiking, or visiting developed sites. All of those activities are projected to see increases in recreation participation in the future.

High Spending Trip Types and Recreation Activity Projections

A few activities (e.g., developed skiing and motorized recreation) have higher than average spending because participants need to purchase specific items (e.g., lift tickets or additional fuel) regardless of the type of trip taken. Other activities generate high trip spending because visitors often stay overnight and/or take trips far from home. Both trip types lead to high trip spending and create significant economic effects for local communities. Federal recreation opportunities that facilitate overnight stays or encourage long distance travel support these types of activities. The RPA projections, coupled with an understanding of what activities are most associated with overnight and long distance trips, can provide insight into how total spending may change in the future because of changing trip type.

Distribution of Visitor Use by Trip Type and Activity

The intensity of visitor use within each of the trip types significantly affects total spending. Overnight trips from non-locals, some coming from very long distances, are most common among visitors who engage in developed skiing, developed site use, swimming and floating (Table 9). A quarter or more of the trips in each of those activities occur in that trip type. Those four activities, along with the wildlife-related activities (birding, hunting, and fishing), have over 30 percent of their visitor use from people traveling 50 or more miles from home. Developed skiing is the only activity with greater than 50 percent of reported visitation (58 percent) coming from distances more than 50 miles from the site. Large percentage increases in participant days are projected for both developed skiing and birding. Relatively small percentage increases are projected for hunting, fishing, and floating. Federal recreation opportunities supporting birding and developed skiing should yield increased out-of-town travelers to communities near the visited sites. Communities close to federal hunting and fishing opportunities will probably see gains in out-of-town visitors, although those gains will not be as large because those activities require low densities of use for quality experiences.

Table 9. Projected change in participant days¹ and current distribution of recreation trips across trip type categories for visitors to U.S. Forest Service lands engaged in a variety of recreation activities (recreation trip type source: White and Stynes 2010)

Activity Groups	Projected Change in Participant Days 2008-2030	Non-local Day Trips	Non-local Overnight Trips	Local Day Trips	Local Overnight Trips	Not primary
	Percent					
Visiting Developed Sites						
Developed site use	27	9	25	43	8	15
Visiting interpretive sites	34	10	16	39	2	33
Viewing & Photographing Nature						
Birding	33	10	21	55	7	7
Viewing	24	10	16	39	2	33
Backcountry Activities						
Challenge	30	8	13	62	2	15
Equestrian	32	8	13	62	2	15
Hiking	33	8	13	62	2	15
Visiting primitive areas	23	8	13	62	2	15
Motorized Activities						
Motorized off-road use	17	7	21	62	5	5
Motorized water use	31	7	21	62	5	5
Motorized snow use	12	7	21	62	5	5
Hunting and Fishing						
Hunting	6	10	21	55	7	7
Fishing	21	10	21	55	7	7
Non-motorized Winter Activities						
Developed skiing	39	14	44	36	2	4
Undeveloped skiing	29	7	16	68	2	7
Non-motorized Water Activities						
Swimming	32	9	25	43	8	15
Floating	22	9	25	43	8	15

¹ Results do not include climate change effects see Table 3.

Local day users tend to dominate recreation trips to FS lands with about two-thirds of the activities having 50 percent or more trips in that category; the largest proportions in backcountry activities, motorized activities, and undeveloped skiing. Relatively large increases in participant days are projected for most backcountry activities and motorized water use. If the distribution of trips across trip types is stable over time, the relatively large increases in participant days in these activities will likely yield associated increases in local trips. Although the spending of these visitors is lower than non-locals, it can be an important economic activity in some communities. Thus, the volume of use from local day users generates significant cumulative economic activity despite their lower average trip spending.

The Potential Influence of Climate Change

Future climate conditions—along with population growth, increasing wealth, and changing preferences, as alluded to above—will likely influence participation patterns in outdoor recreation. The recreation participation projections for 2030 displayed in Table 9 do not include the influence of climate changes. Additional RPA Assessment projection models were estimated with the inclusion of variables to account for future climate conditions. Incorporating climate variables slightly lowered the estimates of participation days in 2030 for most activities relative to the projections without climate change (see

Table 4). In general, the effects of climate change were overwhelmed by increases in participation because of greater future population and income. Although most of the differences between the climate and no climate estimates are small and considered insignificant, three key recreation activities have much lower participation rates when climate change is incorporated (Table 10).

Table 10. Projected future recreation participation with and without climate change for select recreation activities.		
Activity Group	Projected percent change in days of participation without climate change 2008-2030	Projected percent change in days of participation with climate change 2008-2030
Motorized snow use	12	-27
Undeveloped skiing	29	-7
Floating	22	13

Accounting for anticipated future climate change substantively reduces the projections of future recreation participation in motorized snow use, undeveloped skiing, and floating. Climate change is projected to decrease total participation in 2030 for the former two activities and to slow the growth of participation in floating. Some places that still have adequate snow in the future may see muted reductions, or even increases, as visitors are displaced from areas with poor snow conditions. Other locales could experience more significant variations in climate and have more extreme reductions in participation. Recreationists who engage in snowmobiling or undeveloped skiing on federal lands have some of the highest trip expenditures of federal lands recreationists. Large changes in the numbers of participant days in these activities could lead to meaningful reductions in the economic inputs to communities where those activities are currently popular. However, because winter recreation is constrained to areas with specific recreation opportunities and climate conditions, the effects of reductions in spending would not be felt across all communities near federal recreation opportunities. In those places that are affected, reductions could result in significant local economic changes unless the winter activities can be substituted for others in the same region. For example, in the absence of snow cover, snowmobile areas might be suitable for other forms of dispersed recreation.

Climate change is also projected to slow participation growth in floating (rafting, tubing, canoeing, kayaking). Floating is a general recreation activity that occurs on a wide range of locations across most federal land management agencies. Those engaged in floating have average levels of spending during their trips, although the popularity of floating creates an important contribution to the economies of many locales near federal lands. With changing climate, floating participation may grow more slowly than it might otherwise. Similar to non-motorized winter activities, areas offering floating activities will be differentially affected as climate change effects will vary across regions. Some areas will improve and benefit in terms of local conditions, while other areas experience declines.

Demographic Change and Recreation Spending

The racial and ethnic diversity of the U.S. population is projected to continue to increase in the coming decades. Table 11 displays recreation participation by different race/ethnicity groups for the seven composite activity groups. Although the composite groups obscure important differences in individual activities, some overall trends are evident. Amongst all racial and ethnic groups, visiting developed sites and viewing nature have the highest levels of participation. Comparing across racial and ethnic groups, American Indians have the highest rates of participation in those activities, while African Americans report the lowest rates.

Racial and ethnic groups show greater differences in participation for more specialized recreation activities. African American and Asian/Pacific Islanders have relatively low levels of participation in backcountry activities, motorized activities, and hunting and fishing. Hispanics have rates of participation in those aggregate activities that are more similar to, but lower than participation by Whites. American Indians have by far the highest rate of participation in backcountry activities and participate in motorized activities and hunting and fishing similar to that of Whites. The increasing share of Hispanic, African American and Asian/Pacific Islanders in the population is projected to contribute to slower gains in participation in motorized recreation and hunting and fishing. Communities that currently see high levels of spending from visitors engaged in those activities may see slower growth in spending in the future.

Increasing diversity in the population is unlikely to decrease future levels of spending for people engaged in general activities such as visiting developed sites and viewing and photographing nature. Those sorts of activities account for a large share of current recreation visits to federal lands, are popular among most groups, and contribute significant levels of spending. Spending attributed to those general activities will likely remain largely unchanged as the population continues to diversify.

Winter recreation sports are key drivers of local economic activity in some communities. Visitors engaged in developed and undeveloped skiing and snowmobiling have the highest spending per trip in local communities. Among racial and ethnic groups, Whites, Hispanics, and Asian/Pacific Islanders show the greatest rates of participation in winter recreation. Anticipated increases in the number of Hispanics and Asian/Pacific Islanders will likely lead to continued popularity of winter snow sports, especially if the opportunities are not diminished by climate change.

Table 11. Percent participating in outdoor recreation activity groups by racial and ethnic group, 2005-2009 (Cordell 2012).

Activity Groups	White	African American	Asian/Pacific Islander	Hispanic	American Indian
Visiting developed sites	80	69	82	75	84
Viewing and photographing nature	78	59	73	71	79
Backcountry activities	46	21	34	43	60
Motorized activities	41	15	24	35	42
Hunting and fishing	38	21	19	32	38
Non-motorized winter activities	13	4	11	12	7
Non-motorized water activities	24	7	21	19	21

Americans 45 and older report participating in fewer types of recreation activities as they age (Table 12). Projected participation drops significantly for hunting and fishing, motorized activities, backcountry activities and non-motorized winter activities. However, general activities like visiting developed sites and viewing and photographing nature remain popular for almost two-thirds of older individuals. Local communities can expect to continue to see older Americans participating in these

general recreation activities. Since most federal lands offer opportunities to participate in those activities, many local communities are in a position to continue to capture the economic benefits associated with these visitors.

Table 12. Percent participating in outdoor recreation activity groups by age group and gender, 2005-2009 (Cordell, 2012).					
Activity Group	Age 45-54	Age 55-64	Age 65+	Male	Female
Visiting developed sites	81	75	62	76	79
Viewing and photographing nature	80	75	65	74	75
Backcountry activities	48	37	22	49	35
Motorized activities	37	27	17	41	30
Hunting and fishing	38	29	20	46	23
Non-motorized winter activities	10	5	2	15	8
Non-motorized water activities	22	15	7	23	19

Men typically report higher overall rates of participation in outdoor recreation activities. The largest differences occur for non-motorized winter activities, hunting and fishing and to a lesser extent motorized and backcountry activities. Therefore, continued slowing of hunting and fishing participation and associated changes in spending may affect communities with high dependency on those activities.

Other Considerations for Future Economic Contributions from Recreation

Future Visitor Spending Patterns

Expectations for the future effects on local communities from federal recreation opportunities are sensitive to a number of considerations beyond future participation rates. Effects of future changes in recreation participation on economic activity in communities are based on current visitor spending patterns. The current patterns in the expenditures for goods and services by federal recreation visitors have appeared stable in recent years. For example, after accounting for inflation, there has been relatively little change in the relative amounts that visitors spend on food versus gasoline versus lodging. In the future, aside from any inflationary differences, the types and amounts of things that visitors buy could change from current patterns. Changing technology, economic conditions, or preferences could result in unforeseen effects to local economies dependent on tourism associated with federal recreation resources.

User and Entrance Fee Changes

Changes in entrance or user fees charged by providers of federal recreation opportunities or concessionaires and guides operating on federal lands could change the amount of recreation visits to those resources or the patterns of spending of recreation visitors. The relationship between fees and recreation use is complex and difficult to accurately project changes. Bowker et al. (1999) reported that

95% of the public found fees or a combination of fees and taxes acceptable to fund recreation opportunities on public lands. Further, fees can be a relatively insignificant share of trip costs for some types of trips. Nonetheless, changes in fees to recreate at federal sites could change future recreation activity participation beyond the projected levels noted in this report. There is some evidence that increased user fees are associated with reductions in recreation visits (e.g., Stevens et al. 2014, Brown et al. 2008). Conversely, a reduction in fees could lead to an increase in recreation use. However, to the extent that user fees are essential for site maintenance and improvements, reduction in fees could affect the quality of visitor experiences, which may negatively affect participation. Unanticipated changes in recreation visits because of fee changes could lead to economic effects to local communities that differ from the reported projections.

Aside from entrance or access fee changes, changes in the rates charged by concessionaires (e.g., increased lift ticket fees or guide fees) could also affect recreation visit numbers (and the magnitude of future recreation visitor spending) or the patterns of recreation visitor spending. Differential changes in concessionaire fees could lead to substitution between activities or displacement to other sites for the same activities. Ultimately, however, the outcomes from changes in concessionaire fees are difficult to predict. In many cases, the recreation experience or novel recreation opportunity may be great enough to overwhelm the effect of minor increases in concessionaire fees.

Transportation Costs

Future unforeseen cost increases for transportation fuels could result in recreation participation patterns that differ from those discussed here. Fuel constitutes a primary expense for visitors on recreation trips and increased transportation costs can greatly increase overall trip costs. With increased transportation expenses, individuals may complete fewer recreation trips or complete trips that are closer to home and require less transportation expense. There is some indication of this behavior by recreation visitors during fuel price increases experienced in the early 2000s (Cho et al. 2014, Stevens et al. 2014). A reduction in the number of recreation trips would likely reduce the overall amount of visitor spending injected in communities surrounding federal lands. Visitors spend more when they take recreation trips that are away from their local home area. Further, communities that can attract visitors who have traveled from outside the local area achieve the greatest positive economic effect. Increased fuel cost could reduce the economic effects to federal recreation communities as recreationists change their trip behavior and travel shorter distances from home and less often leave their local areas. Conversely, changes in transportation technology, such as increased availability of electric/hybrid vehicles, could have a counter effect.

Climate Change

For most activities, population increases and economic improvements are projected to yield increases in participant numbers that mute any negative effects of a changing climate. At the national level, most future recreation participation numbers are projected to continue to grow even after taking into account future climate. However, the anticipated climate changes vary across U.S. regions and there will likely be variation in the regional effects on recreation from climate change. Because of regional variation in the effects of climate change, there will likely be some regions that experience positive responses in recreation participation because of changing climate. Such positive changes might come about, for example if shoulder seasons become longer, thereby increasing opportunities for activities such as camping and off-road vehicle use. At the same time, there will likely be other regions that experience deleterious effects from climate change that are more severe than (or altogether opposite of) that

experienced elsewhere. For instance, we project that developed skiing participation will remain steady to increasing nationally under anticipated future climates. However, regions that are unable to maintain artificial snow production or that experience increased rain on snow or high overnight low temperatures may see significant declines in developed skiing because of poor snow conditions. This may be even more of a concern for more localized winter activities like snowmobiling and undeveloped skiing. Ultimately, for some activities, regional participation in outdoor recreation under a climate changed environment may differ from the overall national pattern. Some regions will likely experience gains while others will experience losses.

Capacity of Recreation Resources and Community Congestion

There are constraints in the amount of recreation use that federal resources can accommodate with current infrastructure. For example, there are only so many camping sites at existing campgrounds, trailhead parking lots can provide access to a set number of vehicles, and some trails already have limited, permit only, access. It is uncertain whether existing federal facilities and lands will be able to provide expanded opportunities for all the future increases in recreation. Limitations in the capacities of federal opportunities may limit the extent to which federal resources capture expected future increases in recreation participation. If future users are unable to access federal opportunities (perhaps because campgrounds are full or permits cannot be obtained), potential participants may choose not to recreate, choose alternative activities where capacity is not an issue, or use substitute sites provided by other governmental or private providers.

Large increases in recreation participation days may bring large numbers of visitors into local communities around federal recreation resources. Although initial increases may bring about positive economic gains, significant expansions in the numbers of tourists in towns can also bring about a number of negative effects. Traffic congestion, wear to roads and infrastructure, increased costs for public safety, and noise and air pollution are just some of the costs that can accrue to communities because of high rates of tourism. Increased recreation participation may lead to gains to some local businesses but those gains may be overwhelmed by costs to the broader community.

Economic Dependence of Local Communities

Some communities located around federal recreation lands have a high dependence on economic inputs from recreation spending and natural amenity economic inputs. Although strong connections between communities and federal recreation often lead to positive economic outcomes, high economic dependence on a single economic sector can leave a community vulnerable to changes in economic conditions. In the case of recreation, communities with a high dependence on recreation visitor spending may experience negative economic conditions if participation numbers decline or visitor spending patterns change significantly in the future.

Other Economic Outcomes from Federal Recreation Resources

Federal recreation lands also can provide positive economic outcomes for communities in a number of ways beyond attracting recreation visitors and promoting their spending. Commonly noted positive economic effects include aesthetic benefits that attract new residents and businesses to communities, contributions to improved health of rural populations, and the provision of scenic landscapes that serve as backdrops to those passing nearby. Several of these outcomes are briefly described below.

Amenity Migration

The populations and numbers of homes in communities around federal lands have been increasing more rapidly relative to other similar communities. The presence of large expanses of undeveloped, aesthetically-pleasing views and opportunities for recreation has led to high levels of amenity migration to many communities around federal lands (Stein et al. 2007, McGranahan et al. 2011, Radeloff et al. 2010). In-migration of new residents and expansion in local housing stock can lead to increased tax base for local governments, increased demand from the financial, real-estate, and construction sectors of local economies, and expansion in the service and retail businesses (e.g., restaurants and bars, stores, and entertainment). Although amenity migration can be traced in part to recreation opportunities, the economic effects of amenity migration on local economies and tax bases is additional to that reported in studies of the economic effects of visitor spending.

Business Relocation

In addition to attracting new residents, the presence of appealing landscapes and the natural resource amenities of federal lands can encourage business to relocate to communities adjacent to federal lands. Businesses, especially those not tied to location-dependent manufacturing inputs, have relocated to areas that offer desirable amenities to potential employees. Relocation of businesses in particular industries (e.g., technology) can lead to further relocation of related businesses and the creation of business hubs—agglomerations of related businesses. In addition to business relocation, the appeal of some locales as convention destinations (and the success of convention-related businesses) can be credited in at least some part to the presence of amenity-rich federal resources. The role of federal lands in making convention destinations attractive has not been studied.

Health Benefits

With increasing rates of obesity, poor cardiovascular health, diabetes, and stress, positive economic effects can accrue to individuals and communities who take advantage of recreation opportunities on federal lands to pursue activities that can contribute to health. Urban residents often find places for rest, relaxation, and exercise at local- and county-government parks. Often lacking those sorts of recreation resources, in rural communities, federal recreation resources may substitute for local government recreation resources. Across the U.S., people living in the vicinity of FS land—many of them in rural locations—are estimated to burn about 146 billion calories annually while using FS recreation resources (Kline et al., 2011). With increased attention to healthcare costs, the role of federal recreation resources in contributing to improved individual and community health and well-being deserves more attention.

Recreation Backdrops

In addition to providing places for people to recreate, federal lands can provide the backdrop for recreation outings that never involve a formal visit to federal lands. For example, a tourist to Alaska might take a cruise or a ferry through the Inland Passage and view the Tongass National Forest but never step foot on federal lands. Likewise, a visitor to Las Vegas might take a helicopter ride over Grand Canyon National Park to view natural features but may never enter the Park. In typical studies of the economic impact of federal recreation opportunities, the spending of those individuals is not counted. Although the spending of these visitors is excluded from official estimates, and not considered here, the

spending of those who view federal recreation resources also generates positive economic effects in local communities.

Summary and Conclusions

Public lands are crucial resources for nature-based outdoor recreation. Assuming the public land base for outdoor recreation remains stable into the future; an increasing population will result in decreasing per-person opportunities for recreation across most of the United States. Although there are many other factors involved in recreation supply, it is likely that recreation resources will become less available and perhaps less desirable, as more people compete to use them. A major challenge for public natural resource managers and planners will be to ensure that recreation opportunities remain viable and adapt to a changing population. This could be accomplished through more creative and efficient management of existing federal recreation resources.

Choices in outdoor recreation activities have changed over time in response to changing preferences, demographics, and recreation opportunities. Overall, participation in nature-based outdoor recreation has grown in the last decade, continuing a long-term trend. At the same time, recreation visitation to State parks and Federal lands has not increased at similar rates (Walls et al. 2009), indicating that recreationists are increasing their use of other lands. The change in recreation preferences at least partly reflects changing demographics in the American public. As the population ages and becomes more racially and ethnically diverse, it is unclear whether current recreation opportunities will meet future needs.

Given the growing diversity of the American population, and despite studies which have found increasing acculturation related to natural resource-based recreation (Johnson et al. 2005), the relatively low participation rates of all groups except non-Hispanic Whites may signal a shift in overall future recreation participation. The aging population may require different types of recreation opportunities. Recreation activities that have been dominated by rural residents are also likely to decline, as the American population becomes increasingly more urban. Understanding the constraints on recreation participation of various groups could improve the ability of recreation providers to deliver recreation opportunities to underserved groups. Social factors such as time, money, lack of transportation, lack of facilities, lack of information, crowding at sites, poorly maintained facilities, and pollution are constraints felt by potential recreationists.

Based on the available data, future growth is projected for most recreation activities between 2008 and 2030. The five outdoor recreation activities projected to have the highest percentage growth in total days of participation are developed skiing, visiting interpretive sites, day hiking, birding, and equestrian. In contrast, the five activities expected to grow the least are hunting, motorized snow activities, motorized off-road use, floating, and fishing. Several of the activities with high projected growth, such as downhill skiing and equestrian activities, tend to require substantial financial commitments. This factor partially explains the low current participation rates and may limit growth in participant numbers and days depending on the distribution of future income growth. Projected population growth is high enough that the total number of participants and the total number of days for most activities are projected to increase regardless of the direction of the trends in participation rates or days per participant.

Climate can affect individual willingness to participate in recreation activities and/or affect recreation resource availability and quality. The climate variables used in the recreation projection models were limited to those coming directly from the 2010 RPA Assessment climate projections, or variables derived from those basic variables. Generally, the climate variables used in these recreation models were presumed to affect willingness to participate and frequency of participation directly. Despite the lack of existing data, it is reasonable to expect that climate change will affect resource availability. For example, in the case of hunting and fishing, increasing temperatures will likely affect the distribution of plant and animal species that are fundamental to maintaining fish and game populations. Moreover, changes in precipitation may influence local snow cover and thus affect seasonal availability for activities like snowmobiling and undeveloped skiing. Disentangling the effects of the climate variables on recreation participation is difficult. Further exploration of these direct and indirect relationships at different scales will be fundamental to improving forecasts of recreation behavior in the future.

The magnitude of business activity in local communities associated with outdoor recreation on federal lands results from the combination of: 1) people recreating on federal recreation lands, 2) the presence of businesses where visitors can spend money, and 3) the trip spending of those recreation visitors. Communities best able to capitalize from recreation visitor spending offer services and goods that cater to those engaged in outdoor recreation. Communities that have attractive combinations of lodging, restaurants/bars, and entertainment will see more spending from recreation visitors. Resource managers and policy-makers can help facilitate positive economic outcomes in local communities by providing recreation opportunities that are consistent with activities that tend to involve overnight stays or long distance travel, like skiing, developed site recreation, and water use. Providing ‘bundled’ recreation sites or groups of interpretive sites that make it easy for visitors to engage in longer periods of recreation by visiting multiple sites in one area can promote longer stays, and thus, more opportunities to spend money in the community.

Studies specific to recreation on federal lands indicate that visitors spend at least \$51 billion in the local economies around the federal destination. Anticipated future increased participation in general recreation activities like hiking, viewing nature, and visiting developed sites will likely have positive economic effects on the numerous communities located around federal lands. Projected increases in more specialized recreation activities, like developed skiing, motorized vehicle use, and motorized water use, will likely lead to increased economic activity in communities located near those specialized places where visitors can engage in those types of activities.

Racial and ethnic diversity and the age of the U.S. population may alter future participation patterns for some recreation activities. However, generalist activities like hiking, viewing nature, and visiting developed recreation and historic sites remain popular with all population subgroups. Recreation sites that can provide recreation opportunities supporting those types of activities, and local communities around those sites, are in a position to see continued high levels of recreation use. Those engaged in winter recreation have the highest spending of any visitor group. Developed skiing remains popular with people from diverse racial and ethnic backgrounds, especially among young people. Developed skiing is expected to remain a popular recreation activity—and local economic driver—even in the context of an increasingly diverse population.

A changing climate may alter future recreation participation and lead to change in the amount and distribution of money spent in local communities. Expected future climate conditions may lead to lower participation in motorized snow activities and undeveloped skiing. Recreationists engaged in those activities have some of the highest trip expenditures of any federal lands recreationists. Thus, large

reductions in the numbers of participant days in those activities would likely lead to reductions in the economic activity in communities dependent on those recreationists.

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EXHIBIT 4

METAPOPULATION STRUCTURE OF BULL TROUT: INFLUENCES OF PHYSICAL, BIOTIC, AND GEOMETRICAL LANDSCAPE CHARACTERISTICS

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Abstract. Metapopulation structure of species in fragmented landscapes is ultimately the result of spatial variability in demographic processes. While specific information on demographic parameters is desirable, a more practical approach to studying metapopulations in fragmented landscapes may begin with analyses of species' occurrence in relation to large-scale habitat variability. Here, we analyzed occurrence of stream-living bull trout (*Salvelinus confluentus*) in relation to physical, biotic, and geometrical characteristics of habitats. Bull trout occurrence was analyzed at several spatial (10^x m) scales. Data were from nested sampling of 720 sites (10 m), 179 reaches (10^2 m), and 81 patches ($\geq 10^3$ m) of stream habitats within the Boise River basin of central Idaho. Based on previous findings, patches were defined as stream catchments with suitable conditions for spawning and rearing of bull trout (>1600 m elevation). Patch-scale bull trout occurrence was significantly related to patch area and isolation (stream distance between occupied patches). Lack of spatial autocorrelation between patches indicated that isolation effects were more likely the result of limited interaction among habitats (such as dispersal), rather than of correlated environmental conditions. A third factor, human disturbance in the form of roads, was associated with reduced bull trout occurrence at the patch-scale. Analyses of occurrence among reaches within occupied patches showed bull trout may select larger (>2 m width) stream habitats. Occurrence of bull trout was not associated with nonnative brook trout (*Salvelinus fontinalis*) at large (patch), intermediate (reach), or small (site) spatial scales. Definition of a metapopulation structure for bull trout in the Boise River basin was complicated by uncertainties in the frequency and magnitude of dispersal. From the distribution of patch sizes and isolation among occupied patches, we suggest that the metapopulation is a complex mosaic of several elements found in conceptual models. This complexity poses a challenge to empirical and theoretical attempts to study stream-living bull trout. Future work to define the structure of bull trout metapopulations must relate temporal and spatial patterns of patch occupancy with complex patterns of dispersal that likely interact with habitat spatial structure, life history variability, and the historical context of regional climate changes. Results of this work suggest that conservation of bull trout should involve protection of larger, less isolated, and less disturbed (as indexed by road densities) habitats that may serve as important refugia or sources of recolonization. Bull trout populations in smaller, isolated, and more disturbed habitats may be at risk of extinction. Finally, metapopulation structure implies the existence of suitable, but presently unoccupied habitat, which should be managed carefully to facilitate potential natural recolonization or reintroductions of bull trout.

Key words: bull trout; extinction risk; habitat fragmentation; incidence functions; landscape ecology; metapopulations; *Salvelinus*; stream ecology.

INTRODUCTION

Natural landscapes are mosaics of habitats affected by a variety of physical and biotic processes that operate on different spatial and temporal scales (Hansson et al. 1995, Wu and Loucks 1995, Collins and Glenn 1997). Accordingly, the distribution of organisms is rarely homogeneous across landscapes, and populations may be subdivided or patchy (Karieva 1990). Due to extinction of local populations and/or movements of

animals across landscapes, not all suitable habitat patches will be occupied at any single point in time. Populations with these characteristics are typically described as metapopulations (Hanski and Gilpin 1996). Patterns of habitat (patch) occupancy in metapopulations are ultimately the result of spatial variation in demographic processes, namely rates of natality, mortality, immigration, and emigration (Pulliam 1988). Estimates of these population parameters are difficult to obtain (Ims 1995, Ims and Yoccoz 1996), and typically available for only one or a limited number of subpopulations, which may not represent status of the metapopulation (Middleton and Nisbet 1997). An alterna-

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tive approach to studying metapopulations is to analyze patterns of presence or absence of organisms (occurrence) in relation to landscape characteristics (Hanski 1994, Sjögren-Gulve 1994, Bolger et al. 1997). Inferences from patterns of occurrence may be subject to a variety of limitations (see Taylor 1991, Hanski et al. 1996, Sjögren-Gulve and Ray 1996), but can nonetheless provide practical insights into the structure and dynamics of metapopulations.

In this study, we investigated patterns of occurrence in stream-living bull trout (*Salvelinus confluentus*) in relation to physical, biotic, and geometrical landscape characteristics. Bull trout occupy a naturally fragmented and complex mosaic of stream habitats that may be increasingly fragmented by human-related disturbances, including introductions of nonnative fishes, habitat degradation, dams, and altered disturbance regimes (Rieman and McIntyre 1993, 1995, Rieman et al. 1997a). The large-scale geometry of fragmented landscapes is characterized by the size, shape, spatial distribution, and isolation of habitats (Fahrig and Merriam 1994). The interaction of these geometrical characteristics with life histories, local and regional environmental variability, and human disturbance is one of the central problems of landscape ecology and metapopulation dynamics (Wiens 1996). Increasingly, studies of stream-living salmonids (such as bull trout) are revealing important patterns and processes at large ($\geq 10^3$ m) spatial scales that may not be apparent at smaller spatial scales (e.g., Fausch et al. 1994, Rieman and McIntyre 1995, 1996, Keleher and Rahel 1996, Dunham and Vinyard 1997, Wiley et al. 1997).

Previously, Rieman and McIntyre (1995) analyzed bull trout occurrence in relation to large-scale habitat variability in the Boise River basin of Idaho. They found occurrence to be positively related to two measures of habitat size: stream width and patch (stream catchment) area. This suggested that habitat size may play an important role in the persistence of bull trout populations. A second geometrical feature of fragmented habitats, patch isolation, also may be important to population persistence (MacArthur and Wilson 1967, Kindvall and Ahlén 1992, Hanski et al. 1996, Sjögren-Gulve and Ray 1996). Furthermore, the effects of reduced habitat area and increased isolation may act together to increase the risk of extinction of species in fragmented landscapes (Fahrig and Merriam 1994). Here, we combined data from the original 46 habitat patches considered by Rieman and McIntyre (1995) with data from an additional 35 patches surveyed in the Boise River basin in 1993–1994 to look for evidence of such effects. Isolation was defined as stream distance separating a particular patch from the nearest occupied patch in a drainage network. Because drainage networks are linear systems, dispersal can only occur in an up- or downstream direction, a constraint that may increase vulnerability of stream-living organisms to habitat fragmentation (Zwick 1992, Rieman and

McIntyre 1995, Nakano et al. 1996, Rahel et al. 1996, Dunham et al. 1997).

Apparent influences of patch isolation may alternatively be due to spatially correlated environmental conditions within a drainage network. Accordingly, spatial proximity of habitats may lead to correlated population dynamics (Harrison and Quinn 1989), and relationships between patch isolation and occurrence may be due to spatial correlation in unmeasured habitat characteristics, rather than to dispersal alone. To distinguish these alternative explanations, we tested for spatial independence of bull trout occurrence (spatial autocorrelation) using straight-line, rather than stream distance between patches, regardless of patch occupancy (occupied or absent). Recent work on other fish has shown that spatial autocorrelation may strongly affect inferences about large-scale distributional patterns (Hinch et al. 1994, but see Rieman and McIntyre 1996).

While Rieman and McIntyre (1995) considered habitat size, and possibly isolation, to play a key role in the persistence of bull trout populations, an analysis of purely geometrical factors may not provide specific information on factors that directly govern rates of extinction and recolonization within habitat patches (Sjögren-Gulve and Ray 1996). Rieman and McIntyre (1995) considered only stream gradient as an alternative to patch size (stream width or patch area) to explain bull trout occurrence. Here, we examined patch-scale patterns of bull trout occurrence in relation to three additional factors, including occurrence of nonnative brook trout *Salvelinus fontinalis*, road density, and solar radiation.

Nonnative brook trout are frequently implicated in the decline of bull trout, impacting populations through introgressive hybridization, and possibly through interactive segregation (reviewed in Rieman and McIntyre 1993). The negative impacts of roads on salmonid habitats are well known, and include increased erosion and sedimentation of stream basins, alterations in stream channel morphology, changes in flow regimes, migration blockage, and increased human access (Furniss et al. 1991, Lee et al. 1997). Aspect and solar radiation may affect stream temperatures and bull trout, which appear to be associated with relatively cold water temperatures (Fraley and Shepard 1989, Rieman and McIntyre 1993, Rich 1996, Buchanan and Gregory 1997, Rieman et al. 1997b).

While the central focus of this study was on patch-scale patterns, we also considered relationships at smaller spatial scales. Distributional patterns of species in landscapes may be the product of several processes operating on different spatial and temporal scales (Wu and Loucks 1995). Recent work on other salmonids, for example, has clearly demonstrated the importance of considering multiple scales (cf. Fausch et al. 1994, Dunham and Vinyard 1997, Wiley et al. 1997). Our sampling design emulated previous hierarchical classifications of stream habitats (Frissell et al. 1986), and

TABLE 1. List of variables, units of measurement, and spatial scales at which variables were analyzed. See *Methods* for definition of site, stream, and patch terms.

Variable	Units	Scale
Brook and bull trout occurrence	category (0, 1)	site, reach, patch
Stream width	m	reach
Stream gradient	percent	reach
Solar radiation	GJ·m ⁻² ·y ⁻¹	patch
Road density	m/ha	patch
Patch area	ha	patch
Distance to nearest occupied patch	m	patch

covered spatial scales ranging from 10 to 10⁵ m (Table 1).

In particular, we focused on segregation between brook trout and bull trout, as previous work has emphasized the importance of scale-dependent interactions in other stream-living *Salvelinus* species (Fausch et al. 1994). We also analyzed bull trout occurrence among stream reaches within occupied patches in an attempt to resolve collinearity between stream width and patch size observed by Rieman and McIntyre (1995). We considered the influence of both stream width and gradient on bull trout occurrence among stream reaches within occupied patches.

Our primary aim in this study was to determine the status of bull trout in the Boise River basin with regard to potential factors affecting occurrence. Resulting patterns of bull trout occurrence in relation to physical, biotic, and geometrical factors were then evaluated to determine the relevance of alternative models of metapopulation structure (Harrison and Taylor 1996). In addition, the influences of potentially confounding factors (scale dependence, spatial autocorrelation, multicollinearity) were considered in the analysis. Collectively, these results were used to evaluate the efficacy

of presence-absence analyses (incidence functions) as a practical approach to studying metapopulations in complex landscapes, such as those inhabited by bull trout.

METHODS

Study areas were described in detail by Rieman and McIntyre (1995). Study areas were located in the upper Boise River basin in southwestern Idaho, which consists of three major subbasins (North Fork, Middle Fork, and South Fork), covering ~5700 km² (Fig. 1). These three subbasins were all isolated from the lower Boise River by dams constructed prior to the 1950s. Bull trout populations in the South Fork Boise River are presently isolated behind Anderson Ranch Dam, while those in the North and Middle Forks are potentially interconnected.

Bull trout exhibit a variety of life history patterns. Juveniles typically rear in natal or adjacent streams for 2–3 yr. Some fish may assume a “resident” life history, remaining in the natal or closely associated streams for life, while others may migrate to larger rivers or lakes, returning to the natal streams at maturity to spawn (Rieman and McIntyre 1993). Larger, migratory bull trout

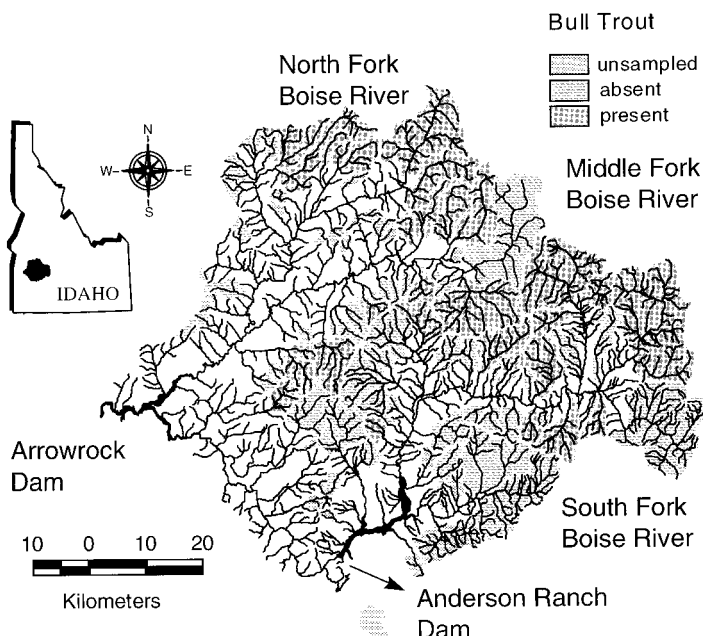


FIG. 1. Map of Boise River basin, west-central Idaho, showing outlines of 104 habitat patches (stream catchments) within the basin. Shading indicates patches occupied (present) or unoccupied (absent) by juvenile bull trout, and unsampled patches.

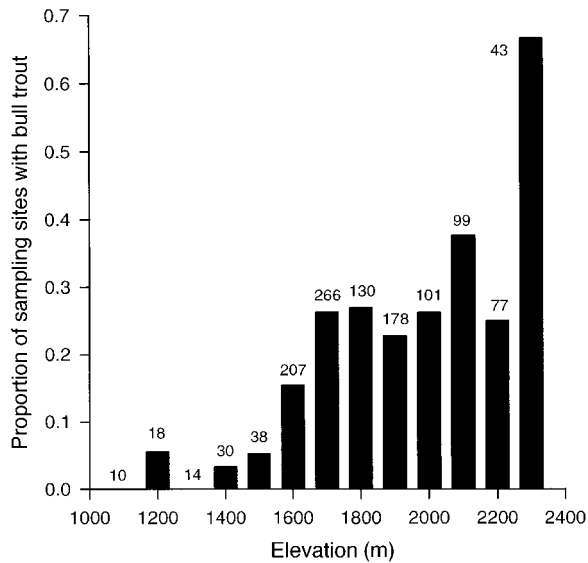


FIG. 2. Occurrence of small (<150 mm) bull trout from 1045 sample sites distributed across a gradient of stream size and elevation in 18 streams (including and surrounding the Boise basin) that were known to support extant bull trout populations. Numbers over bars indicate number of samples in each bin. Data include those reported in Rieman and McIntyre (1995: their Fig. 2) and additional observations from studies conducted by the U.S. Forest Service Rocky Mountain Research Station, Boise, Idaho, and are independent of the work reported in this paper.

may occur throughout the Boise River basin and similar systems (Rieman et al. 1997a, Swanberg 1997). Our observations of juvenile fish, however, suggest spawning and initial rearing occur almost exclusively in higher elevation headwater streams (Fig. 2; also see Rieman and McIntyre 1993, Swanberg 1997). Bull trout distributions and densities have been consistently linked with colder waters than those of other salmonids (Rieman and McIntyre 1993, Buchanan and Gregory 1997), so this pattern is presumably a result of a temperature constraint or preference (Rieman and McIntyre 1995). Other details of bull trout life history can be found in Pratt (1992), and Rieman and McIntyre (1993).

Habitat selection by salmonid fishes may be reinforced through strong breeding-site fidelity (homing, Dittman and Quinn 1996), and, consequently, local breeding populations of stream-living salmonids are best defined on the basis of the distribution of smaller, presumably "premigratory" or resident individuals (Allendorf and Waples 1995, Rieman and McIntyre 1995). Migratory or large resident bull trout adults may use habitats well outside of areas used for spawning and initial rearing (Pratt 1992, Rieman and McIntyre 1993, Swanberg 1997). These larger fish and the habitats they use may be important in terms of among-patch dispersal and other life history characteristics, but patch structure must be defined according to the condition that constrains the reproductive portion of the life cycle (Haila et al. 1993, Hanski 1996). For bull

trout, this is represented by headwater stream networks (Rieman and McIntyre 1995). Recent work with similar bull trout populations has confirmed genetic structuring among tributary populations at this scale (P. Spruell and F. W. Allendorf, *unpublished data*). Based on observed distributions of juvenile bull trout (<150 mm), Rieman and McIntyre (1995) defined habitat patches as the stream catchments above 1600 m elevation and with an accessible perennial stream. Watersheds <400 ha were not included in the analysis because they rarely supported perennial streams large enough to support fish. We retained that definition for this analysis and identified a total of 104 potential habitat patches throughout the basin (Fig. 1).

Sampling of stream habitats and fish occurrence followed methods in Rieman and McIntyre (1995). Fish sampling intensity was evenly distributed among all habitat patches and involved electrofishing or snorkeling (Rieman and McIntyre 1995). To determine occurrence within patches, sampling was conducted in one to three reaches of the main stem of each patch. The term "main stem" refers to the largest perennial stream draining a patch. Each reach was ~0.5 km in length and contained five sample sites, each 30 m in length. Sampling continued until bull trout were detected, or when three reaches, located in the lower, middle, and upper portions of the main stem were sampled, unless the middle or upper portions of the streams clearly had become too small to support fish.

Assuming a minimum detection efficiency of 0.25 for each site, a Poisson sampling distribution, and minimum density of 15 fish/km in a 10-km stream, Rieman and McIntyre (1995) estimated a minimum detection efficiency of 0.82 for cases where all three reaches were sampled. Recent comparisons of day and night snorkeling to electrofishing estimates of bull trout abundance in a nearby stream suggest minimum detection efficiencies were actually much higher (Thurow and Schill 1996). Accordingly, detection efficiencies in this study may be much larger than 0.82, but it is possible that some "false absences" were recorded during surveys (e.g., Reed 1996). We assumed most false absences, if present at all, were likely due to very small population sizes. Such small populations are likely to be at high risk of extinction, and therefore destined to become bona fide absences in the near future (Lande 1993).

To consider factors that may influence bull trout distributions at finer scales, we sampled additional sites and reaches in tributary streams within occupied patches. Reaches in tributaries were at least 500 m above the mouth of the stream, but because of problems with access they were not randomly or systematically distributed across the accessible length of a stream. Sites (30 m) represented the smallest spatial scale (10¹ m), reaches (0.5 km) represented an intermediate spatial scale (10² m), and patches represented the largest spatial scales (≥10³ m) for the subsequent analysis. This

sampling strategy emulated hierarchical classification of stream habitats (e.g., Frissell et al. 1986), and permitted an analysis of processes occurring at different spatial scales. A total of 81 of 104 potential patches (Fig. 1), 179 reaches, and 720 sites were sampled for occurrence of bull trout.

Fish occurrence, stream width, and gradient were measured following Rieman and McIntyre (1995). Briefly, brook trout and bull trout were considered present in a patch, reach, or site if any individuals were observed in the relevant samples. Wetted widths were taken at a random point for each site and averaged for a reach. Because sampling occurred during late summer, widths approximated base flow conditions. Stream gradients were measured at each site with a clinometer and averaged for a reach. Patches were identified as the catchments above 1600 m and delineated from U.S. Geological Survey 30 m Digital Elevation Models (DEM) using ARC/INFO GRID 1 extension. An estimate of annual solar radiation was assigned to each 30-m grid cell in each patch based on the slope and aspect of the cell and approximated annual solar radiation for 63 slope-aspect classes from Buffo et al. (1972). The estimates for each cell were averaged for the patch. Road densities were calculated as the total length of all forest system roads within a patch divided by patch area. Digitized road coverages were provided by the Boise National Forest, Boise, Idaho.

Interpatch distances were calculated as the minimum distance between patches along the network of streams connecting those patches, using the ARC/INFO NETWORK extension and the U.S. Geological Survey 1:24 000 digitized hydrography. Interpatch distances were calculated only where the connecting stream corridors were not blocked by dams or natural barriers to fish dispersal. We considered distance to nearest occupied patch as a measure of patch isolation (Table 1). Factors other than linear stream distance (e.g., isolation due to other biotic or physical barriers) were not considered in the analysis. Isolation may be indirectly related to environmental factors that could affect migratory behavior, such as proximity to downstream feeding habitats (e.g., large rivers, lakes, reservoirs). Habitats in areas with a greater probability of supporting migratory individuals may be more likely to support bull trout for at least two reasons. First, migratory individuals generally are larger, and therefore may have greater reproductive potential. Second, migratory individuals use areas outside of spawning and rearing habitat, therefore reducing the chance that disturbance to such habitats will extirpate all individuals in a breeding population ("risk-spreading" in space, den Boer 1968). Because little is known in general about life history variability in bull trout and relations to dispersal behavior, we considered only the simplest measure of patch isolation (Table 1). Another issue with our measure of isolation concerns the potential effects of dams in the Boise basin. A major dam prevents bull trout

movement between formerly connected habitats in the South Fork Boise River from other habitats in the Boise basin. We did not consider such long-distance dispersal in this study, and the dam had no influence when distance to nearest occupied patch was considered (see Fig. 1).

Data analyses began with patterns of patch-scale bull trout occurrence (Table 1). All data analyses used logistic regression (Hosmer and Lemeshow 1989, SAS Institute 1995). Best subsets logistic regression (SAS Institute 1995) was initially used to screen the five patch-scale predictors (Table 1). Logistic regression analysis, in contrast to other methods (e.g., discriminant function analysis, ordinary least-squares regression), is considerably more flexible in terms of model assumptions, such as the assumption of a linear relationship between response and predictor variables, normality, and equal variance among groups. If, however, these conditions are satisfied, the power of logistic regression to detect relationships may be increased (Tabachnick and Fidell 1996). Log₁₀ transformations of patch area, interpatch-patch distances, and solar radiation, and an inverse transformation of road density, resulted in the best fitting model (using the score statistic, Hosmer and Lemeshow 1989, SAS Institute 1995). Unless otherwise specified, all further references to these variables refer to transformed values. Jackknifed classification rates from logistic regression models were calculated using SAS (SAS Institute 1995).

Multicollinearity among predictor variables was first addressed by evaluating pairwise correlations. A second, common multicollinearity diagnostic, the variance inflation factor (VIF), was estimated by regressing each predictor variable in relation to others in the model. Variance inflation factors estimate how much the variances of regression coefficients are inflated relative to the case when predictor variables are not linearly related (orthogonality). The VIF for each variable was calculated as $1/(1 - R^2)$, where R^2 is the coefficient of determination from ordinary least-squares regression of a predictor variable in relation to all other predictors in the model (Phillipi 1994). Variance inflation factors of 10 or greater were considered to indicate problems with multicollinearity (see Phillipi 1994). Finally, we evaluated the possible influence of collinearity by checking the sensitivity of parameter estimates from logistic regressions to removal of each predictor variable (Hosmer and Lemeshow 1989).

Spatial autocorrelation in patch-scale occurrence of bull trout was examined with Mantel tests (Fortin and Gurevitch 1994). The Mantel test is used to test for associations between pairwise distance matrices (Manly 1997). We used Mantel tests to look for associations between pairwise distances between patches and bull trout occurrence. Pairwise distances between patches were estimated from Universal Transverse Mercator (UTM) map projections. Euclidean distances between

TABLE 2. Results of variable selection with best subsets logistic regression of patch-scale bull trout occurrence.

Number of variables	Score value	Variables included in model
1	14.83	patch area
1	14.17	stream distance to nearest occupied patch
2	28.07	patch area, stream distance to nearest occupied patch
2	23.75	patch area, road density
3	30.95	patch area, stream distance to nearest occupied patch, road density
3	28.70	patch area, stream distance to nearest occupied patch, solar radiation
4	32.24	patch area, stream distance to nearest occupied patch, road density, solar radiation
4	30.95	patch area, stream distance to nearest occupied patch, road density, brook trout
5	32.31	all patch-scale predictors (see Table 1)

all pairs of patches were calculated with X–Y coordinates determined as eastings and northings, respectively, measured in meters. Both linear and inverse Euclidean distances were used in Mantel tests of spatial autocorrelation. Values in the pairwise matrix of bull trout occurrences were coded as zeros when both patches shared the same state (e.g., both habitats were either occupied or not occupied), and as ones when they were in different states (e.g., occupied vs. not occupied). This coding was similar to design matrices used by Fortin and Gurevitch (1994).

Mantel tests were conducted with the “R” package for spatial analysis (Legendre and Vaudor 1991). The Mantel Z statistic was normalized (r) so that r values varied between -1 and 1 , similar to the familiar values of Pearson’s linear correlation coefficient (Fortin and Gurevitch 1994). The significance of r values was evaluated with a reference distribution of r values created by Mantel tests on 9999 randomizations of matrix elements, which also contained the original r value for a total of 10 000 observations (see Jackson and Somers 1989, Manly 1997).

Finally, covariation between bull trout occurrence and selected variables was analyzed at smaller spatial scales with logistic regression. Stream width and gra-

dient were analyzed in relation to variability in bull trout occurrence among stream reaches within occupied patches only. Restricting the analysis of stream width and gradient to reaches within patches was necessary to distinguish width (and potentially gradient) effects due to habitat selection by bull trout, as hypothesized by Rieman and McIntyre (1995). Previous analyses could not distinguish patch-scale stream width and patch-area effects due to collinearity (Rieman and McIntyre 1995).

Because results of the patch-scale analysis strongly suggested that bull trout may not have free access to stream habitats in unoccupied patches, due in part to patch isolation, we restricted the analysis of stream width and gradient effects to variability among stream reaches within occupied patches. Similarly, co-occurrence of bull trout and brook trout was analyzed among stream reaches and sites within patches occupied by bull trout (brook trout effects were not significant at the patch scale, where all potential patches were analyzed). Segregation between potentially interacting species may be more apparent at smaller spatial scales, especially for stream-living salmonids, which typically defend holding positions within streams, while larger scale patterns may result from large-scale variability in abiotic factors (Fausch et al. 1994).

RESULTS

Patch-scale analyses

In all, 81 patches were used in patch-scale analyses of bull trout occurrence. Bull trout were present in 29 patches and absent in 52. Based on the score criterion (Hosmer and Lemeshow 1989), a logistic regression model of bull trout occurrence with four predictors (patch area, distance to nearest occupied patch, road density, and solar radiation) was selected as the best subset (Table 2). Logistic regression analyses of the four-variable model revealed a highly significant and positive relationship between bull trout occurrence and patch area, and inverse relationships with distance to nearest occupied patch and road density (Table 3, Fig. 3). Solar radiation was not significant ($P = 0.16$) and was dropped from the model. Pairwise interactions were tested among all significant predictors and none were detected. The resulting model (Table 3) correctly

TABLE 3. Results of logistic regressions of patch-scale bull trout occurrence (transformed predictors, see *Methods*). Values in parentheses are lower and upper 95% confidence limits for parameter estimates.

Variable	df	Parameter estimate	SE	Wald chi-square	P
Intercept	1	-3.2	3.49	0.84	NS
Patch area	1	1.26 (0.61, 2.05)	0.36	12.05	0.0005
Distance to nearest occupied patch	1	-0.84 (-1.48, -0.30)	0.30	8.10	0.004
Road density†	1	1.59 (0.07, 3.19)	0.79	4.10	0.04

† Note that the sign of the slope parameter estimate for road density is for an inverse transformation, and thus the sign is reversed from that expected with untransformed data.

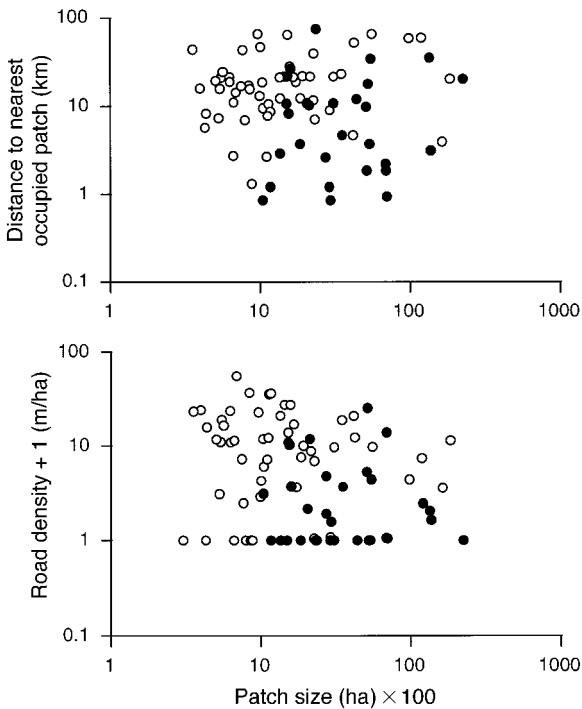


FIG. 3. Relationships between bull trout occurrence (solid circles = present, open circles = absent) and patch size, distance to nearest occupied patch (top), and road density (bottom). An $X + 1$ transformation was necessary to display road density values of zero.

predicted >80% of bull trout occurrences at the 0.50 probability cutoff.

Multicollinearity.—A highly significant correlation between distance to nearest occupied patch and road density was apparent ($r = -0.41$, $P = 0.0002$). The potential influence of this collinearity on variance inflation and regression coefficients was therefore evaluated in more detail. Regressions of the predictor variables in Table 2 (results not shown) indicated that none of corresponding VIF values was >1.25 , while the average VIF of all variables was 1.16. This value indicates that multicollinearity is of little concern (Phillipi

TABLE 4. Results of logistic regressions of bull trout occurrence to evaluate the potential influence of multicollinearity. See *Results* for details.

Variable	df	Parameter estimate	SE	Wald chi-square	P
a) Model without distance to nearest occupied patch					
Intercept	1	-10.58	2.57	17.00	0.0001
Patch area	1	1.18	0.318	13.67	0.0002
Road density	1	2.27	0.71	10.08	0.0015
b) Model without road density					
Intercept	1	-0.75	3.18	0.06	0.81
Patch area	1	1.27	0.35	13.05	0.0003
Distance to nearest occupied patch	1	-1.04	0.29	12.86	0.0003

TABLE 5. Mantel matrix correlations of bull trout occurrence in relation to two measures of interpatch distance. Probabilities are for a one-tailed test (to test alternative hypothesis that geographically proximate sites are more similar).

Distance	r	P
Euclidean	0.30	0.12
Inverse Euclidean	-0.29	0.15

1994). Separate logistic regressions of bull trout occurrence with and without road density and distance to nearest occupied patch were conducted to test if the inclusion (or exclusion) of either in the model affected parameter estimates (see Hosmer and Lemeshow 1989). From the results in Table 4, it can be seen that point estimates of regression slopes do change to a small degree. Confidence limits for regression slopes (Table 3) indicate that these changes are of little significance, however.

Spatial autocorrelation.—Mantel tests with Euclidean and inverse Euclidean measures of pairwise geographic distances indicated that bull trout occurrence was not spatially autocorrelated among patches (Table 5). A plot of bull trout occurrence in relation to geographic distances similarly showed no obvious spatial patterns (Fig. 4).

Analyses at finer spatial scales

Logistic regression indicated bull trout occurrence among stream reaches within occupied patches ($n = 72$) was positively related to stream width (Wald $X^2 = 6.09$, $P = 0.01$). Occurrence of bull trout in stream reaches was not related to stream gradient. Logistic regression of bull trout occurrence in relation to occurrence of brook trout revealed no significant associations at patch, stream, or site scales.

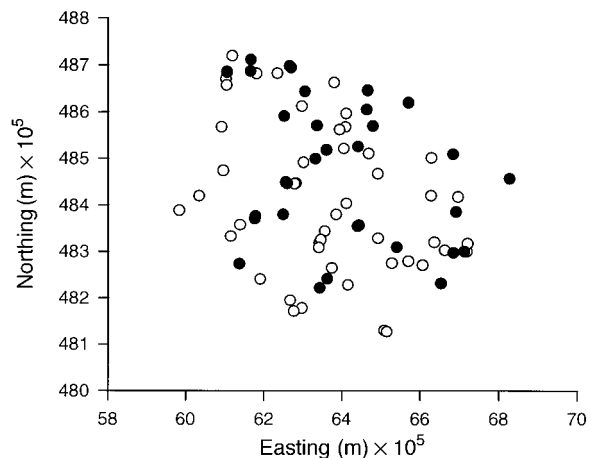


FIG. 4. Scatterplot of geographic coordinates (eastings and northings, in meters), and bull trout occurrence (solid circles = present, open circles = absent) in the Boise River basin.

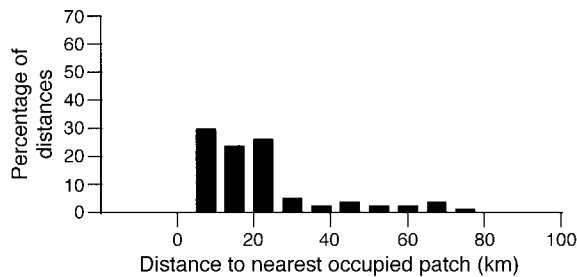


FIG. 5. Distribution of distances to nearest occupied patch for 81 patches of potentially occupied bull trout habitat in the Boise River basin.

DISCUSSION

Results of this study confirm earlier findings (Rieman and McIntyre 1995) that habitat size may play an important role in the patch-scale persistence of stream-living bull trout populations. It also appears that patch-scale persistence may depend on habitat connectivity and human disturbance in the form of road density. Within occupied patches, bull trout were found to select wider stream habitats, but gradient and occurrence of nonnative brook trout did not explain bull trout occurrence.

Factors affecting patch-scale persistence of bull trout

Habitat size may be positively related to local population persistence for at least two reasons. First, larger habitats may support larger populations. Larger populations should be less vulnerable to extinction due to stochastic demographic factors, and may be less vulnerable to the effects of environmental variability and catastrophes (Lande 1993). The effects of environmental variability and catastrophes on population persistence may interact with habitat complexity, which may be greater in larger stream habitats (Frissell et al. 1986, Schlosser 1987). In large habitats, localized disturbances are less likely to affect all segments of a population, thus reducing the chance that all individuals will be killed or displaced by a single event (Harrison and Quinn 1989). Effects of physical disturbance in stream basins may be very localized (Resh et al. 1988, Reeves et al. 1995, Schlosser 1995, Rieman et al. 1997a), and thus populations in larger and more complex stream basins may be more resistant to local extinction. It is possible that habitat size may increase population vulnerability, by facilitating occurrence of predators (Sjögren-Gulve 1994), for example, or by intensifying intraspecific competition when resources are concentrated around habitat edges (Pearman 1993). Such does not appear to be the case for bull trout in this study, however.

The significant relationship between distance to nearest occupied patch and bull trout occurrence suggests dispersal also may be important to local population persistence (Fig. 5). The potential for spatial

autocorrelation due to unmeasured environmental characteristics was examined but rejected as a likely alternative explanation to dispersal. Some bull trout have been shown to move over relatively long (>50 km) distances in streams (Bjornn and Mallet 1964, Swanberg 1997). Larger (>150 mm) individuals may undergo extensive seasonal feeding and spawning migrations within stream basins (Swanberg 1997), but juveniles and resident individuals may be restricted in their movements (Rieman and McIntyre 1993). Some bull trout may easily move the distances separating local populations in the Boise River basin. We know little, however, about the actual rates of dispersal (or "straying" of reproducing adults from natal habitats) necessary to link those populations demographically. It is reasonable to assume that such dispersal is more likely among populations that are closer together, and that it is more likely in populations with migratory life history patterns than in those that are strictly resident. The relationship between dispersal and migration of small bull trout in relation to life history variability is a critical area of uncertainty (see *Implications for metapopulation structure*).

We found that bull trout occurrence was negatively related to density of roads within stream basins. Roads increase human access to streams, which may facilitate increased angling mortality and introductions of non-native salmonids (Furniss et al. 1991, Lee et al. 1997). Erosion and sedimentation caused by roads may lead to stream channel instability and habitat degradation that may increase vulnerability of bull trout as well (Rieman and McIntyre 1993). Details of road location, construction methods, and variability in local geology and hydrologic regimes may all affect the impact of roads on salmonid habitats (Furniss et al. 1991), which may lead to greater variability in the response of bull trout populations. Roads also are related to other human land uses, such as mining, timber harvest, and livestock grazing, which may affect the quality of salmonid habitat (see papers in Meehan 1991). In spite of these potential sources of variability, the significant association of roads with distribution of bull trout in the Boise River basin and across the region (Rieman et al. 1997b, Baxter et al. *in press*) suggests that the negative effects of road-related impacts may be pervasive.

Implications for metapopulation structure

Relationships between variability in patch quality (e.g., size, carrying capacity, and productivity), patch spacing, and dispersal are the key elements determining the structure and dynamics of metapopulations (Hanski and Simberloff 1996, Harrison and Taylor 1996, Fig. 6). Patch size (area) was the single most important factor determining bull trout occurrence in this study, and variability in patch area is large (Fig. 7). Patterns of occurrence for Boise River bull trout are not consistent with the simple metapopulation structure envisioned by Levins-type models (Harrison and Taylor

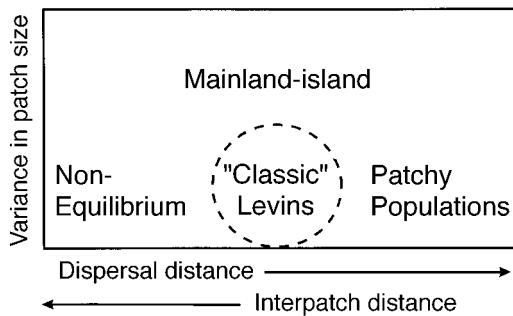


FIG. 6. Metapopulation structure in relation to variance in patch size, dispersal distance, and interpatch distance (modified from Harrison and Taylor [1996]). See *Methods* for definition of terms.

1996). Resolution of where bull trout metapopulations in the Boise River basin may lie along other parts of the continuum of potential configurations (Fig. 6) is restricted by lack of direct information on rates of dispersal and local extinction.

If we assume that long-distance dispersal is frequent, and that local extinctions are more likely to occur in smaller habitat patches, then we may reasonably conclude that Boise River bull trout lie somewhere along the continuum between mainland-island and patchy metapopulation configurations (Fig. 6). Alternatively, if dispersal is restricted, Boise River bull trout must lie somewhere between nonequilibrium and mainland-island metapopulation configurations. If Boise River bull trout are in an mainland-island configuration, then some local populations may be relatively persistent (e.g., those in large patches), while others may be more ephemeral, perhaps functioning as population sinks (Pulliam 1988). On the ends of this continuum, bull trout may exist in a nonequilibrium state, where all local populations are destined for extinction due to restricted dispersal (and presumably recolonization), or as a patchy metapopulation, where high rates of recolonization lead to high rates of patch occupancy (Harrison and Taylor 1996, Fig. 6). Several lines of evidence suggest bull trout in the Boise River basin may consist of a complex metapopulation structure that is a composite of these possibilities.

Overall, we found bull trout in 36% of potentially occupied habitat patches in the Boise River basin. If dispersal was widespread and local extinctions were relatively uncommon throughout the basin, we should have observed much higher occupancy rates. At finer spatial scales, Rieman et al. (1997a) observed rapid (<3 yr) recolonization of defaunated bull trout habitats following severe fires in tributaries of the Boise River. Rapid recolonization was likely facilitated both through complex life-histories with overlapping generations, and through movements within local stream systems. These observations suggest that the complexity of habitats played a key role in the persistence of bull trout populations influenced by the fires (Rieman

et al. 1997a). Because the complexity and diversity of stream habitats are expected to vary directly with patch (catchment) size (Frissell et al. 1986, Schlosser 1987, Rieman and McIntyre 1995), the risk of local extinction should as well. The few large (>10⁵ ha) occupied patches may possibly serve as important sources of bull trout for recolonization of unoccupied habitat within the Boise River basin, and parts of the basin may function as mainland-island or patchy metapopulations (Fig. 6).

Bull trout populations in the Pacific Northwest are generally believed to be in a state of decline (Rieman and Myers 1997, Rieman et al. 1997b). Although there is no clear evidence of such a trend in the Boise River basin, fishing and habitat disruption have occurred at potentially important levels across the system. The association of bull trout occurrence with road density is an indication of such effects. If populations are in a general state of decline across the basin, the significant patch-area effect could emerge simply as an artifact of smaller populations disappearing more quickly. We suggest it is unlikely that these bull trout populations are strictly in a nonequilibrium decline, because distance to nearest occupied patch was also a significant predictor. This suggests that some recolonization does occur at broader scales. A number of patches are also found within Forest Service Wilderness or roadless areas with very limited access, and the area effect is still apparent (e.g., patches with low densities of roads in Fig. 3). Populations in these areas have likely been influenced little by habitat disruption or fishing.

Dispersal behaviors are complex, and may be a function of several biotic and abiotic processes operating on different spatial and temporal scales (Ims 1995, Ims and Yoccoz 1996). Habitat fragmentation itself may directly affect dispersal behaviors of animals (Ims 1995, Yahner and Mahan 1997). Fragmentation of stream habitats may have effects that parallel restricted dispersal observed for salmonid populations that are isolated above waterfalls (Jonsson 1983, Northcote and Hartman 1988, Northcote 1992). In such cases, the potential benefits of movement (Northcote 1992, Jonsson and Jonsson 1993) are clearly outweighed by costs. Bull trout, like many salmonids, may consist of several life history "forms" with different dispersal or migra-

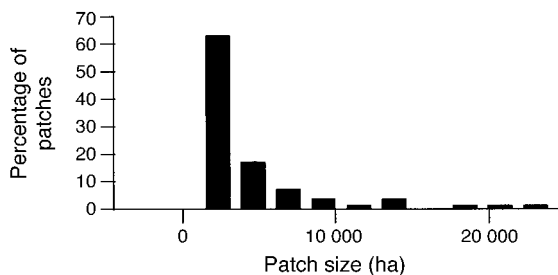


FIG. 7. Distribution of sizes (areas) for 81 patches of potentially occupied bull trout habitat in the Boise River basin.

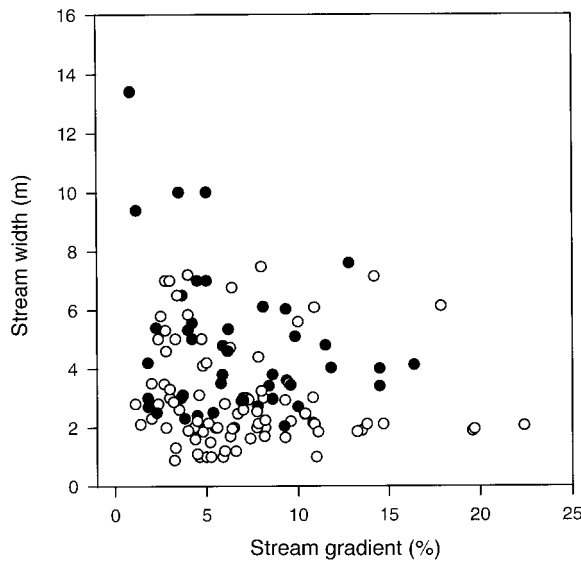


FIG. 8. Relationships between bull trout occurrence in stream reaches within occupied patches and stream width and gradient (solid circles = present, open circles = absent).

tory behaviors (Rieman and McIntyre 1993, Willson 1997). Relationships between bull trout life histories, habitat structure, and the potential for habitat fragmentation to restrict dispersal of bull trout clearly require further research.

Patterns at smaller spatial scales

Rieman and McIntyre (1995) found patch-scale occurrence of bull trout in the Boise River basin to be positively related to both patch area and stream width, but not to stream gradient. Because patch area and stream width were correlated, they could not distinguish the effects, and hypothesized that width effects may be due to habitat selection by bull trout. The positive relationship between bull trout occurrence and stream width within occupied patches found in this study supports their explanation. A pattern similar to patch-scale relationships (Rieman and McIntyre 1995) emerged within patches (Fig. 8). Bull trout were found only in streams >2 m in width, even with free access to many smaller habitats within occupied patches (see also Figs. 2 and 3 in Rieman and McIntyre 1995). There are several instances in which bull trout were not found in streams >2 m in width, and this may be due to low densities of fish, perhaps resulting from past disturbances (Platts and Nelson 1988), or avoidance of some other feature of the habitat.

Analyses of co-occurrence of bull trout and brook trout at stream and site scales revealed no associations, suggesting bull trout and brook trout do not segregate among habitats at spatial scales considered in this study. We strongly caution that the possibility of competition between bull trout and brook trout cannot be ruled out by this result, because co-occurrence data may be misleading (Hastings 1987). Segregation may

occur at smaller spatial scales (e.g., among microhabitats within sites), especially if feeding territories are defended (Grant and Kramer 1990, Fausch et al. 1994, Nakano and Kaeriyama 1995), but we have no data to evaluate this possibility. Larger scale patterns may emerge through time if bull trout are systematically displaced or replaced by brook trout, or if the reverse were to occur. Interspecific hybridization of bull trout and brook trout could play an important role in replacement of the former by the latter, for example (Leary et al. 1993). Finally, it is possible that the influence of brook trout on bull trout may extend outside occupied patches considered here if the presence of brook trout in downstream areas hinders dispersal through, or occupancy of, downstream habitats (see Fraser et al. 1995).

Conclusions and conservation implications

It has long been recognized that aquatic habitats are organized by processes that can be ultimately traced to landscape-scale influences on stream catchments or watersheds (e.g., Hynes 1975, Frissell et al. 1986). Technological advances in methods to acquire and analyze information on large-scale patterns and processes have dramatically increased the ability of aquatic ecologists to study such phenomena, while at the same time management policies are being revamped to incorporate large-scale perspectives of aquatic ecosystems (Johnson and Gage 1997).

Past analyses, while providing exciting insights on a number of large-scale factors, have often neglected the spatial extent and distribution of landscape elements within stream catchments (Johnson and Gage 1997). For example, assessments of fish-habitat relationships (Hinch et al. 1991) were dramatically modified after spatial autocorrelation of sites was considered (Hinch et al. 1994). In the case of bull trout, metapopulation structure implies suitable habitats are often not occupied, and attempts to relate occurrence of bull trout to habitat characteristics without accounting for patch occupancy are potentially misleading (e.g., Watson and Hillman 1997). As we have shown here for bull trout, the large-scale geometry of stream catchments can strongly influence the distribution of aquatic species, independent of other more commonly considered habitat characteristics. Our analyses revealed that additional factors operating on smaller spatial scales may be important as well. Small-scale factors should be considered together with large-scale patterns, because their effects may otherwise go undetected.

While our study of bull trout was extensive in terms of spatial dimensions, we have limited information to evaluate rigorously the influence of temporal variability. Aquatic landscapes are highly dynamic systems, and long-term data are needed to define more clearly interactions between temporal and spatial processes occurring on different scales (Schlosser 1995, Wiley et al. 1997). Furthermore, we stress the need for better

information on parameters related to dispersal success, which can dramatically affect interpretations of spatially explicit population models (including metapopulation models), as recently emphasized by Ruckelshaus et al. (1997).

Our analysis suggests that the actual structure of bull trout metapopulations is highly complex. Real metapopulations of aquatic organisms may be complex mosaics that contain several elements of the structures found in simple conceptual models (Schlosser and Angermeier 1995, Harrison and Taylor 1996). In the case of bull trout and other stream-living fish, habitat spatial structure and life history variability likely function interactively to affect patterns of migration, dispersal, and patch occupancy (Rieman and McIntyre 1993, Gresswell et al. 1994, Schlosser 1995, Schlosser and Angermeier 1995, Willson 1997). These complexities pose important challenges to empirical and theoretical attempts to understand metapopulation dynamics of fish and other aquatic organisms, but insights provided by such studies may prove critical to developing effective long-term management strategies for aquatic ecosystems.

Results of this work have several important implications for management of bull trout. Bull trout populations in larger, less isolated, and less disturbed habitats may be more likely to persist, and these habitats may prove critical in terms of providing long-term refugia and recolonization potential. Disturbance to these populations and their habitats should be minimized. In particular, disturbances associated either directly or indirectly with roads are a critical concern. On the other end of the continuum, small, isolated, and disturbed habitats may be at risk. Management to ensure persistence of these populations may be challenging. In the middle are populations and habitats of intermediate size and/or isolation, where opportunities for conservation and restoration may be greater. Furthermore, the existence of metapopulation structure implies availability of suitable, but presently unoccupied, habitat, which should be managed carefully to facilitate potential natural recolonization or reintroductions of bull trout.

We do not recommend that management activities be prioritized on the basis of this study alone. Clearly, genetic concerns and occurrence of other species of concern merit consideration (see papers in Nielsen 1995). In particular, information on the genetic structure of bull trout populations in the Boise basin would prove useful in terms of prioritizing efforts to maintain genetic diversity. Previous work on bull trout (Leary et al. 1993) and more recent genetic evidence in other basins (P. Spruell and F. W. Allendorf, *unpublished data*) suggest strong genetic divergence among populations, but relatively little within-population variability. One hypothesis to explain this pattern is that current metapopulation structure of bull trout is the result of long-term fragmentation of habitat related to historical changes in regional climate. If so, this implies that

dispersal occurs very infrequently and over long periods, perhaps on the order of centuries, and that contemporary losses of local bull trout populations may not be balanced in the near term by recolonization. This time scale may be considerably longer than that hypothesized for dispersal and recolonization for other salmonids (Reeves et al. 1995). We emphasize that further study is needed to define more clearly the temporal scale over which metapopulation dynamics of bull trout occur.

With regard to patterns we observed at smaller spatial scales, it is clear that bull trout select larger habitats, when they are available. However, we caution that results of this study regarding effects of brook trout not be extrapolated to other areas. In other cases within the range of bull trout, negative effects of brook trout on bull trout populations are evident (e.g., Howell and Buchanan 1992, Leary et al. 1993, Rich 1996) and likely scale-dependent, as emphasized above.

A final important issue for managers regards the effects of downstream dams on bull trout in the Boise basin. From a metapopulation perspective, long-term isolation of the South Fork Boise River by dams may restrict long-distance dispersal, the significance of which is unclear at this point. Reservoirs created by downstream dams do support migratory populations of bull trout, and they may be of significance to some local populations (e.g., Rieman et al. 1997a). Perhaps most importantly, dams in the Boise basin and further downstream in the Snake River have extirpated runs of anadromous salmon (primarily *Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*). The importance of these species to the productivity of aquatic and terrestrial ecosystems (Willson and Halupka 1995) may have affected viability and productivity of bull trout populations directly through loss of a prey base of juvenile salmonids and indirectly through effects on associated species.

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Adapting transportation to climate change on federal lands in Washington State, U.S.A.

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A. F. Hamlet • C. Lauver

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Abstract Research scientists collaborated with federal land managers of two national parks and two national forests to conduct a climate change vulnerability assessment and to identify adaptation strategies for a transportation network covering 28,900 km of roads and trails in north-central Washington, U.S.A. The assessment employed observations of sensitivity and response to climatic variability, downscaled climate projections, literature reviews, current management policies and practices, expert knowledge, and stakeholder engagement. Primary pathways for climate impacts focused on projected increases in extreme high flows and flooding, elevated winter soil moisture and landslide hazards, and loss of snowpack. The biggest impacts to roads and trails are expected from temperature-induced changes in hydrologic regimes that enhance autumn flooding and reduce spring snowpack. Projected higher winter soil moisture caused by changes in seasonal precipitation and snow accumulation could reduce slope stability. Earlier snowmelt may lengthen the snow-free season for visitor use and agency operations. Infrastructure age, design, maintenance, location, use, and limited redundancy along with funding policies and management, influence the sensitivities of the transportation system. Vulnerabilities were identified based on when and where these sensitivities to changes in climate may emerge. Adaptation strategies and tactics identified to address these vulnerabilities included: upgrading stream crossing and drainage design, changing use and maintenance, relocating or closing roads and trails, modifying funding policies, and expanding public

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engagement. Many adaptation options are “no regrets” approaches to changes in climate projected for the 2040s and 2080s that can be applied to other resource sectors and mountainous regions.

1 Introduction

During the past century, roads and trails in the United States in remote locations were built to extract furs, minerals, timber, and energy. Travel along roads and trails is now primarily associated with recreation, and is the principal means by which the public visits the nation’s parks and forests (Louter 2006). Safe and strategic access to and within public lands is vital for facilitating recreational enjoyment, education, managing natural resources, and responding to emergencies. However, maintaining roads and trails in areas of rugged terrain is challenging, and hydrologic extremes are a recurrent source of infrastructure damage. Climate variability strongly influences the timing and location of land management activities and visitor use. Because climate change has the potential to affect whether or not specific land areas will deliver historical benefits and services in the future, understanding the extent and magnitude of climate change impacts on travel on federal lands is needed to minimize consequences. The U.S. Forest Service (USFS) and National Park Service (NPS) are adapting transportation planning and management activities as part of a broader effort to ensure sustainability (USDI NPS 2010; USDA FS 2010).

A multi-agency partnership was created in 2010 among four federal jurisdictions in Washington State that share common borders and a vision to address climate change impacts that cross jurisdictional boundaries (Raymond et al. 2013, 2014; Strauch et al. 2014). The North Cascadia Adaptation Partnership (NCAP) includes Mount Rainier National Park (MORA), North Cascades National Park Complex (NOCA), Mount-Baker Snoqualmie National Forest (MBSNF), and Okanogan-Wenatchee National Forest (OWNF). These contiguous federal lands occupy over 24,000 km² in north-central Washington and contain 28,900 km of roads and trails (Fig. 1). The NCAP landscape is part of the Cascade Range, oriented north to south with high topographic relief (184 m to 4392 m). Mean annual temperatures are similar on both sides of the Cascade Range, but the eastside has higher seasonal variability. Abundant mountain precipitation supports over 67,000 km of streams and rivers and vegetation dominated by coniferous forest, except at the elevation extremes where vegetation transitions to shrubs and meadows.

The NCAP identified climate change effects on the transportation system as a high priority because of recent impacts associated with extreme storms and the importance of access to public lands. For example, intense storms in autumn 2003 and 2006 caused flooding and landslides throughout the NCAP landscape, leading to millions of dollars in damage to roads and trails, a 6-month closure of MORA, followed by years of repairs. Transportation infrastructure is increasingly compromised by interrelated climate change impacts (Schwartz et al. 2014; Maurer et al. 2011). However, adaptation strategies in the transportation sector have received less attention than mitigation for transportation-related greenhouse gas emissions (GHG) emissions (Chapman 2007; NRC 2008). This paper describes a vulnerability assessment that examines transportation adaptation in the context of the NCAP landscape. The context is unique compared to urban and suburban transportation systems because of the multiple federal lands, large contiguous geographic area in rugged terrain, extensive network of mostly dirt roads and trails, and relatively low average daily travel on many routes. Furthermore, there is an emphasis on visitor uses and seasonal access, protection of aquatic species, and maintenance rather than expansion of infrastructure with minimal development pressures.

Mountain ecosystems are acutely sensitive to climate change (IPCC 2007), and some portions of the Pacific Northwest (PNW) are particularly sensitive to climate-induced loss of

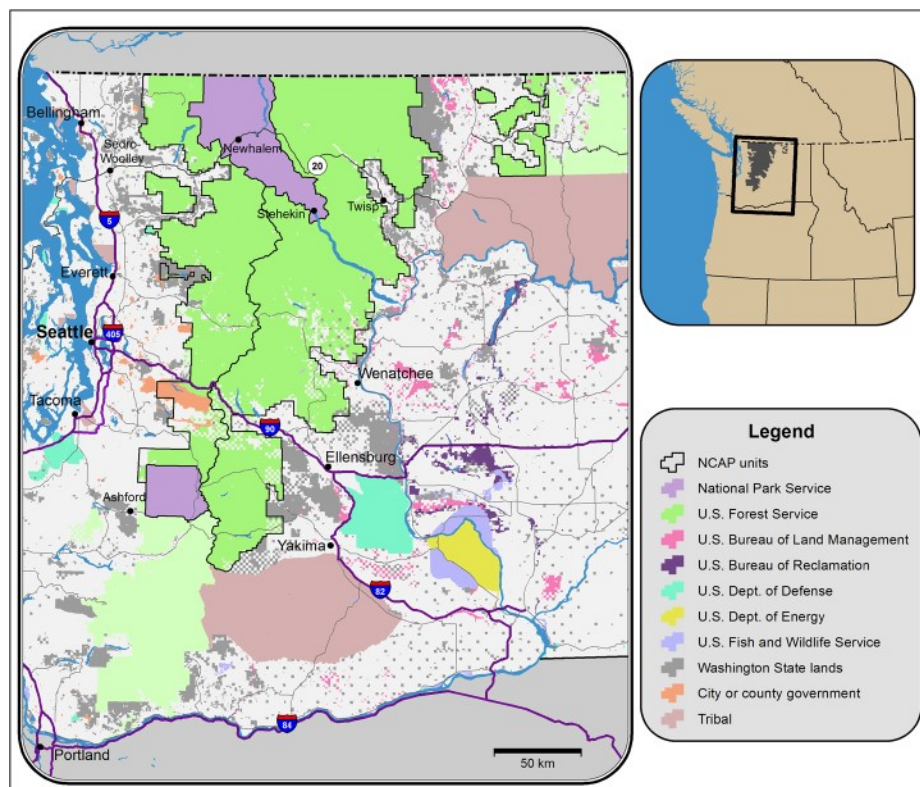


Fig. 1 The National forests and national parks that comprise the core of the North Cascadia Adaptation Partnership (NCAP) landscape cover a total land area of 2.4 million ha and are surrounded by several other municipal, state, federal, private, and tribal ownerships

snowpack and changes in hydrologic regime (Elsner et al. 2010; Mote and Salathé 2010; Hamlet et al. 2013). In the PNW, warming observed over the 20th century (+0.7 °C since 1906) is expected to continue and intensify, with annual average temperatures 3.2 °C warmer by the 2050s compared with historical (1950–1999) averages and greater warming projected later in the century (Snover et al. 2013). Climate models project little change in annual precipitation, but seasonal precipitation is projected to change with more precipitation in autumn, winter, and spring, and less in summer (Mote and Salathé 2010). Precipitation intensity is also projected to increase (Snover et al. 2013). Snowpack is projected to decline further in Washington with reductions in April 1st snow-water equivalent (SWE) of 38 to 46 % by 2040 compared with historical averages (Elsner et al. 2010). Warming and changes in seasonal precipitation in the NCAP landscape generally result in increased soil moisture and streamflow in autumn and winter and higher peak flows (Hamlet and Lettenmaier 2007; Hamlet et al. 2013; Mantua et al. 2010).

2 Approach and methods

Collaboration among scientists and agency resource managers is vital to understanding specific impacts on access and to identifying climate change adaptation strategies

(Kloprogge and Van der Sluijs 2006). Accordingly, the NCAP held a workshop on climate change, hydrology, and access that convened resource managers, scientists, engineers, and representatives of recreation groups to assess vulnerabilities of access to climatic variability and change (see [online supplemental](#)). Resource managers identified impacts of current climate on the transportation system and trends in recent impacts associated with extreme weather and climate change. Scientists supported the vulnerability assessment by focusing on three pathways by which climate change directly influences access in mountain landscapes: (1) extreme high flows and flooding, (2) less snow and extended warm season, and (3) elevated winter soil moisture and landslide hazard. These pathways were considered the most relevant to the NCAP landscape by workshop participants given current impacts and sensitivities, topography, and climate.

Projections of average temperature and precipitation in the vulnerability assessment were generated from an ensemble of 10 global climate models (GCMs) based on the A1B GHG emissions scenario, which aligns with the current emission trajectory (Nakicenovic and Swart 2000). Ensemble averages report the central tendency of the projections; two additional GCMs (PCM1 and MIROC 3.2) were used to provide a range of future climates based on variations in model sensitivity from the 10 GCMs. PCM1 simulates relatively lower increases in annual temperature and slightly drier conditions in the PNW for the 2040s (least warming and drier). MIROC 3.2 simulates relatively larger increases in annual temperature and wetter conditions (most warming and wetter) (Littell et al. 2011). Downscaled projections of temperature and precipitation were applied as monthly changes to meteorological inputs to the Variable Infiltration Capacity (VIC) macroscale hydrologic model (Liang et al. 1994; Elsner et al. 2010). The VIC model implementation provided hydrologic information at 1/16th degree resolution (about 34 km² grid cell), and routed flows were used for projected changes in stream flow (Hamlet et al. 2013; Tohver et al. 2014). Details on these datasets are available in Hamlet et al. (2013) and Littell et al. (2011). Snowpack simulations were available from a high-resolution version of the VIC model implemented at 800-m resolution (Mauger 2011).

In similar studies, extreme flooding was defined as the 100-year flood (the annual peak flow with a 1 % probability of exceedance, or Q100) and changes to Q100 were reported as a ratio of future Q100 to historical Q100 (Tohver et al. 2014). Projections of hydrologic variables were provided for the 2020s, 2040s, and 2080s using GCM statistics from a 30-year time window to generate 91 years of climate-adjusted data (see Tohver et al. 2014). Hydrologic response was characterized by basin type determined from simulated spring snowpack and cool season precipitation (Hamlet et al. 2013): (1) rain-dominant, (2) mixed-rain-and-snow, and (3) snowmelt-dominant, depending on percentage of winter precipitation entrained in spring snowpack (<10 %, 10–40 %, and >40 %, respectively). Although VIC does not simulate slope stability failures or landslides, projections of soil moisture from VIC were used as an indicator of landslide hazard. The PNW typically experiences highest precipitation in November and December, and climate models project increases in future autumn precipitation in Washington (Mote and Salathé 2010). Therefore, the percent change in VIC projections of total column soil moisture on December 1 were used to indicate future slope stability associated with elevated soil moisture (Crozier 1986). To understand the influence of snow on seasonal access, the change in date when 90 % of snow is melted in spring was assessed.

Using these impact pathways and climate projections, scientists, engineers, and resource managers identified vulnerabilities of infrastructure to climate change. Vulnerability was qualitatively determined by the exposure, sensitivity, and adaptive capacity of the transportation system to changing climate. Exposure was determined using spatial data on projected changes in hydrologic processes relevant to access. Sensitivity was determined by assessing qualities of the transportation system that influence the degree to which it could be affected by

climate change, including location, design, use, management, and current condition, and recreation patterns. Adaptive capacity was determined by reviewing the ability of current management practices and policies to respond and adjust to the influence of climate. Vulnerabilities were based on expert local knowledge and current climate-related impacts, combined with projections of changes in climate and hydrologic regimes. These vulnerabilities were refined with further literature review, data analysis, and discussions among scientists and agency staff (Snover et al. 2007; Peterson et al. 2011). The assessment process was a first step in identifying vulnerabilities by agencies within NCAP that have limited financial and personnel capacity for climate change planning. Thus, a more parsimonious process was followed similar to Michalak et al. (2013) rather than a prescribed risk management framework often used in the transportation sector (Wall and Meyer 2013; Maurer et al. 2011).

Based on initial vulnerabilities identified at the workshop, participants identified adaptation strategies, and opportunities and barriers to implementing strategies within institutional processes, policies, and practices. Workshop participants focused on three adaptation strategies: 1) creating resistance (i.e., “hardening”), 2) increasing resilience, and 3) enabling systems to respond to a changing climate (Millar et al. 2007). On-the-ground tactics were identified for implementing general strategies. Given current climate change uncertainties and the limited capacity of both agencies for adaptation planning, the group identified “no regrets” actions as likely first steps towards adaptation, also but recognized the value of actions addressing sizeable impacts or reducing long-term consequences. No regrets actions satisfy other agency goals, such species protection or improved ecological function, with the co-benefit of reducing the impacts of climate change (Peterson et al. 2011).

3 Results

3.1 Vulnerability assessment



Flooding in the PNW is a function of precipitation intensity and duration, freezing elevation during storms (which determines where precipitation falls as rain or snow), and effects of temperature and precipitation on seasonal snow and soil moisture (Hamlet and Lettenmaier 2007; Tohver et al. 2014). The flood regime is largely determined by basin types, which are projected to shift as climate changes (Fig. 2). Within the NCAP landscape, 26 watersheds are currently rain-dominant basins, containing 19 % of the landscape’s 19,591 km of roads, 34 are currently mixed-rain-and-snow basins with 48 % of roads, and 27 are snowmelt-dominant with 33 % of roads. By the 2040s, the ensemble projections are for equal number (39) of rain-dominant and mixed-rain-and-snow basins; only 9 are projected to remain snowmelt-dominant. Autumn and winter flood hazard in the Cascade Range is projected to increase with more autumn and winter precipitation, coupled with warmer temperatures that raise freezing elevations, effectively increasing basin area during storms (Hamlet and Lettenmaier 2007; Mantua et al. 2010; Tohver et al. 2014). The largest increases in flood hazard are expected in mixed-rain-and-snow basins where current mid-winter temperatures are within a few degrees of freezing (Hamlet et al. 2013; Tohver et al. 2014). Most of the coldest snowmelt-dominant basins at high elevation in the NCAP landscape are expected to continue to experience peak flows in spring, but with smaller and earlier peak flows by the 2040s. Some snowmelt-dominant basins may experience a small increase in flooding due to more snowpack resulting from persistent cold mid-winter temperatures and more cool-season precipitation.

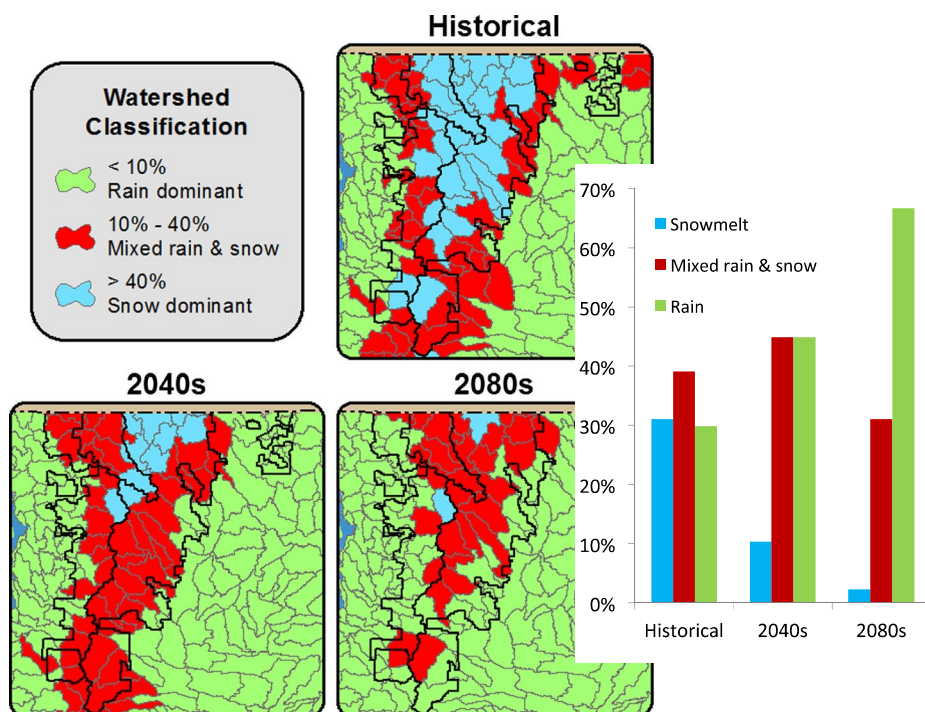


Fig. 2 Projected shift in watershed basin type in the NCAP landscape from historical (1981–2010) to the 2040s (2030–2059) and 2080s (2079–2099). Basins represent the spatial resolution of 10-digit hydrologic unit codes (HUC), or the 5th level watershed classification as delineated by the U.S. Geological Survey. Basin classification is defined by the percent (shown in legend) of cool season (Oct.–Mar.) precipitation captured in the April 1 snow water equivalent (SWE). Future projections were modeled using the A1B emission scenario and an ensemble of 10 GCMs. Inset graph shows the percent of each basin type for each time period

By the 2080s, only two basins within the NCAP landscape may remain snowmelt-dominant, but contain less than 1 % of the roads. Many of the current mixed-rain-and-snow basins may transition to rain-dominant basins in the future, shifting annual peak flows that historically occurred during spring snowmelt to rainy periods in autumn and early winter (Tohver et al. 2014). Extreme floods (e.g., Q100) are also projected to increase throughout much of the NCAP landscape, particularly by the 2080s. The highest increases are projected for the east side of the Cascade crest, where Q100 is projected to be more than double the historical value in several watersheds (Fig. 3).

Shifts in basin type and Q100 are expected to alter flood exposure of roads and trails, although the rate and magnitude of change (i.e., road kilometers associated with shifting basin type) and associated management cost may differ by jurisdiction (Fig. 4). For example, 78 % of NOCA roads and 37 % of OWN road are currently in snowmelt-dominant basins; however, by the 2080s, all roads are projected to be in mixed-rain-and-snow or rain-dominant basins. The cost associated with altered flood exposure would be greater for OWN than for NOCA because it contains more roads.

Climate projections support the hypothesis that landslide-triggering conditions may increase in winter because 1) more precipitation is projected to fall as rain rather than snow, 2) soil moisture is projected to increase in winter due to loss of snowpack and increased soil infiltration in autumn and early winter, and 3) increasingly intense winter storms are projected

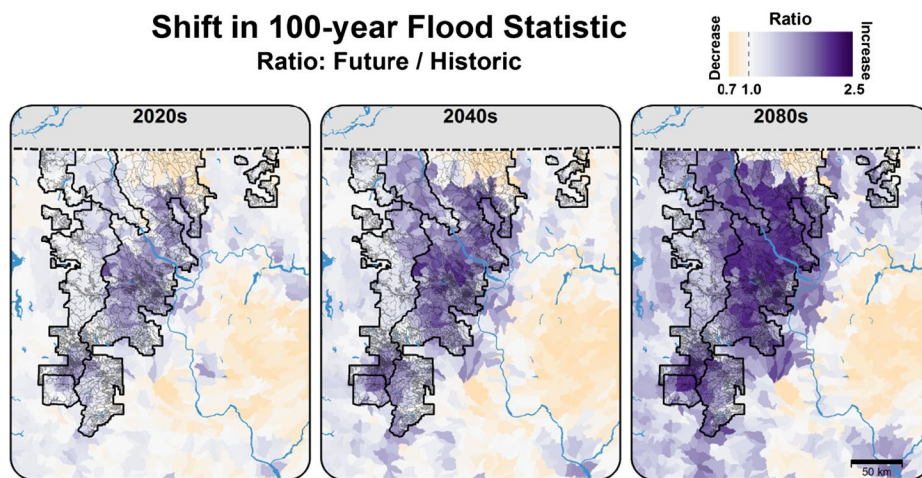


Fig. 3 Shifting trend in the 100-year flood statistic in watersheds within the NCAP landscape. Flood level is designated as the annual peak flow with an estimated 100-year return frequency (Q100). The flood statistic represents the ratio of Q100 in 2020s, 2040s, and 2080s to historical (1916–2006) levels. Ratios >1 indicate increasing peak flows in the future (Fig. 3). Ratios <1 indicate decreasing peak flows (Fig. 3). Roads and trails are shown in black

(Salathé et al. 2014; Hamlet et al. 2013; Dominguez et al. 2012). These effects would likely vary with elevation because higher elevations typically have steeper slopes and more precipitation during storms. By the 2040s, December 1 soil moisture is projected to be higher throughout the NCAP landscape, particularly at higher elevations and in the east central area, which may become more vulnerable to landslides in late autumn and early winter (Fig. 5a).

Projected declines in SWE will likely influence the timing of access to mountain roads and trails in the NCAP landscape. Although decadal climatic variability also affects SWE on shorter timescales, April 1 SWE has declined over the 20th century due to observed warming and precipitation change, and is projected to continue to decline (Hamlet et al. 2005; Mote et al. 2008). Throughout the NCAP landscape, the date when 90 % of winter snow has melted is projected to be earlier than historical dates, especially west of the Cascade crest and at low elevation (Fig. 5b).



Impacts on access with exposure to climate change, particularly the shifts in hydrologic processes, depend on the sensitivity of the transportation network to these exposures. The condition of roads and trails varies as a function of age, maintenance, surface treatment, and use. Many roads and trails were built decades ago and are near the end of their design lifespan. Advanced design of materials, alignment, drainage, and subgrade that are required standards today were generally not available when much of the road network was built. New culverts and bridges are often wider or higher (or both) than historical structures to meet hydraulic regulations or more stringent design standards. Consequently, new or replaced infrastructure is likely to be less sensitive to climate change, especially if climate change is explicitly considered in the design.

Lack of redundancy in a transportation network can cause systemic operational sensitivity when damage disconnects critical links in the system. The transportation system in the NCAP landscape lacks redundancy in national parks. Numerous roads and trails, especially at high elevation, provide sole access to recreation areas. Many roads and trails are built on steep slopes or along river corridors, which are sensitive locations impacted by landslides, washouts, and

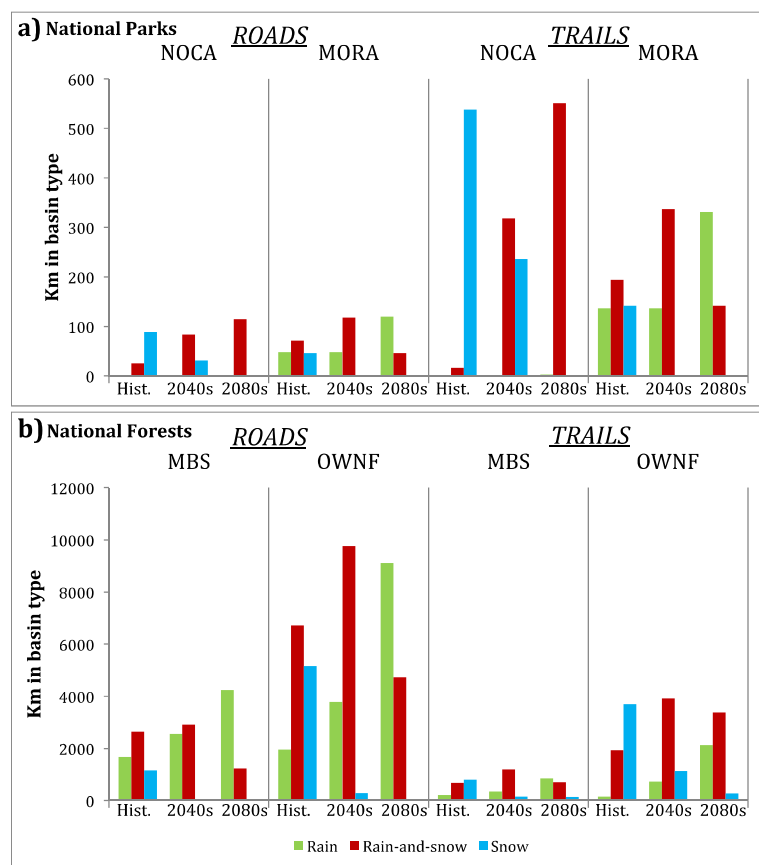


Fig. 4 Kilometers of roads and trails in each hydrologic basin type within the two national parks (a) and two national forests (b) across the NCAP landscape during three time periods: historic, 2040s, and 2080s

flooding. Management of roads and trails (e.g., planning, funding, maintenance, response) differs by agency, which can affect sensitivity of the transportation system. For example, snow removal operations by one jurisdiction can influence when a road is open, affecting when a connecting road in another jurisdiction can open.

The integrity and operation of the transportation network in the NCAP landscape are affected by stream channel migration and scour, landslides, and debris flows, which make it difficult to maintain fixed crossing structures and operational travel routes near streams. Projected increases in peak streamflows elevate flood risk, and sediment transport increase risks to structures, roads, and trails (MacArthur et al. 2012). Individual intense storms during any season can overwhelm the water-holding capacity of soil and concentrate high velocity flows into channels that erode soils, remove vegetation, and initiate debris flows, which may be particularly pronounced below receding glaciers (Pelto and Riedel 2001; Huggel 2009). During floods, roads and trails can become preferential flow paths for floodwaters. Landslide impacts to infrastructure may expand due to projected changes in soil moisture and precipitation form and intensity, particularly in autumn and winter. Landslide hazard may also increase with tree mortality caused by fire and insect outbreaks because tree mortality reduces root adhesion with soil and decreases interception and evapotranspiration, further increasing soil moisture (Schmidt et al. 2001; Neary et al. 2005; Martin 2006).

Climate change effects on access may create public safety concerns. A longer snow-free season may extend visitor use in early spring and late autumn at higher elevations (Suffling and Scott 2002; Albano et al. 2013). Earlier snowmelt may reduce snow-related closures for a greater portion of the year and allow visitors to reach trails and camps earlier in the spring. Trailheads, which start at lower elevations, may be snow-free earlier, but hazards associated with melting snow bridges, avalanche chutes, and frozen snowfields may persist at higher elevations. In addition, greater variability in cool-season precipitation and increased flooding (Hamlet and Lettenmaier 2007) may expose early-season visitors to more intense hydrologic or weather extremes than they have historically encountered (Scott et al. 2007). Higher precipitation intensity could decrease driver safety (Hambly et al. 2013) and higher flood hazard in autumn could make river recreation more perilous. Amplified fire regimes driven by climate change (Rogers et al. 2011) emphasize the value of access for fire management, but could also reduce safe operation of some roads and require additional emergency response to protect recreationists and communities. Earlier access to roads and trails may also increase the need for extended seasonal maintenance and construction activities (Mills et al. 2009).

3.2 Adaptation

Workshop participants identified adjustments to operations, designs, management, and planning that may increase resistance and resilience to changing high flows and flood hazards. One “no regrets” strategy is to continue to upgrade the aging system of roads and stream crossings as required by the Northwest Forest Plan and the 2005 Travel Management Rule (36 CFR part 212). These upgrades are intended to increase the resistance of roads at stream crossings to higher peak flows and flood frequency, and can enable adaptation if climate change is considered in design (Halofsky et al. 2011; Littell et al. 2012). Currently some culverts on fish-bearing streams are being replaced with culverts designed for aquatic organism passage, following the U.S. Forest Service Stream Simulation design standards and requirements of the Endangered Species Act. This design often results in higher culvert flow and debris capacity and provides a resistance strategy for higher peak flows. Given projected changes in basin types and Q100, engineers may consider upgrades of culverts and bridges in areas with projected greater hydrologic change (e.g., in mixed-rain-and-snow basins) (Meyer 2008; Halofsky et al. 2011). They could also use projections of future Q100 as future flood hazard (Fig. 3) to design replacements or to identify areas for enhancing culvert and bridge capacity projects (Halofsky et al. 2011; Tohver et al. 2014).

Another “no regrets” tactic is to expand current efforts to inventory roads, culverts, and stream crossings as part of a sustainable roads analysis. These inventories provide critical information for identifying future repairs, replacements, and upgrades, increasing the capacity of the transportation system to adapt to changing hydrologic regimes. Areas where damage is most likely to escalate can be identified by combining information on where roads currently experience frequent flood damage with spatial data on infrastructure condition and projected changes in flood hazard.

Funding limitations were identified as a key barrier to climate adaptation because they often hinder efforts to upgrade the transportation system (Eisenack and Stecker 2012). Extreme floods that damage roads and culverts were identified as opportunities to replace existing structures with ones that are more resistant to higher peak flows. However, these replacements, called “betterments,” can be difficult to fund under eligibility requirements for the Emergency Relief for Federally Owned Roads (ERFO) program because the default policy proscribes “like-kind” replacement with the same infrastructure that was in place at the time of damaged. Sufficient

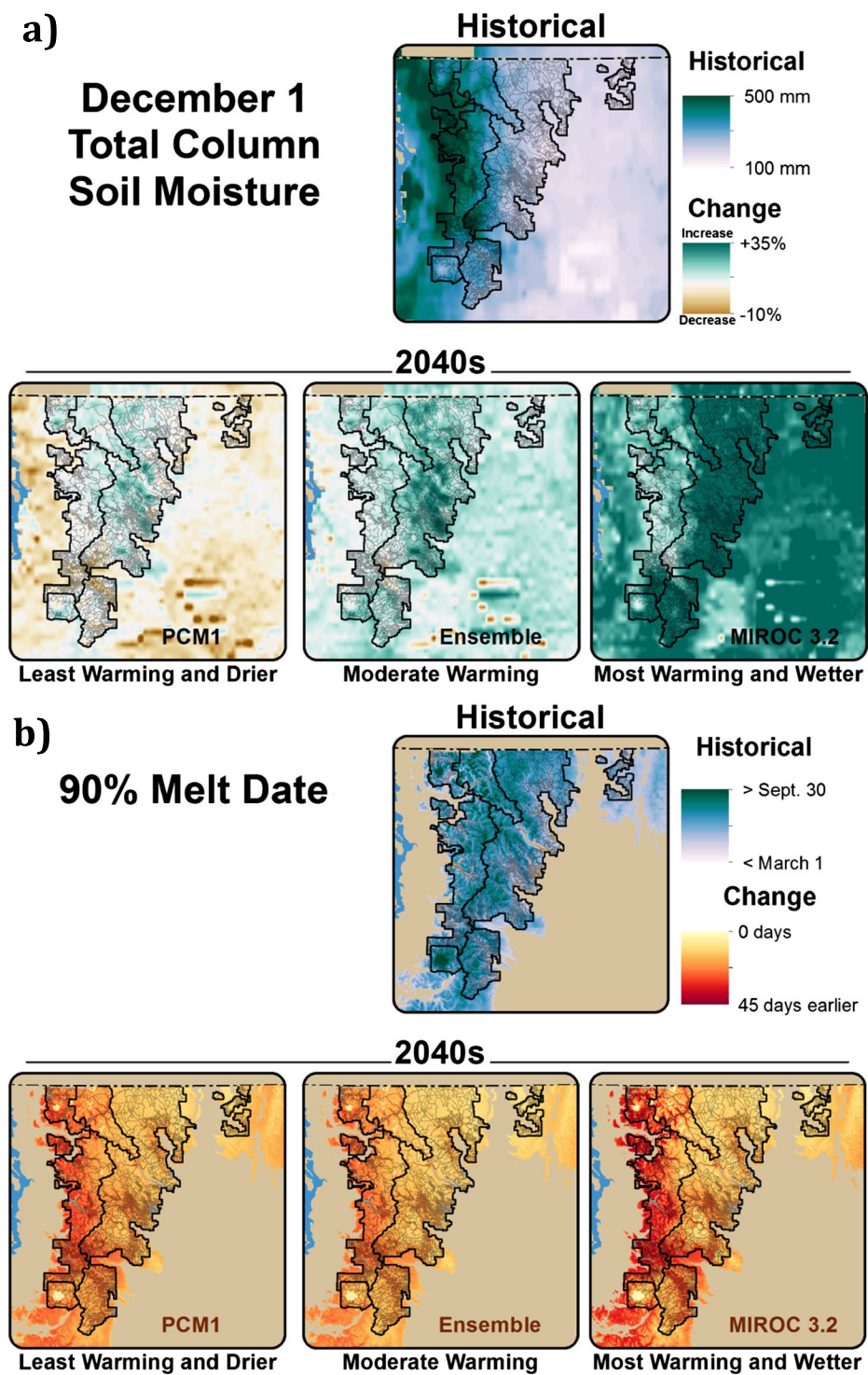


Fig. 5 Percentage change in total soil moisture content on December 1 within the NCAP landscape for 2040s (2030–2059), compared with historical levels (1916–2006), calculated as $[(\text{future} - \text{historical}) / \text{historical}] * 100$ (a). Average change in date at which 90 % of SWE is melted from historical date (1916–2006) and the 2040s date compared to historical dates (1916–2006) (b). Future projections modeled using A1B emission scenario and three model configurations, an ensemble of 10 GCMs and two individual GCMs projecting less warming and drier conditions (PCM1) and more warming and wetter conditions (MIROC 3.2) than ensemble mean. **a** shows roads and trails

justification for betterments based on climate change impacts could provide new avenues to increase resistance and resilience of repaired and replaced infrastructure (Tohver et al. 2014).

Response strategies to address projected changes in high flows include: rerouting roads and trails farther from streams and rivers, relocating transportation routes to locations that do not require culverts or bridges, and decommissioning highly vulnerable roads or trails. The USFS has a large inventory of logging roads no longer used in forest management. In some cases, the current road system may provide multiple routes to specific destinations, and climate vulnerability assessments can be used to identify which roads to maintain and which roads to close (Meyer 2008). However, the lack of redundancy in roads and trails in national parks will likely focus adaptation efforts on increasing resilience or resistance of the existing infrastructure, such as change in use or modes of transportation from car to bike or foot. Changes to the road and trail system are often opposed by a public accustomed to access for recreation. Working with local communities and recreational user groups, land managers can convert roads from vehicle to non-vehicular use, which can reduce maintenance costs and risks to aquatic habitat. Greater public involvement can generate political support and possibly funding from external sources to maintain access (Irvin and Stansbury 2004). Incorporating decision “triggers” as an adaptation measure in long-term plans (e.g., closure of a road if it is damaged by flooding) can enhance the capacity to respond to climate change impacts with well-defined actions already vetted through public review (Eisenack and Stecker 2012).

Road and trail management may need to be modified to reduce adverse impacts and maintenance costs associated with higher soil moisture. Increased soil saturation could create more boggy areas around roads and trails and associated erosion and damage to infrastructure. Recreation managers may consider locations with projected increases in winter soil moisture in their maintenance prioritization process (Fig. 5a). Short-term “no regrets” adaptation tactics for trails include improving drainage, stabilizing slopes, and restoring vegetation cover. More repairs and reroutes may be necessary to avoid damage to vegetation when users stray from established trails to avoid saturated soils and inundated sections. Short-term adaptation tactics for roads include reducing weight on the road, altering road surface type, drainage improvements, and planning for higher maintenance costs. However, repeated landslides and slope failures may require that vulnerable roads and trails be closed and that new construction avoid areas with elevated hazard.

Climate change may necessitate greater emphasis on hydrologic impacts in road and trail design. Roads and trails constructed perpendicular to the slope can intercept, block, restrict, and channel water, which can exacerbate landslide hazards projected due to increasing soil moisture. Road and trail resilience can be increased by constructing improved drainage and enhanced erosion control. Monitoring erosion and saturated soils near roads and trails will be important for identify deterioration and prioritize locations for restoration and repair. Monitoring may be more effective if it focuses on infrastructure in areas with the highest projected increases in soil moisture (Fig. 5) and in mixed-rain-and-snow basins (Fig. 2), where the largest shifts in precipitation type are expected.

Reduced snowpack and earlier snowmelt could allow earlier access for visitors to higher elevations and a longer “summer” recreation season (Michalak et al. 2013). However, an expanded visitor season would increase the cost of operating facilities (e.g., visitor centers and campgrounds) and require modifications to recreation management (Albano et al. 2013). Due to budget constraints, NPS and USFS managers are challenged to maintain visitor facilities and access. Therefore, longer snow-free seasons may not necessarily result in longer visitor access because agencies may lack capacity to open transportation routes earlier in the spring. Additionally, risks to public safety could increase with more frequent disruptions to access from flooding and landslides. A long-term adaptation strategy would be to increase funding to allow for greater maintenance and an expanded visitor season. Public safety may be improved through regulation of seasonal use, combined with better information about current conditions and weather forecasts, especially in early spring and late autumn, before and after maintenance activities. Partnerships with recreational user groups may generate opportunities to communicate this message to the public, thus enhancing awareness of safety issues. Monitor changes in the timing, location, and number of visitors can provide data on where management policies could be modified.

4 Summary and discussion

Historical development of roads and trails and regional climate exert strong controls on current patterns of access in the north-central Cascade Range of Washington, U.S.A. Climate change is expected to result in important changes in access via impacts to flooding, landslide hazard, and seasonal snowcover. The NCAP science-management collaboration evaluated the vulnerability of access to climate change and identified adaptation options applicable throughout the contiguous lands of two national forests and two national parks where altered weather patterns are already affecting the transportation network (Maurer et al. 2011; MacArthur et al. 2012). Hydrologic models project continued and escalating exposure to climate-induced changes in access due to shifting hydrologic regimes (Tohver et al. 2014; Salathé et al. 2014).

In the short term, natural climatic variability may exacerbate, compensate for, or even temporarily reverse expected trends in some hydroclimatic processes. However, in the long term (40–100 years; Meyer 2008), the cumulative impacts of climate change are expected to become the dominant factor, particularly for temperature-related effects (Mote et al. 2008). In response to these challenges, the NCAP identified adaptation strategies and tactics to enhance the resistance, resilience, and response of the transportation system. The federal lands context of this assessment provides opportunities to implement adaptation over a large geographic area, such as design standards, operations, and planning with consideration of a dynamic climate. Incorporating adaptation into long-term planning is an important element of climate change planning (NRC 2008; Whitely Binder et al. 2010; Hamlet 2010) and an adaptive management system can allow decisions regarding repairs, restoration, and closures to evolve as hydrologic regimes evolve. The vulnerability assessment and adaptation planning described here focuses on transportation systems on federal lands, providing an approach that can be applied to other resource sectors and mountainous regions. The results are particularly relevant to areas where snowpack is a key hydrologic component and infrastructure is in close proximity with streams.

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How vulnerable are denning bears to disturbance?

John D. C. Linnell, Jon E. Swenson, Reidar Andersen, and Brian Barnes

Abstract When exposed to human disturbance, most large carnivores are able to move away from the source with little energetic cost. Bears represent an exception in that during winter, most individuals spend several months in an energy-saving state of hibernation in a den. This implies that disturbance of denning bears has the potential to have a large energetic cost, although data on the subject are rather diffuse. We reviewed the literature on den-site selection, denning physiology, and responses to disturbance for the brown bear (*Ursus arctos*), black bear (*U. americanus*), and polar bear (*U. maritimus*). Generally, bears select dens one to 2 km from human activity (roads, habitation, industrial activity) and seemed to tolerate most activities that occurred more than one km from the den. Activity closer than one km and especially within 200 m caused variable responses. Some bears tolerate disturbance even inside the den, but bears will abandon dens in response to activity within this zone, especially early in the denning period. Den abandonment by brown and black bear females with cubs of the year can lead to increased cub mortality. Specific excavated or ground dens are rarely reused, whereas natural caves or hollow trees are reused with varying frequency. There is often some distance between an individual bear's consecutive dens. This indicates that loss of a single denning area following human disturbance will not always lead to deleterious effects, if alternative denning areas are available within the home range.

Key words black bear, brown bear, dens, disturbance, hibernation, physiology, polar bear, *Ursus*

Human activities such as recreation and resource extraction, even when they do not involve direct persecution or habitat degradation, can disturb wildlife (Bromley 1985, McLellan 1990). Responses of mammals to disturbance vary in degree from minor changes in activity pattern to displacement (escape) and reduced reproductive success or survival (Bromley 1985). Some species are able to minimize effects of chronic disturbance by moving away from disturbed areas or limiting use to times when disturbance is absent (Bromley 1985, Mace

and Waller 1996). Only if the habitat they are displaced from is limited in availability and critical will other costs, such as increased predation risk or a long-term decrease in foraging efficiency, become significant enough to affect survival and recruitment. However, many animals have certain life stages when they are more vulnerable. Carnivores, for example, tend to be confined to an area around a breeding den during the postpartum period when altricial offspring are developing locomotory skills. Disturbance resulting in displacement at this stage

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of the life cycle could have deleterious effects as a new den site must be found and offspring moved (Chapman 1977, Ballard et al. 1987, Thomson 1992).

For most carnivores, the denning period corresponds with summer conditions and, only reproductive animals are affected. Bears (Ursidae) represent an exception. Parturient females and most individuals of other age and sex classes remain sequestered in dens for up to 6 months when hibernating (Ramsay and Dunbrack 1986). Because of strict energy constraints and the importance of the den structure, disturbance in this phase of the annual cycle may have greater negative effects on survival and reproduction than disturbance at other times of the year.

For many bear populations, potential for human disturbance at winter dens has increased because 1) winter recreation in bear habitats is becoming increasingly popular, 2) extraction industries (logging, mining) are increasing their activity in bear habitat, and 3) bear populations are re-expanding their range into many areas with human activity. Many authors have expressed concern about the impacts of human activity on denning bears (Mannville 1983, Peek et al. 1987, Mattson 1990, Goodrich and Berger 1994, Wiig et al. 1996), and the subject was ranked among the top 5 research needs with respect to military activity (Asherin and Gladwin 1988).

This review summarizes what is known about bear denning chronology, behavior, physiology, and habitat selection and how denning bears respond to specific disturbance stimuli. The review covers 3 species of bears found in temperate and arctic regions, polar bears (*Ursus maritimus*), brown bears (*U. arctos*), and black bears (*U. americanus*).

Chronology of denning: potential for disturbance in time

While hibernation and denning are effective methods to conserve energy during winter, not all bears enter dens (Table 1). Among polar bears, pregnant females are the only class to consistently use dens (Ramsay and Stirling 1988). Other age and sex classes may reduce activity for periods of up to a month and use temporary shelters, but these are not regarded as true dens (Messier et al. 1992, 1994). Most age and sex classes of brown bears enter dens for part of winter. One exception is on Kodiak Island, Alaska, where some males remain

active all winter, possibly because of the availability of spawning salmon (*Oncorhynchus* spp., Van Daele et al. 1990). Some male brown bears from southern Europe also remain active during all or part of winter (Clevanger et al. 1992, Huber and Roth 1996, Roth et al. 1996). The variation observed in denning behavior reflects the large geographic area over which black bears are found. All black bears in northern latitudes den for winter, but many males and nonreproductive females remain intermittently or continually active during winter in southern ranges that lack snowfall (Hellgren and Vaughan 1987, Doan-Griber and Hellgren 1996).

Within populations, dates of den entry and exit vary greatly among age and sex classes and years. Adult males den consistently for shorter periods than pregnant females, with other classes having intermediate denning periods (Table 1, Lindzey 1981). In consequence, entry or emergence dates can vary by several months within a population in the same year (LeCount 1983, Van Daele et al. 1990). Annual variation in dates of den entry is generally attributed more to availability of autumn foods (berries, nuts, mast, salmon) than snowfall (Craighead and Craighead 1972, Johnson and Pelton 1980a, Tietje and Ruff 1980, Schooley et al. 1994, Van Daele et al. 1990). Emergence dates can vary with spring snowmelt and the consequent risk of dens being flooded (Schoen et al. 1987). Generally, length of time spent in dens is determined by climate and thereby habitat, latitude, and altitude. Bears living in northern areas den for longer periods than their southern counterparts. For example, duration of hibernation for pregnant female black bears can vary from 7 months in Alaska (Smith et al. 1994) to 3 months in Tennessee (Johnson and Pelton 1980a).

The period with potential for disturbing denning bears clearly varies with region and year. This period is not just the period of snow cover, as many bears begin denning before snow falls and may emerge before or after snowmelt. Because the denning period appears to be relatively predictable within a given region if snow conditions and autumn food abundance are monitored, there is a possibility of avoiding potentially disturbing activity during the period when bears den. However, hunting in early spring or late autumn, any snow-oriented winter recreation activities, and extraction industries that use frozen ground in winter all have the potential to disturb denning bears.

Table 1. Chronology of denning for polar, brown, and black bears.

Location	Latitude	Who dens? ^a	Denning period ^b										Ref. ^d
			Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	
Polar bears													
Svalbard	78	rF only							oo	oo			1
Canada													
archipelago	72–76	rF only	oo*o	oo++	++++	++++	++++	++++	ooo*	o			2
Beaufort Sea	68–76	rF only		oooo	oo*o	++++	++++	++++	oooo	*ooo			3
Wrangel Island	72	rF only		?	?				oo*	oo			4
Manitoba	57	rF only		?	?			o	o*oo	o			5
Manitoba	57	rF only		oooo	o+++	++++	++++	++++	oooo				6
Ontario	55	rF only		?	?			o	*ooo	o			7
Brown bears													
NW Alaska	68	all		ooo*	oooo	++++	++++	++++	++++	++oo	o*o		8
N Sweden	67	all	o	*oo+	++++	++++	++++	++++	++++	++oo	*ooo		9
Central Alaska	62	all	o	o*oo	o+++	++++	++++	++++	++++	+ooo	*ooo	o	10
S Sweden	61	all	o	ooo*	oooo	++++	++++	++++	oooo	o*oo	oooo	o	9
SE Alaska	57	all		oo*	oooo	oo++	++++	++++	+++o	oooo	*ooo		11
NE Kodiak Island	57	not all aM		oo	*oo*	oooo	++++	++++	+ooo	oooo	*ooo	oooo	12
SW Kodiak Island	57	all		oo	ooo*	oooo	++++	++++	oooo	oooo	*ooo	oooo	12
Banff NP Alberta	52				oo++	++++	++++	++++	+++o	oo			13
NW Montana	48	all			o*o	++++	++++	++++	+++o	o*o			14
NW Montana	48	all		ooo	*oo*	o+++	++++	++++	+ooo	*ooo	oo		15
Croatia	48	not all											16
Yellowstone NP	44	all		o	o*++	++++	++++	++++	++++	oo			17
Yellowstone NP	44	all	o	oooo	o*oo	ooo+	++++	+++o	ooo*	oo			18
N Spain	43						oo			oo			19
N Spain	43					ooo	oo*o	++++	+o*o	oo			21
Abruzzo, Italy	42	not all aM											21
Black bears													
Central Alaska	64	all	oo	*oo+	++++	++++	++++	++++	++++	+oo*			22
Central Alaska	62	all	ooo	o*oo	oo++	++++	++++	++++	++++	ooo	*oo		23
Kenai, Alaska	60	all	o	oo*o	oo++	++++	++++	++++	+++o	oo*o	oo		23
Central Alberta	55	all		oo*o	o+++	++++	++++	++++	++++	o*o			24
Central Ontario	55	all	o	ooo*	oooo	++++	++++	++++	+++o	o*oo			25
NW Montana	48	all		oooo	o*oo	++++	++++	++++	+++o	*ooo	o		15
N Minnesota	47	all		*						*			26
N Maine	46	all		ooo	o*o+	++++	++++	++++	++++	ooo*	o		27
Washington	46	all		o	*ooo	++++	++++	++++	o*oo	oo			28
S Montana	45	all	o	oo*o	o+++	++++	++++	++++	++++	o*oo	o		29
N Michigan	45	all			ooo	o*oo	++++	++++	o*oo	oo			30
Idaho	44	all		ooo	*ooo	++++	++++	++++	++++	+o*o			31
New York	42	all			oooo	*ooo	++++	++++	+ooo	*ooo			32
California	38	63% aM act			o	oo*			*	oooo	oooo		33
Nevada	37	all				o*o+	++++	++++	+o*o	o			34
Nevada	37	all			o*	o+++	++++	++++	+ooo	*o			34
Virginia	36	14% act				oo*	oo++	++++	++oo	*oo			35
N. Carolina	35	some act				oo*	o+++	++++	+++*	o			36
Arizona	35	all		oo	oo*o	oo++	++++	+++o	oooo	*ooo	o		37
Tennessee	35	all				o	*o++	++++	++oo	*ooo	o		38
E Arkansas	35	5 % act				*o	oo++	++++	++oo	o*			39
E Arkansas	33	all					o*o+	++++	+o*o				40
California	34	no			oooo	o*oo	++++	++++	oo*o	o			41
Louisiana	fo ^c 32	34 % act			o	*o++	++++	++++	++++	ooo*	oooo		42
Florida	fo 30	all aM act				o*	o+++	++++	++++	+++*	oo		43
N. Mexico	fo 29	all aM act				o*	o+++	++++	++++	+o*o			44

^a "rF" = reproductive female (with yearlings or cubs-of-the-year), "aM" = adult males, "act" = active.

(continued)

Table 1 (continued). Chronology of denning for polar, brown, and black bears.

^b Each month is divided into 4 quarters. The quarter containing the average entrance and emergence dates (•), the range of quarters in which bears began to den or emerge (o), and the quarters during which all bears were denned (+) are shown.

^c Populations where data on females only is presented are marked with "fo".

^d 1=Larsen 1985, 2=Messier et al. 1994, 3=Armstrup and Gardner 1994, 4=Uspenski and Kistchinski 1972, 5=Jonkel and Cowan 1971, 6=Ramsay and Stirling 1988, 7=Kolenosky and Prevett 1983, 8=Ballard et al. 1991, 9=Swenson unpublished, 10=Miller 1990, 11=Schoen et al. 1987, 12=Van Daele et al. 1990, 13=Vroom et al. 1977, 14=Servheen and Klaver 1983 cited in LeFrance et al. 1997, 15=Aune 1994, 16=Huber and Roth 1996, 17=Craighead and Craighead 1972, 18=Judd et al. 1986, 19=Clevanger and Purroy 1991, 20=Naves and Palomero 1993, 21=Roth et al. 1996, 22=Smith et al. 1994, 23=Schwartz et al. 1987, 24=Tietje and Ruff 1980, 25=Kolenosky and Strathearn 1987, 26=Rogers 1987, 27=Schooley et al. 1994, 28=Lindzey and Meslow 1976, 29=Mack 1990, 30=Manville 1987, 31=Beecham et al. 1983, 32=O'Pezio et al. 1983, 33=Graber 1990, 34=Goodrich and Berger 1994, 35=Hellgren and Vaughan 1989, 36=Hamilton and Marchinton 1980, 37=LeCount 1983, 38=Johnson and Pelton 1980a, 39=Smith 1986, 40=Oli et al. 1997, 41=Novick et al. 1981, 42=Weaver and Pelton 1994, 43=Wooding and Hardisky 1992, 44=Doan-Crider and Hellgren 1996.

Den construction and den-site selection: potential for disturbance in space

Types of dens used and the locations selected varied within and among species (Table 2). Polar bears generally use snow dens (dens tunneled into snowdrifts). Only in the southerly Hudson Bay region did polar bears excavate dens in the soil (Kolenosky and Prevett 1983, Clark et al. 1997). Generally, polar bear dens were located in tundra habitats, although pack ice was used extensively in the Beaufort Sea (Lentfer and Hensel 1980, Armstrup and Gardner 1994) and the tundra-boreal forest ecotone was used around Hudson Bay (Ramsay and Stirling 1990, Clark et al. 1997). Dens on land were commonly concentrated, resulting in locally high densities (Uspenski and Kistchinski 1972, Larsen 1985, Armstrup and Gardner 1994, Clark et al. 1997, Ovsyanikov 1998), although this trend was not universal (Messier et al. 1994). These concentrations often were associated with the upper portion of steep hillsides and lee slopes (Larsen 1985, Ovsyanikov 1998). Dens in the tundra-forest ecotone tended to be more dispersed, although confined generally to specific suitable regions (Clark et al. 1997, Ramsay and Stirling 1990). Successive dens occupied by individual bears tended to be within the same geographic region, but not at the same site, with a mean of 308 km (range 20–1,300 km) between dens. In some regions, annual variation in denning location could be due to shifting ice conditions (Stirling and Andriashek 1992). Dens varied in distance from the sea, with dens on Svalbard (Norway) averaging 3 km and dens around Hudson Bay ranging from 29 to 118 km (Kolenosky and Prevett 1983, Larsen 1985, Ramsay and Andriashek 1986). Pack-ice dens

were the most dispersed and least predictable, in part due to the shifting nature of the substrate (Armstrup and Gardner 1994, Lentfer 1975). The nature of snow dens precludes reuse.

Brown bears used a greater variety of den types, with much variation among populations. Excavations in soil, often dug under tree roots or ant hills for stability, were the most common, although natural cavities and caves appeared to be used where they occur, especially in southern European and coastal Alaskan areas. Brown bear dens were associated rarely with hollow trees or were simply dug in snow. Dens in natural cavities were reused at much greater rates than excavated dens, indicating that they were either preferred and more limited or that excavated dens did not persist (Van Daele et al. 1990, Groff et al. 1998). Concentrations of denning brown bears have been found in areas where natural cavities (Naves and Palomero 1993, Huber and Roth 1996) and excavated dens (Swenson et al. 1996) were used. Successive dens for individual bears tended to be within the same region but almost never in the same den structure, with mean distances varying from 1.7 km to 8.8 km in separate studies and with a few individuals moving up to 30 km (Schoen et al. 1987, Miller 1990, Van Daele et al. 1990, Ballard et al. 1991). Females showed greater degrees of den-area fidelity than males (distances separating dens in separate years averaging 3.5 versus 8.8 km in Southeast Alaska, 1.7 versus 7.8 km on Kodiak Island for females and males, respectively). Fidelity to region rather than den also indicated that suitable denning sites are not often limited. Dens were located in treeless alpine areas, the forest-alpine ecotone, or forest depending on availability. There appeared to be a trend for middle elevations to be used, with valley bottoms and high peaks avoided (Table 2). The general pattern was

for the use of relatively high-altitude areas with the most stable snow conditions possible, rather than specific habitat types. Use of steep slopes was

strong, with mean slopes ranging from 30° to 50°. Aspect use varied enormously within and between studies (Harding 1976, Judd et al. 1986), perhaps

Table 2. Topographic and habitat characteristics (mean and (range)), and den construction type of brown bear and black bear dens.

Location	n	Slope use in degrees	Altitude used	Altitude available	Den construction (%) ^a				Habitat type (%) ^b				Ref ^c			
					N	Exc	Cave	Veg	Sn	Tr	n	Tun		For	Eco	Alp
Brown bears																
N. Yukon	70	40 (20-80)			24	96			4		24	100		1		
N. Alaska	70	54	816		29	93	7				29		10	90	2	
N. Alaska	70		1,063		49	70	30								3	
NW Alaska	68	>30	500	0-1,200	86	100									4	
N Alaska	68	(20-35)			52	75	25								5	
N Sweden	67				21	47	43		10						47	
Central Alaska	62	32 (11-60)	1,200 (320-1,626)		96	99	1				102		48	52	6	
SW Yukon	62	35 (30-40)	1,250		10	100									7	
S Sweden	61				125	86	10		4						47	
SE Alaska	57	35 (5-75)	640 (6-1,190)	0-1,400	38	29	63		8		38		52	22	13	8
Kodiak Island	57	>45	450 (128-915)	0-1,000	135	82	13		5		320		1	43	56	9
(2 sites)			665 (91-1,189)	0-1,300												
SW Alaska	57	40 (0-60)	450 (30-1,000)	0-1,200	30	96			4		30		50	50	10	10
Rocky Mts.	53	57	2,174		60	93	7				60		100		11	11
Rocky Mts	53	26	2,057								24		42	8	50	12
Jasper NP	53	27 (15-40)	2,236		10	90	10				38		71	29	13	13
Banff NP	53	33 (21-35)	2,200 (2,050-2,300)	1,300-1,500	47	100										14
NW Montana	48	30 (21-35)	2,124 (2,050-2,500)	850-3,000	15	100										15
NW Montana	48	57 (51-62)	2,166	1,280-2,800												16
N. Italy	46	39 (28-60)	1,431 (970-1,940)	500-3,000	21	10	90				19		95	5	17	17
N. Italy	46	44 (<63)	1,600 (951-2,450)	700-2,300	12	75	25									18
Croatia	46	48 (20-90)	836 (450-1,370)	400-1,500	28	7	79		10	4	28		100		19	19
Yellowstone NP	44	45 (30-60)	2,470 (2,000-3,050)	1,500-4,200	33	91	6		3		55		100		20	20
Yellowstone NP	44				11	100										21
N Spain	43		(1,400-1,520)		7		100				7		100		22	22
N Spain	43	32 (11-52)	1421 (580-2,400)		74	22	78				74		95	5	23	23
S France	43				11	42	68				11		100		24	24

continued

^a Exc = excavated, Cave = natural cave or cavity, Veg = vegetation only nest, Sn = snow den, Tr = tree or hollow log den,

^b Tun = tundra / muskeg, For = forest / swamp forest and shrub, Eco = forest / alpine ecotone, Alp = alpine meadows

^c 1=Harding 1976, 2=Garner et al. 1984, 3=Quimby and Snarski 1974 cited in LeFranc et al. 1987, 4=Ballard et al. 1991, 5=Reynolds et al. 1976, 6=Miller 1990, 7=Russell 1978, 8=Schoen et al. 1987, 9=Van Daele et al. 1990, Smith and Van Daele 1990, 10=Lentfer et al. 1972, 11=Aune et al. 1986, 12=Wielgus 1986 cited in LeFranc et al. 1987, 13=Russell 1978 cited in LeFranc et al. 1987, 14=Vroom et al. 1977, 15=Servheen and Klaver 1983 cited in LeFranc et al. 1987, 16=Aune 1994, 17=Groff et al. 1998, 18=Roth 1972, 19=Huber and Roth 1996, 20=Judd et al. 1986, 21=Craighead and Craighead 1972, 22=Clevenger and Purroy 1991, 23=Naves and Palomero 1993, 24=Camarra 1987, 25=Smith et al. 1994, 26=Schwartz et al. 1987, 26=Tietje and Ruff 1980, 28=Kolenosky and Srathearn 1987, 29=Lindzey and Meslow 1976, 30=Jonkel and Cowan 1971, 31=Manville 1987, 32=Mack 1990, 33=Beecham et al. 1983, 34=Alt and Gruttdauria 1984, 35=Beck 1986, 36=Goodrich and Berger 1994, 37=Hayes and Pelton 1994, 38=Oli et al. 1997, 39=Hellgren and Vaughan 1989, 40=Hamilton and Marchinton 1980, 41=LeCount 1983, 42=Johnson and Pelton 1980b, 43=Wathen et al. 1986, 44=Novick et al. 1981, 45=Weaver and Pelton 1994, 46=Wooding and Hardisky 1992, 47=Doan-Crider and Hellgren, 1996, 48=Swenson unpublished.

due to selection for slopes with the right wind and sun exposure to produce stable snow conditions for the required length of time.

Black bears used a much greater diversity of den types (Table 2) compared to polar or brown bears. Excavated dens and natural cavities are used commonly in northern regions, whereas hollow trees and ground nests constructed in dense vegetation are used commonly in southern regions. Rates of reuse vary from 5–6% to 30–58% for excavated dens (Lindzey and Meslow 1976, Tietje and Roff 1980, Beecham et al. 1983, LeCount 1983, Schwartz et al. 1987) and up to 70–100% for natural cavities (Schwartz et al. 1987). Reuse is rarely by the same bear (Novick et al. 1981). Forest or dense shrub areas were the most commonly used habitats for dens. Many black bear populations live in flat taiga or coastal swamp areas, where slope or altitude selection cannot be displayed. In areas with greater topographic variation, 20–50° slopes are generally selected at middle altitudes. In areas where black and brown bears have been studied in sympatry, black bears selected lower altitudes than brown bears (Miller 1990, Aune 1994). Aspect selection was complex, without a clear trend, but it was presumed that the local stability of snow conditions is among the important determinants.

Spatial potential for disturbing denning bears is great, as their choice of habitat is often similar to that of people. In arctic areas, industrial activity tends to concentrate along the coast, therefore leading to potential conflict with denning polar bears (Armstrup 1993, Armstrup and Gardner 1994, Wiig et al. 1996). While much development (road and house construction, hydroelectric development) occurs in valley bottoms and thus avoids prime den areas, ski resorts tend to be built on steep slopes with stable snow conditions, exactly the same conditions that brown and black bears select (Goodrich and Berger 1994). Black bears will generally be more vulnerable to valley-bottom disturbance than brown bears because of their greater use of lower slopes (Miller 1990, Aune 1994). The fact that suitable denning habitat can be identified, from field study or by using GIS maps (Clark et al. 1998), means that important areas with concentrations of sites can be given special consideration when planning activity in winter. If disturbance is unavoidable, the fact that bears usually move several kilometers between successive denning seasons and generally have a low level of den reuse implies that loss of a localized denning area (smaller than individual home ranges) to devel-

opment should have minimal effects provided suitable alternative habitat is available nearby (within the individuals' home ranges). An exception may occur if the disturbed area contains a high number of natural cavities or hollow trees, where these are favored over excavated dens.

There are reasons to expect that different den types offer different levels of physical protection, thermal insulation, acoustic insulation, and vulnerability to flooding and that these factors should have significant effects on reproduction and vulnerability to disturbance (Smith 1986, Oli et al. 1997, McDonald and Fuller 1998). Despite the fact that this data is essential to evaluate the relative importance of the different den types, there is not enough information yet for definitive conclusions.

Hibernation physiology and the potential energetic costs of disturbance

The occurrence of true hibernation in bears has been debated for over 30 years, but the answer depends on how hibernation is defined (Watts et al. 1981). If the definition is generalized to include significant energy savings through body temperature reduction and a slowing of metabolism, then bears must be regarded as functional hibernators (Folk et al. 1977, Farley and Robbins 1995).

During the denning period, bears decrease core body temperature to between 32°C and 35°C (Hissa 1997, Hellgren 1998). Although smaller hibernating species may allow their body temperatures to drop to close to 0°C, bears appear to have a limit of 32°C (Hissa 1997, Hellgren 1998). Metabolism is reduced and heart rate slows to approximately 18 beats/minute (Reynolds et al. 1986). An energy-sparing sleep state called non-rapid eye movement (NREM) is entered. The structure of the den, any bedding, and the layer of air trapped between bear and den wall provide thermal insulation from winter temperature extremes. Rates of heat flow between the bear and outside are therefore reduced and rates of energy use are reduced by between 60 and 80% (Watts et al. 1987, Watts and Jonkel 1988, Watts and Cuyler 1988).

Bears do not eat, drink, defecate, or urinate between den entry and den emergence. Therefore, all energy is provided by fat reserves, water is obtained as a product of fat metabolism, and all metabolic waste products are stored (Folk et al. 1972, Ramsay and Dunbrack 1986, Hissa 1997,

Hellgren 1998). Energy requirements of pregnant females are relatively high while denning because they give birth to multiple altricial young in mid-

winter and lactate for several months (Ramsay and Dunbrack 1986, Farley and Robbins 1995). Despite the reduced metabolism of the hibernation state,

Table 2 (continued). Topographic and habitat characteristics (mean and (range)), and den construction type of brown bear and black bear dens.

Location	Slope use in degrees	Altitude used	Altitude available	Den construction (%) ^a					Habitat type (%) ^b					Ref ^c
				N	Exc	Cave	Veg	Sn	Tr	n	Tun	For	Eco	
Black bears														
Central Alaska	64		Flat	41	83	5		12		41	100			25
Central Alaska	62	624 (267-1,324)	300-2,300	91	56	41			3	91		91	9	26
South Alaska	61			17	20	60			20					26
South Alaska	60		Flat	96	96	3			1	96		100		26
Central Alberta	55		Flat	37	95					37		100		27
Central Ontario	53		Flat	98	89	3			5	98		100		28
NW Montana	48	1,715 (1,632-1,798)	1,280-2,863											16
Washington	46			12	67	16			17					29
Central Montana	46			127	14	72	13							30
N Michigan	45		Flat	31	78		3	19		31		100		31
S. Montana	45	2,239 (1,768-2,682)	1670-3000	16	31	69								32
W. Idaho	44	15		65	72	3			25	65		100		33
Pennsylvania	40			27	11	63	22		4					34
Colorado	37			55	35	62	3							35
Nevada	37	15(0-35)	2,656 (2,250-3,000)	9		56	22		22					36
Nevada	37	21 (10-33)	2,310 (1,799-2,713)	30	3	37			60					36
Arkansas	36			48	12	67	17		4	48		100		37
Arkansas	36		Flat	51	4		6		90	51		100		38
Virginia	36		Flat	28	39		50		11	29		100		39
N Carolina	35		Flat	5			80		20	5		100		40
Arizona	35	30 (7-48)	1,500 (750-1,900)	68	76	24				68		100		41
Tennessee	35			36	28	6			66	36		100		42
Tennessee	35			95	13	11			69					43
S California	34	963	230-2,024	7	100		7			7		100		44
Louisiana	32	49 (30-60)	2,250 (1,900-2,500)	32						32		100		45
N. Florida	30		Flat	14			44		56	32		100		46
N. Mexico	29		Flat	14		100	100			14		100		47

^a Exc = excavated, Cave = natural cave or cavity, Veg = vegetation only nest, Sn = snow den, Tr = tree or hollow log den,

^b Tun = tundra / muskeg, For = forest / swamp forest and shrub, Eco = forest / alpine ecotone, Alp = alpine meadows

^c 1=Harding 1976, 2=Garner et al. 1984, 3=Quimby and Snarski 1974 cited in Lefrance et al. 1987, 4=Ballard et al. 1991, 5=Reynolds et al. 1976, 6=Miller 1990, 7=Russell 1978, 8=Schoen et al. 1987, 9=Van Daele et al. 1990, Smith and Van Daele 1990, 10=Lentfer et al. 1972, 11=Aune et al. 1986, 12=Wielgus 1986 cited in Lefrance et al. 1987, 13=Russell 1978 cited in Lefrance et al. 1987, 14=Vroom et al. 1977, 15=Servheen and Klaver 1983 cited in Lefrance et al. 1987, 16=Aune 1994, 17=Groff et al. 1998, 18=Roth 1972, 19=Huber and Roth 1996, 20=Judd et al. 1986, 21=Craighead and Craighead 1972, 22=Cleaver and Purroy 1991, 23=Naves and Palomero 1993, 24=Camarra 1987, 25=Smith et al. 1994, 26=Schwartz et al. 1987, 26=Tietje and Ruff 1980, 28=Kolenosky and Srathearn 1987, 29=Lindzey and Meslow 1976, 30=Jonkel and Cowan 1971, 31=Manville 1987, 32=Mack 1990, 33=Beecham et al. 1983, 34=Alt and Gruttaduria 1984, 35=Beck 1986, 36=Goodrich and Berger 1994, 37=Hayes and Pelton 1994, 38=Oli et al. 1997, 39=Hellgren and Vaughan 1989, 40=Hamilton and Marchinton 1980, 41=LeCount 1983, 42=Johnson and Pelton 1980b, 43=Wathen et al. 1986, 44=Novick et al. 1981, 45=Weaver and Pelton 1994, 46=Wooding and Hardisky 1992, 47=Doan-Crider and Hellgren, 1996, 48=Swenson unpublished.

weight loss during winter can be substantial. Weight losses of 8–20% have been reported for nonreproductive animals and from 25 to 40% for reproductive females (Tietje and Ruff 1980, Watts et al. 1981, Kingsley et al. 1983, Watts 1990, Farley and Robbins 1995) and appear to be more pronounced for brown bears than black bears (Farley and Robbins 1995). Clearly there is a limited margin of energy available for bears to compensate for increased energetic expenditure due to disturbance while denning.

In general, little is known about the physiological responses of denning bears to disturbances and their energetic costs, but there are enough indications and a sufficient understanding of the behavioral and physiological processes to make predictions. Potential responses to disturbance range along a continuum. First-level responses could involve waking from NREM sleep, slight body warming, or increased heart rate. These are followed by movement within the den, raising body temperature to normal levels with an accompanying 60–80% increase in metabolic rate, and ultimately den abandonment. Based on the data reviewed here, we predict that the impact of these responses on survival increases dramatically at each step, with den abandonment having the greatest cost, especially for neonatal cubs, which may not survive exposure to ambient temperature during midwinter (Blix and Lentfer 1979). However, even minor physiological changes like frequent waking or small increases in body temperature may have a cumulative effect on energy use and consequent weight loss that may be significant.

Unlike small mammalian hibernators, bears can wake and achieve relatively full mobility over a matter of minutes (Nelson and Beck 1984). Observations indicate that experimental bears are sensitive to sounds and may change physiological state in response to minor

acoustic stimuli (B. Barnes, personal observation), although no experimental work is known which specifically tested these responses. The period required to regain their previous quiescent, hibernating state may vary from a few days to over a week (Craighead et al. 1976).

How do denning bears respond to disturbance?

No systematic data are available on how denning bears react to disturbance using controlled stimuli. The only response that has been generally reported is den abandonment, which is the most extreme reaction possible. Here we review the available information and try to derive some patterns from it.

Reynolds et al. (1986) presented data on heart rate and activity responses of 3 brown bears exposed to human activity (seismic exploration). Results were varied, but in 3 of 5 cases, bears responded to seismic shots, drilling, or a vehicle driving at a distance of one to 2 km with increased heart rate or increased physical activity. A snow-tractor driving within 100 m of the den had no effect on one bear. Other studies have reported increased activity of denned bears indicated by motion-sensitive radio-collars in response to radio-

Table 3. Linear mean distances (with range) of bear dens to various centers of human activity.

Region	Distance ^a to human activity ^b km				Reference
	Path	Road	Habitation	Activity	
Brown Bear					
Yellowstone		0.5 (0.1–1.5)	1.5 (0.2–4.0)		Craighead & Craighead 1972
Italy	0.2(0.1-0.5)	1.2 (0.4–2.8)	3.5 (1.3–6.5)		Groff et al. 1998
Spain		1.7	2.0		Naves & Palomero 1993
Croatia		0.5 (0.1–1.6)	1.4 (0.2–4.0)		Huber & Roth 1996
SW Alaska				≥1.5	Smith & Van Daele 1990
Black Bear					
Nevada		≥0.8			Goodrich & Berger 1994
Alberta		≥0.3		≥1.5	Tietje & Ruff 1983
Michigan				1.0(0.1–2.7)	Manville 1987
SE Alaska				≥3.4	Schoen et al. 1987

^a Distances do not account for differences in altitude, which in some cases may be significant. In several cases the distance presented does not represent the mean or the range, but is based on a minimum distance that some bears were observed to den from human activity areas.

^b Path = a nonvehicle pedestrian path, road = vehicle use, habitation = house, village or town, activity = industrial activity and other unspecified point sites with human presence in winter.

tracking overflights (Schoen et al. 1987, Smith and Van Daele 1990).

Further indications of bear response to disturbance are available from the distances of dens from human features like roads, towns, and industrial sites (Table 3). The presence of bear dens within one kilometer of regularly traveled roads or areas of active human habitation indicates that bears do not totally avoid denning in areas purely because of their proximity to human activity (Tietje and Ruff 1983). A large black bear population denned within an extensive military training area (Fort Wainwright, Alaska) without any registered cases of disturbance by military activity (Hechtel 1991; Smith et al. 1994; M. E. Smith, personal communication). Although Schoen et al. (1987) reported that brown bears gradually withdrew their den sites from an area of developing mining activity in Alaska, the short distances reported for European brown bears were to long-established sources of potential disturbance. In general, bears often appeared to choose dens close (within one km) to fixed sources of predictable disturbance (Smith and Van Daele 1990, McDonald and Fuller 1998). In a sparsely populated area of southern Sweden, brown bears were shown to prefer den sites more than one km from roads and houses and >3 km from villages (Swenson et al. 1996).

Armstrup (1993) and Armstrup and Gardner (1994) present data on polar bear response to disturbance. Denned polar bears appeared to be very tolerant to disturbance close to dens, although when disturbed, they were more prone to leave dens earlier in the season. After they gave birth, the cost of den relocation rises dramatically, as young cubs will be exposed to thermal stress and predation before they are fully mobile. Therefore, females with cubs should tolerate greater levels of disturbance without abandoning dens. Oil-field activity, snow vehicles, and aircraft were tolerated to within 500 m of dens without abandonment. Some approaches <250 m of a few dens caused abandonment, although there was no overall difference between the abandonment rates of disturbed and nondisturbed bears. Two bears were approached to <50 m by snowscooters without effect. This variation could result from how different sounds or vibrations are transferred through snow to the denning bear, as snow dens provide excellent acoustic insulation (Blix and Lentfer 1992). The stress of prepartum recapture inside the den and subsequent relocation of den site did not appear to have

any dramatic effects on litter size or spring weight of cubs (Ramsay and Stirling, 1986).

Brown bears showed a similar tolerance for industrial activity disturbance within a few kilometers of dens (Harding and Nagy 1980, Schoen et al. 1987, Smith and Van Daele 1990). Dens that were approached directly were sometimes abandoned (Harding and Nagy 1980, Reynolds et al. 1986, Huber and Roth 1996). Craighead and Craighead (1972) dug into a den, photographed the occupant, and retreated without the bear abandoning the den. Den abandonment also may result from natural circumstances such as flooding (Schoen et al. 1987, Huber and Roth 1996, Oli et al. 1997).

Swenson et al. (1997) found that in Sweden, 9% of brown bears (194 bear winters) abandoned or changed their dens during winter, with no differences between males and females. Adult females with cubs of the year that abandoned dens during winter had significantly greater mortality among their cubs than those that did not abandon their dens (60% versus 6% lost at least one cub). In 18 cases of den abandonment that were investigated on the ground, 12 showed evidence of human activity close by. These activities included hunters (4), forest workers (2), dog tracks (1), digging machine (1), and "people" (4, Swenson et al. 1997). New dens were found within a mean of 5.1 km (range 0.1–30 km) from the former den. In Norway in April 1996, an unmarked female with cubs of the year abandoned her den after being disturbed by a skier and dog looking inside the den. These cubs were abandoned and were humanely killed after several days.

Black bears also abandon dens through natural causes (Hamilton and Marchinton 1980, LeCount 1983, Schwartz et al. 1987, Smith 1986, Mack 1990, Oli et al. 1997). Flooding has been shown to cause cub mortality (Alt 1984); however, the greatest proportion of den abandonments were caused by human disturbance, especially researcher activity. Black bears in dens are often approached on foot to determine den structure and reproductive state and are often weighed and recollared in dens as part of standard field protocols. While some individuals tolerate approach and handling (Doan-Griber and Hellgren 1996) and even weighing and collaring of cubs (Elowe and Dodge 1989) without abandoning their den, others do abandon the den (Table 4). This has led to the abandonment of newborn cubs (Graber 1990, Goodrich and Berger 1994). Black bears that changed dens during winter had a

Table 4. Studies of black bears that report den abandonment (abnd.) from various human-induced causes.

Region	Bear response to disturbance	Reference
Alaska	3 cases of abnd. after den visit	Schwartz et al. 1987
Alberta	6 of 109 den visits caused abnd.	Tietje and Ruff 1980
Ontario	19 of 97 den visits caused abnd.	Kolenosky and Strathearn 1987
Michigan	22 of 45 den visits caused abnd. 2 cases of abnd. following mechanical activity within 200m	Manville 1983 Manville 1987
Montana	3 of 26 bears abnd. during winter following human activity	Mack 1990
Minnesota	2 litters died following female abandonment caused by nonresearch, human disturbance	Elowe and Dodge 1989
Minnesota & Massachusetts	Den visits led to abandonment and cub mortality (unspecified percentage)	Macdonald and Fuller 1998
Idaho	11 of 19 den visits caused abnd. early in season	Beecham et al. 1983
California	8 of 63 den visits caused abnd.	Graber 1990
Nevada	12 of 36 den visits caused abnd.	Goodrich and Berger 1994
N. Carolina	10 of 14 den visits caused abnd.	Hellgren and Vaughan 1989
N. Carolina	1 cases of abnd. after researcher approach 1 case of hunting dogs driving bear from den	Hamilton and Marchinton 1980 Hamilton and Marchinton 1980
N. Carolina	8 of 11 bears abnd. dens due to disturbance	Lombardo 1990
Arkansas	9 of 36 den visits caused abnd.	Smith 1986

greater weight loss than undisturbed bears (25% weight loss versus 16%, Tietje and Ruff 1980). Bears appeared more likely to abandon dens when disturbed early in the season (Tietje and Ruff 1980, Smith 1986, Kolenosky and Strathearn 1987) than later. Southern bears appeared to abandon dens at greater frequency than northern bears (Table 4, but see Doan-Griber and Hellgren 1996 for an exception). Milder winter climates clearly impose a smaller cost of abandonment, thereby implying that bears vary their threshold to disturbance depending on costs. Thresholds varied, but often a cautious human approach (<100 m) to the den was enough to make some bears leave (Manville 1983, Graber 1990, Goodrich and Berger 1994). Smith (1986) found different thresholds for different den types, with tree-denning bears being more tolerant of approach than ground-nesting bears. Other documented sources of disturbance leading to abandonment have included military training (Lombardo 1990), hunting dogs (Hamilton and Marchinton 1980), snowscooter traffic (Elowe and Dodge 1989), and oil-well activity within 200 m of the den (Manville 1987). Most disturbed bears redenned (Kolenosky and Strathearn 1987, Hellgren and Vaughan 1989) and even successfully had cubs (Smith 1986), although this trend was not universal, as some cubs died following den abandonment (Elowe and Dodge 1989, Goodrich and Berger 1994).

In conclusion, there appears to be a pattern that bears readily den within one to 2 km of human activity (roads, habitation, industrial activity) and appear to be undisturbed by most activities that occur at distances greater than one km. Activity closer than one km and especially within 200 m has variable results, with some bears tolerating activity right up to the den. However, there is a significant risk that activity within this zone will lead to abandonment, especially early in the denning season. Den abandonment has been shown to cause cub mortality in black and brown bears. The fact that dens are rarely reused (cavities and tree dens excepted) and that bears usually separate consecutive dens by several kilometers implies that loss of an area to disturbance will not have a great effect, provided that other suitable areas exist nearby.

Recommendations and research needs

Based on this review and analysis, we recommend the following regarding human activity and bear denning:

- 1) Den concentrations should be identified;
- 2) den trees or natural cavities should be protected;
- 3) winter activity should be minimized in suitable or traditional denning areas;
- 4) if winter activity is unavoidable, it should

begin around the time bears naturally enter dens, so that they can choose to avoid disturbed areas;

5) winter activity should be confined to regular routes as much as possible; valley-floor activity should generally have less effect than valley-slope activity;

6) activity should avoid known bear dens by at least one km;

7) the slightest degree of off-road activity is likely to cause greater effects than any degree of fixed-point or predictable-route activity and should therefore be minimized;

8) tagging cubs in dens may lead to extra mortality and should be avoided in small or endangered populations.

These conclusions are tentative. Controlled disturbances and experiments are required to further determine 1) thresholds that bears have to different stimuli, 2) how bears behaviorally respond to stimuli, and 3) what the costs are in terms of increased metabolism. Because of the endangered nature of many bear populations, such experiments should be conducted on captive bears or on large populations. Furthermore, experiments on the thermal and acoustic properties of different den types are required, as is an extended analysis of existing data on the reproductive effects of den type.

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EXHIBIT 7

CHAPTER II. BIOLOGICAL OPINION FOR GRIZZLY BEARS

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A. CONTEXT OF THE PROPOSED ACTION FOR GRIZZLY BEARS

The proposed action is described in detail in Chapter I of this biological opinion.

This section identifies the action area for the proposed action. Next this section describes the guidelines and standards that provide conservation for grizzly bears when actions are carried out under the Proposed Action (i.e., the Revised Plan). Section B. of this biological opinion describes the status of the grizzly bears. Section D. describes the baseline condition of the grizzly bears populations and their habitat in the action area. Section E. provides an analysis of the effects of the proposed action on the grizzly bears. This is followed by our conclusion, incidental take statement, reinitiation notice, and literature considered in the biological opinion. This opinion will consider the effects of implementation of the proposed framework of the Revised Plan as well as the effects of proposed measures to be implemented at the project level. However, this biological opinion does not provide a detailed analysis for effects of specific projects. Future projects undertaken by the USFS will undergo detailed, site-specific analysis for effects on listed species.

1. Action Area

The “action area” includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action [50 CFR §402.02]. The action area does not necessarily include all areas potentially frequented by far-ranging, or migrant, species (USFWS and NMFS 1998, pp. 4-15 to 4-19).

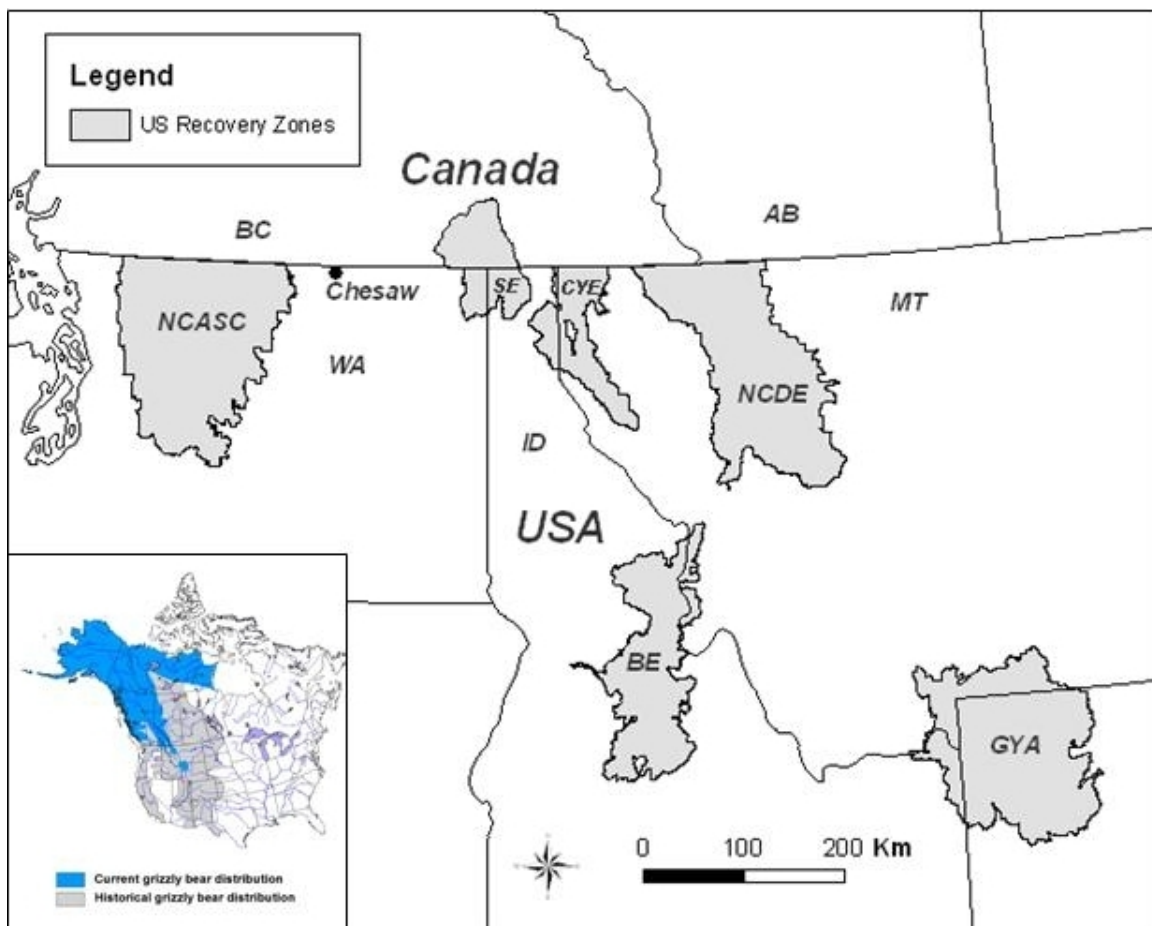
The Recovery Plan prompted the identification of six grizzly bear recovery zones ([Figure II-1](#)), defined as areas within which the population and habitat criteria for achievement of recovery will be measured (USFWS 1993, p. 33): CYE, NCDE, Selkirk Ecosystem (SE), Bitterroot Ecosystem (BE); North Cascades Ecosystem (NCASC), and Yellowstone Grizzly Bear Ecosystem (YGBE). As previously described in Chapter I, two grizzly bear recovery zones overlap the IPNF: the CYE and the SE. The CYE is situated in the KNF, IPNF, and a small portion of the Lolo National Forest. The SE is situated in the IPNF, Colville National Forest (CNF), and British Columbia, Canada.

In some areas, grizzly bears associated with the CYE and SE have been consistently documented in places outside the boundaries of the CYE and SE. These land areas are referred to as “bears outside recovery zone” (BORZ) areas and are characterized by recurring use by grizzly bears (USFS 2011d, p. 11; [Figure II-2](#)). Grizzly bears may also be observed infrequently on other areas of the IPNF outside the recovery zones and BORZ areas. Therefore, the action area is the entire IPNF.

After grizzly bears were listed under the ESA, the Interagency Grizzly Bear Committee (IGBC) was established to develop guidelines for bear management (see IGBC 1986). The National Forests, Bureau of Land Management, and National Parks, in coordination with the Service, delineated bear management units (BMUs) within each recovery zone to aid in managing habitat and monitoring population trends and to apply the recommendations of the IGBC. In the CYE and SE recovery zones, BMUs approximate the annual home range size of adult females (from 50 to over 150 square miles). The BMUs and are not intended to depict the actual location of

female home ranges on the landscape. Rather, the BMUs were identified to delineate analysis areas of the appropriate size for considering land use effects upon grizzly bears, to provide enough quality habitat for home range use, and to ensure that grizzly bears were well distributed across each recovery zone.

Figure II-1. Current and historic grizzly bear range and location of recovery ecosystems (In USFWS 2011a, p. A-11).



- Inset map illustrates historic (grey shade) and current grizzly bear distribution (dark blue). Adapted from Proctor et al. (in review),
- GYA = Greater Yellowstone Area; NCDE = Northern Continental Divide Ecosystem; CYE = Cabinet-Yaak Ecosystem; SE = Selkirk Ecosystem; BE = Bitterroot Ecosystem; NCASC = North Cascades Ecosystem.

2. Relationship of the Proposed Action to Existing Management

Current management of grizzly bear habitat is prescribed by the 1987 Forest Plan (existing plan) and the Interagency Grizzly Bear Committee (IGBC) was established to develop guidelines for bear management (see IGBC 1986).

Under the existing plan, the IPNF applies the Guidelines of the IGBC (USFS 1986, entire) across the grizzly bear Management Situations (MS) (1 through 5) as delineated throughout the two recovery zones in the IPNF. All of the lands within each recovery zone have been delineated into one of two management situations: MS1 or MS3. As information and science related to grizzly bears evolved, the USFS began managing MS1 and MS2 essentially the same on NFS lands, according to direction for MS1. In MS1, management focuses on grizzly bear habitat maintenance and improvement and the minimization of grizzly-human conflict and management decisions are expected to favor the needs of the grizzly bear when grizzly habitat and other land use values compete. MS3 lands include private lands, campgrounds, or other lands where grizzly bear presence and factors contributing to their presence will be actively discouraged. The IGBC Guidelines list eight elements on how to minimize grizzly bear-human conflict potential as it relates to wildlife management (USFS 1986, pp. 6-7). If the guidelines are met, then the management direction for each management situation is met.

The IPNF also implements the recently completed Forest Plan Amendments for Motorized Access Management within the SE and CYE Grizzly Bear Recovery Zones on the Kootenai, Idaho Panhandle, and Lolo National Forests (Grizzly Bear Access Amendment or Access Amendment [USFWS 2011a, entire]). The Grizzly Bear Access Amendment established standards for core, open motorized route density (OMRD) and total motorized route density (TMRD) for each BMU in the CYE and SE. Route densities include both roads and motorized trails. The road density standards are derived from the research of Wakkinen and Kasworm (1997, pp. 22-25). Based on these findings, the mix of roaded, semi-roaded, and core areas are likely to provide adequate habitat that provide for breeding, feeding, and sheltering activities for grizzly bears, especially females (USFWS 2011a, p. A-65). The Grizzly Bear Access Amendment also limits linear miles of open or total permanent roads to the existing baseline conditions in BORZ.

In 2008, the Idaho Roadless Rule (IRR) (36 CFR 294 Subpart C) was finalized and designated 797,100 acres of the IPNF as Inventoried Roadless Areas. The 2008 IRR effectively modified where timber production, road construction, and mineral activities could occur in some of the original 1987 Forest Plan management area (MA) allocations. The IRR specifically added restrictions on and allowances for activities in several of the MAs in the existing plan overlapping inventoried roadless areas (IRAs). Briefly, the restrictions added by the IRR include additional prohibitions on road construction, timber harvest, and mineral leasing in existing plan MA1b,c,e; additional limited allowances for roads in MA5; additional allowances for roads and timber harvest both within and outside community protection areas in MA5; conditions on road construction and timber harvest associated with mineral leasing and the applicable land management plan in MA6; and direct that MA2a,b, 3, and 4a should be managed in accordance with the applicable land management plan.

3. Proposed Action Description

As described in Chapter I, the Revised Plan direction is organized by goals, desired conditions, objectives, guidelines, and standards. The Revised Plan Forest-wide direction describes the framework under which lands will be managed for the next 10 to 15 years on the Forest.

The Revised Plan desired conditions for wildlife and vegetation and guidelines and standards for wildlife are discussed in Chapter I and contained in Appendix B of the Terrestrial BA (USFS 2013a). Guidelines and standards are the procedures and requirements (respectively) applied to project and activity decision-making to achieve goals, desired conditions, and objectives. All project-level activities must meet the guidelines and standards. The project-level requirements that provide conservation of grizzly bears are described in [Table II-1](#). The guidelines and standards address the following grizzly bear management needs: linkage, access, general habitat, human-bear conflicts, and denning habitat.

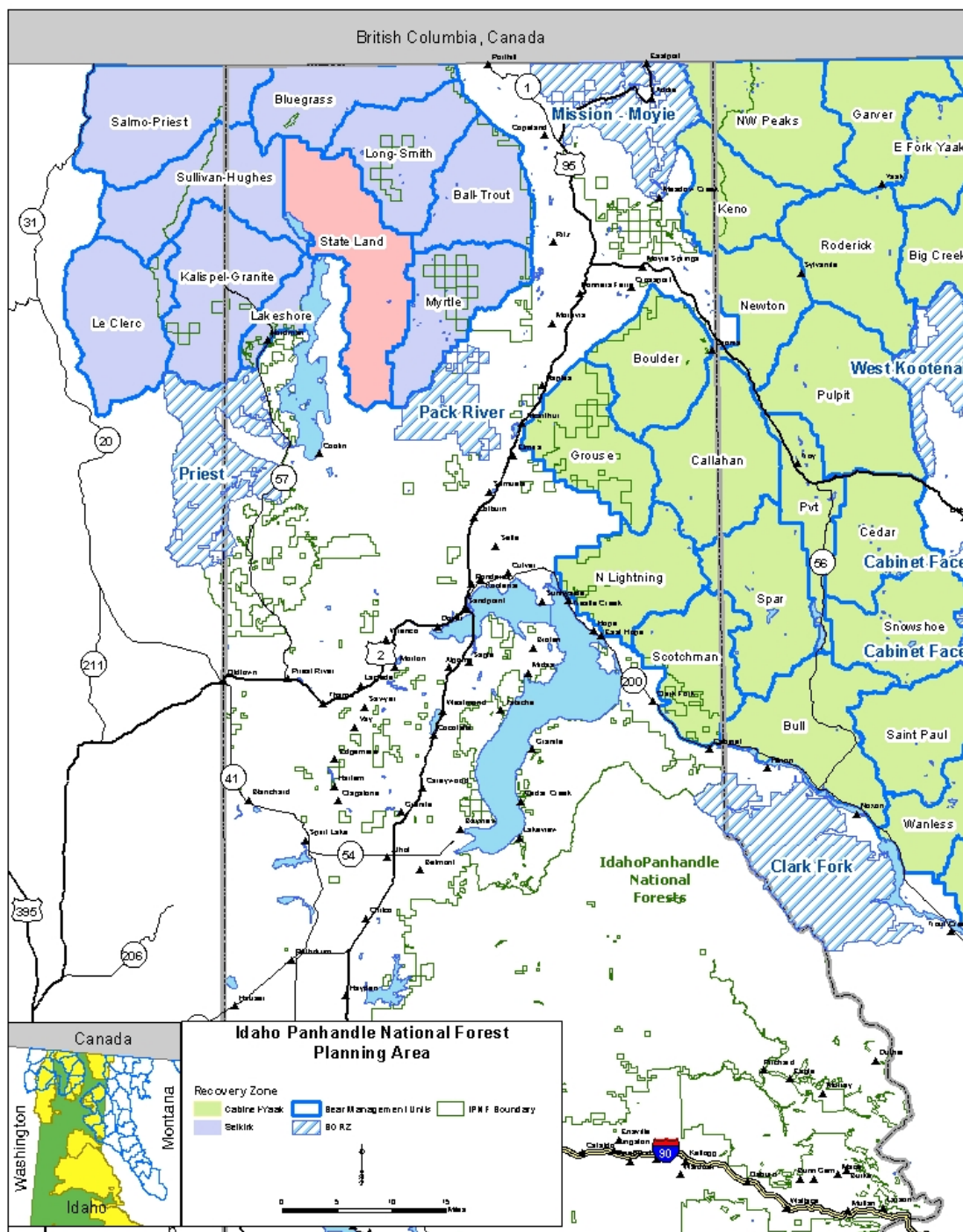


Figure II-2. Bear Management Units (BMUs) and Bears Outside Recovery Zones (BORZ) in relation to the Idaho Panhandle National Forest boundary.

Table II-1. Guidelines and standards in the IPNF Revised Plan for grizzly bear conservation.

Grizzly Bear Management Need	Element¹ Code	Element Description
Linkage	FW-GDL-WL-15	Sets direction for interagency coordination and inclusion on wildlife crossing features in roadway construction and reconstruction.
Linkage	FW-GDL-WL-16	Restricts management activities within one-quarter mile of existing crossing features, and future crossing features.
Linkage	FW-GDL-WL-17	Maintains federal ownership in wildlife linkages identified through interagency coordination.
General Habitat	FW-GDL-WL-18	Applies “Interagency Grizzly Bear Guidelines,” or a conservation assessment once a grizzly bear population is delisted. .
Access Management / Secure Habitat	FW-STD-WL-02.	Applies the Access Amendment direction in the CYE and SE.
Human-Bear Conflict	FW-STD-WL-03.	Requires sanitation measures to reduce human/wildlife conflicts and mortality in all permits and operating plans.
Denning Habitat / Human-Bear Conflict	FW-STD-WL-04.	Prohibits grooming of snowmobiles routes in grizzly bear core habitat in spring after April 1 each year.

1. Elements of the plan include the Goals, objectives, desired conditions, guidelines and standards.

The standards and guidelines discussed in Chapter I, Appendix A of this biological opinion and [Table II-1](#) would be applied forest-wide as well as across MAs and geographic areas (GAs). Each of the twelve management area designation has its own prescription for management and allowed uses. Table I-4 in Chapter I describes the allocation of all National Forest Systems (NFS) lands across the MAs. The distribution of the CYE and SE recovery zones to the MAs is provided in [Table II-2](#).

Table II-2. Distribution and percent of CYE and SE recovery zone acreages on the IPNF across the designated management areas under the Revised Plan.

Proposed Action Management Areas	Acres¹ in the SE (%)	Acres in the CYE (%)
1a – Wilderness	9,882 (3)	0
1b – Recommended Wilderness	55,418 (14)	24,540 (10)
1c – Wilderness Study Area	0	0
1e – Primitive Lands	18,564 (5)	0
2a – Wild & Scenic Rivers (Wild & Recreational)	0	0
2b – Eligible Wild & Scenic Rivers (Wild &	7,035 (2)	883 (<1)
3 – Special Areas	4,975 (1)	4,600 (2)
4a – Established & Proposed Research Natural	4,651 (1)	2,737 (1)
4b – Experimental Forests	0	0
5 – Backcountry	118,839 (31)	82,719 (33)
6 – General Forest	164,353 (43)	133,103 (54)
7 –Primary Recreation Areas	839 (<1)	0
Total:	384,446	248,582

¹Where special designation MA's overlap, acre calculation based on primary MA, following the hierarchy listed in the Plan

Geographic areas have desired conditions that are specific to a locale, such as a river basin or valley. The GA desired conditions were developed to refine Forest-wide management to better respond to local conditions and situations that may occur within a specific GA. The desired conditions in GAs for listed species will not exert additional effects on the species, rather the desired condition will help the Forest achieve a Forest-wide desired condition, objective, standard, or guideline for the species. This is done within the GAs by identifying or prioritizing areas where these conditions should be achieved. For example, a desired condition for wildlife in the Pend Oreille GA provides low levels of disturbance for grizzly bear denning in the Scotchman Peaks and Selkirk Mountain ranges. This condition complements Forest-wide desired condition for wildlife (FW-DC-WL-04), which states that low levels of disturbance exist in all grizzly BMUs to facilitate denning activities, spring use, limit displacement, and reduce human/bear conflicts and potential bear mortality and Forest-wide guideline (FW-GDL-WL-01) which states that management activities on NFS lands should avoid/minimize disturbance in areas of predicted denning habitat during spring emergence (April 1 through May 1). In these examples, the GA desired conditions are identifying specific locations where the Forest-wide desired condition and guideline will be targeted.

The Revised Plan incorporates the recently completed Grizzly Bear Access Amendment as well as the IGBC Guidelines (IGBC 1986). As described in Appendix E to the draft Revised Plan (USFS 2011a), where the IRAs overlap the Revised Plan MA designations, the provisions of the IRR prevail.

B. STATUS OF THE GRIZZLY BEAR

1. ESA Listing Status

In 1975, the Service listed the grizzly bear as a threatened species in the contiguous United States (U.S.) (40 FR 31734-31736, July 28, 1975). The Service subsequently developed a grizzly bear recovery plan in 1982, and revised it in 1993 (USFWS 1993, entire).

Since the original listing of the grizzly bear, the Service has completed 4, five-year status reviews (46 FR 14652, February 27, 1981; 52 FR 25523, July 7, 1987; 56 FR 56882, November 6, 1991; and September 6, 2011). None of these reviews resulted in a change in the listing status of the grizzly bear. Since then, the Service has undertaken a number of actions to review the status of individual grizzly bear populations.

On March 13, 1990, the Service received a petition requesting the grizzly bear in the North Cascades Ecosystem (NCASC) be reclassified from threatened to endangered. We made a positive 90-day finding on the petition and initiated a status review of the NCASC grizzly bear population (55 FR 32103, August 7, 1990). On January 28, 1991, we received a petition requesting that we reclassify grizzly bear populations in the CYE, SE, and the Northern Continental Divide Ecosystem (NCDE) from “threatened” to “endangered.” Then, on February 4, 1991, we received a petition requesting that grizzly bear populations in the SE, CYE, Yellowstone Grizzly Bear Ecosystem (YGBE) and NCDE recovery zones be reclassified from threatened to endangered. In 1992, we made a positive finding on these 2 petitions regarding the CYE and SE and initiated a status review for these 2 ecosystems (57 FR 14372, April 20, 1992). This same finding found that there was not substantial information presented about the YGBE or NCDE recovery zones and that the request to uplist the North Cascades Ecosystem population was already being addressed through initiation of a status review in 1990 (see 55 FR 32103, August 7, 1990).

In July 1991, the Service released a 12-month finding that reclassification of the population from threatened to endangered was warranted but precluded (56 FR 33892, July 24, 1991). In 1993, we published a 12-month finding that the grizzly bear population in the CYE was warranted for uplisting to endangered status while the population in the SE was not (58 FR 8250, February 12, 1993). This warranted status for the CYE, like the North Cascades Ecosystem population, was determined to be precluded by higher priority actions. In 1998, we re-affirmed this position, publishing a notice that the North Cascades population and the CYE populations are warranted for endangered status, but precluded by higher priority actions (63 FR 30453, June 4, 1998). In 1999, after a Court remanded our finding regarding the SE population back to the Service, we released a 12-month finding that both the CYE and the SE populations were warranted for endangered status but precluded by higher priority actions (64 FR 26725, May 17, 1999). Since then, the North Cascades Ecosystem, SE, and CYE populations have remained warranted for reclassification from threatened to endangered status but precluded by higher priority actions (64 FR 57534, October 25, 1999; 66 FR 54808, October 30, 2001; 67 FR 40657, June 13, 2002; 69 FR 24876, May 4, 2004; 70 FR 24870, May 11, 2005; 71 FR 53756, September 12, 2006; 72 FR 69034, December 6, 2007; 73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009).

2. Species Description, Life History, Population Dynamics

Much of the following information is summarized from the grizzly bear recovery plan (USFWS 1993, pp. 5-8).

Grizzly bears are large (averaging 400-600 lbs. for males, and 250-350 lbs. for females) and long-lived (up to 40 years old) (Blanchard 1987, p. 102) but usually no more than 15-25 years in the wild. Grizzly bears are omnivorous, opportunistic feeders that require caloric intake in excess of maintenance requirements, particularly in later summer and fall, in order build fat levels to survive denning.

Generally solitary, grizzly bears avoid one another, except during the mating season when male and female bears tolerate one another. Grizzly bears do not defend territories, but instead have home ranges they share with other grizzly bears, although social systems influence movements and interactions among resident bears. Home range sizes for adult female grizzlies vary from 50 to 150 square miles; an adult male can have a home range size as large as 600 square miles (Servheen 1983, p. 1026).

Grizzly bears in the contiguous U.S. spend 5 to 6 months in dens, typically beginning in October or November (Craighead and Craighead 1972, p.6). The bears hibernate for as long as 7 months. During this period, they do not eat, drink, urinate, or defecate. Over the course of the denning season, a bear may lose 30 percent of its body weight. All of this weight is stored as fat, which is acquired during the 2 to 4 months prior to entering dens. During the pre-denning period, bears increase their food intake dramatically and may gain as much as 3.64 pounds per day (Craighead and Mitchell 1982, p. 544). The “active bear year” (time when a grizzly bear is active – i.e. not in the den) differs slightly between the U.S. portions of the SE and CYE populations. Research on radio-collared bears has demonstrated that most bears in the U.S. portion of the SE are active between April 1 and November 15th. Similarly, Cabinet-Yaak grizzly bears are active between April 1 and November 30th (Johnson et al. 2008, pp.1-2). In the U.S. portion of the CYE, den emergence for female grizzly bears ranged from the third week of March to the third week of May and peaked between the 2nd and 4th weeks of April (Kasworm et al. 2010, p. 58-59, Figure 50). Den emergence for male grizzly bears ranged from the 4th week of March to the 4th week of April and peaked between the first and second weeks of April (ibid, p. 58-59, Figure 50). In the U.S. portion of the SE, den emergence dates have not been identified because funding limitations restrict the ability to monitor during this time period (W. Wakkinen 07/01/2013 pers. comm.). In the U.S. portion of the CYE, female grizzly bears entered their dens between the third week of October and the second week of December (Kasworm et al. 2010, pp. 58-59, Figure 51). Male grizzly bears entered their dens between the first week of November and the 4th week of December (ibid, pp. 58-59, Figure 51). Grizzly bears in the Cabinets Mountains generally entered dens at least 2-3 weeks earlier than bears in the Yaak river drainage (ibid, p. 58). In the U.S. portion of the SE, female grizzly bears entered their dens between the first week of October and the second week of November. Male grizzly bears entered their dens between the second week of October and the third week of November. Overall, 93 percent of the monitored bears in the U.S. portion of the SE denned on or prior to November 18th (W. Wakkinen 07/01/2013 pers. comm.). Mating occurs from May through July, and cubs are born inside the den in late January

or early February. Cubs remain with their mother for 2 to 3 years (Schwartz et al. 2003, p. 564). The age at which females produce their first litter varies from 3 to 8 years, with litter size varying from one to four cubs. Grizzly bears have one of the lowest reproductive rates among terrestrial mammals. Grizzly bear females cease breeding successfully some time in their mid to late 20s (ibid, pp. 109-110).

3. Habitat Requirements

Grizzly bears are opportunistic omnivores and will eat fish, berries, grasses, leaves, insects, roots, carrion, small mammals, fungi, nuts, and ungulates. The bears are selective in their seasonal use of various kinds of forage and, therefore, move across the landscape as they follow the growth and abundance of preferred forage items (Mace et al. 1996, p. 1403; McLellan et al. 1999, p. 912, Kasworm et al. 2010, p. 64).

Grizzly bears are habitat generalists. Basic habitat requirements include the availability of food, water, security (from humans and other bears), and den sites (Mace et al. 1996 p.1403, 1999, pp. 374-376; Linnell et al. 2000, p. 346) (Table II-3). While biologists agree that preferred habitats of grizzly bears are early seral, fire-successional types, the proximity of hiding cover is also an important variable that has been shown to influence the use of foraging habitat. Given equal foraging opportunities, under cover and in the open, bears prefer to feed under cover.

Grizzly bears are selective in their seasonal use of various kinds of forage and, therefore, move across the landscape as they follow the phenological development and abundance of their preferred forage items. As a result, the productivity of grizzly bear populations is likely more strongly influenced by the availability of high quality food resources than by density-dependent regulating factors (IGBC 1987, pp. 51-59). It has also been observed that grizzly bears of all ages will congregate readily at plentiful food sources and form a social hierarchy unique to that grouping of bears (Hornocker 1962, Craighead 1979, *In* USFWS 1993, p. 2).

Table II-3. Grizzly bear key habitat requirements (In USFWS 2011a, p. A-3).

Habitat Requirement	Key Habitats
Spring foraging ¹	Low-elevation mesic vegetation
Summer, autumn foraging ¹	Moderate- to high-elevation mesic vegetation
Security cover and isolation from humans ^{2,3}	Cover provided by vegetation and topographic breaks; absence or low density of roads and trails
Denning habitat ⁴	Remote, high-elevation areas with slopes greater than 30 degrees; friable, deep soils; and snow accumulations

Sources:

¹ Mace et al. (1996); Mace et al. (1999); McLellan and Hovey (2001); Nielson et al. (2002); Waller and Mace (1997).

² Archibald et al. (1987); Kasworm and Manley (1990); Mace et al. (1996); Mace et al. (1999); Mattson et al. (1987); McLellan and Shackleton (1988,1989); Wielgus et al. (2002).

³ Mace and Waller (1997); White et al. (1999); Graves (2002).

⁴ Pearson (1975); Servheen (1981); Zager and Jonkel (1983); Podrutzny et al. (2002).

With the exception of a few forest vegetation types, the majority of vegetative food items preferred by grizzly bears occur in early seral communities where forest cover is absent or relatively sparse (Servheen 1983, pp. 1030-1031). Foraging areas that are consistently described in the literature as favored by bears include avalanche chutes (Mace et al. 1996, p. 1395; Waller and Mace 1997, p. 1034; Ramcharita 2000, p. 27; McLellan and Hovey 2001, p. 97), fire-mediated shrub fields (McLellan and Hovey 2001, p. 97), and riparian areas (Servheen 1983, p. 1082; McLellan and Hovey 2001, p. 97; Kasworm et al. 2010, p. 65). Avalanche chutes may be used at any time of year, but seem to attract bears particularly in the spring. These areas are usually quite wet (due to deep snows that melt later than in other areas), and they contain both valuable forage species and a tangle of vegetation that provides visual screening. Fire-mediated shrub fields often contain soft-mast (e.g., berry) producing shrub species, an important food source for foraging bears in mid-summer and early fall. Riparian areas are primarily used in spring and early summer when habitats at higher elevations are still covered with snow or plant growth is otherwise delayed. Riparian areas provide a variety of key forbs and grasses, and complex tree and shrub structure offering hiding cover.

When bears emerge from their dens in the spring, their fat stores have been severely depleted; therefore, foraging to rebuild energy reserves is their primary focus. It is important that bears have adequate spring foraging opportunities close to their dens, especially when cubs have been born, to build up fat stores quickly.

Food habits not only vary between seasons but also between the recovery zones. Radio collared grizzly bears in the Cabinet Mountains and Yaak River made greatest annual use of closed timber, timbered shrubfields, mixed shrub snowchutes, mixed shrub/cutting units, alder shrubfields, huckleberry shrubfields, and graminoid and beargrass sidehill parks (Kasworm et al. 2010, p.59). Grizzly bears in Cabinet Mountains made greater use of mixed shrub snowchutes, alder shrubfields, huckleberry shrubfields, and beargrass sidehill parks whereas grizzly bears in the Yaak River used closed timber, timber, timbered shrubfields, mixed shrub/cutting units, and graminoid sidehill parks (Kasworm et al. 2010, p.59).

In the SE, grizzly bears rely primarily on newly emerging vegetation, either in south-facing avalanche chutes or low elevation areas like Bismark Meadows, Hughes Meadows, and the Kootenai Valley on the eastern side of the ecosystem (W. Wakkinen 07/01/2013 pers. comm.). The distribution of grizzly bears in the SE varies each year, depending on snow pack and spring conditions. For example, in 2013, very few bears were documented in low elevation areas, likely due to sufficient green-up at moderate elevations following den emergence. This was confirmed by collared bears and the lack of bears in low elevation locations where they have been previously documented (ibid). In July, the SE grizzly bears begin eating available berries. Thimbleberry is an early emergent, but huckleberries are the largest food source for SE grizzly bears from July until October. Grizzly bear distribution changes elevation (low to high) and aspect (south to north) as the berry season progresses (ibid). Grizzly bears in the SE will take advantage of winter killed ungulates; however these are opportunistic events since there are no concentrated ungulate winter ranges in the SE. Also, there aren't sufficient fish runs, moth irruptions or white bark pine ecosystems to provide alternate grizzly bear food sources in the SE (ibid).

In the GYA, four food sources have been identified as important to grizzly bear survival and reproductive success (Mattson et al. 1991a). Winter-killed ungulates serve as an important food source in early spring before most vegetation is available (Green et al. 1997, p. 140; Mattson 1997, p. 165). During early summer, spawning cutthroat trout (*Oncorhynchus clarki*) are a source of nutrition for grizzly bears in the Yellowstone population (Mattson et al. 1991a, p. 1623; Felicetti et al. 2004, pp. 496, 499). Grizzly bears feed on army cutworm moths (*Euxoa auxiliaris*) during late summer and early fall as they try to acquire sufficient fat levels for winter (Mattson et al. 1991b, p. 2432). Lastly, in some years, whitebark pine (*Pinus albicaulis*) seeds serve as an important fall food due to its high-fat, energy-rich content (USFWS 2011b, pp. 9-11).

In the NCDE during summer, before berry crops are available, grizzly bears eat roots/corms/bulbs and other vegetation (Aune and Kasworm 1989, p.46, 64; McLellan and Hovey 1995, p. 704). On the eastern front and in Glacier National Park, grizzly bears also feed on concentrations of lady bird beetles and army cutworm moths (Mattson et al. 1991b, p.2430). Once berries become available, grizzlies in the NCDE consume a wide variety of available berries (McLellan and Hovey 1995, p. 704). The amount and species of berries in scats varies annually based on their availability (ibid, p. 704). During late summer to fall, grizzly bears in the NCDE continue to eat berries but also consume more meat and roots/bulbs/corms (Aune and Kasworm 1989 p.46; McLellan and Hovey 1995, p. 704). Late summer to fall is also the time when grizzlies make use of whitebark pine nuts when and where they are available (ibid, p. 71).

In addition to foraging habitat, a degree of isolation from humans and human-associated activities and hiding cover are necessary habitat components for grizzly bears (Mattson et al. 1987, pp. 18-22; McLellan and Shackleton 1988, pp.458-459, 1989, pp. 378-379; Mace et al. 1996, p. 1402-1403, 1999, pp. 374-376).

Human activities can result in direct mortality of bears, as well as indirect negative effects by displacing bears to less suitable habitats (McLellan et al. 1999, p. 918, Wakkinen and Kasworm 2004, p. 74). In certain settings, the most effective way to minimize the risk of adverse interactions between humans and bears is to provide spatial separation between areas of human activity and areas of bear activity; for example, area closures or restrictions during times of concentrated feeding. In areas where such separation is not possible, providing large areas of secure habitat that include seasonal habitats may reduce the potential for contact and minimize risk of disturbance and illegal mortality (Mace and Waller 1998, p. 1014).

Managing public motorized access to grizzly bear habitat is one of the most common and effective ways to maintain a level of separation between grizzly bears and humans, which — (1) minimizes human interaction and reduces potential grizzly bear mortality risk; (2) minimizes displacement from important habitat where energetic requirements can be met with limited disturbance from humans; and (3) minimizes habituation to humans (Mattson et al. 1987, pp.19-20; McLellan and Shackleton 1988, pp.458-459; McLellan 1989, p. 1856; Mace and Manley 1993, pp.24-27; Mace et al. 1996, pp. 1402-3; Wakkinen and Kasworm 1997, pp.22-26). Secure habitat for grizzly bears referred to as “core areas” is specifically defined by the Interagency Grizzly Bear Committee (IGBC) (1998, p.4) as areas that are at least 0.3 mile from any open road or motorized trail and that receive no motorized use of roads or trails during the period they

are considered secure habitat (typically at least 10 years). Such lands should also encompass areas of seasonal importance for grizzly bears throughout the year.

While security cover allows grizzly bears to avoid contact with humans, the cover is sometimes necessary for bears to avoid contact with other bears. Strict territoriality among grizzly bears is not known, and intraspecific defense behavior generally tends to be limited to defense of limited food concentrations, defense of young, and surprise encounters (USFWS 1993, p.2). Adult male bears are known to kill juveniles, and adults also occasionally kill other adults. Females with cubs require spatial separation from aggressive males. This is particularly true in spring, when cubs-of-the-year are most prone to attack. Data are insufficient to fully assess the effects of predation on younger bears by adult bears (USFWS 1993, p. 5), particularly when considering potential indirect effects of various human activities that may displace a subadult bear into the home range of an aggressive adult bear. Sows with cubs often select rugged and isolated habitats for this reason (Mace and Waller 1997, p. 148; Russell et al. 1979, p.124). Shrub and tree cover, as well as topographic landscape features, are commonly used as security from humans or other bears (McLellan and Hovey 2001, p. 97; Wielgus et al. 2002, p. 1604), and dispersing subadult bears may be forced to choose poor home ranges that may be equally dangerous to their survival (USFWS 1993, p. 5). There are no broadly accepted Service or IGBC standards related to grizzly bear cover.

Another key habitat requirement for grizzly bears is the presence of suitable denning habitat. Den site characteristics are variable, but several researchers have described dens located at high elevations in remote areas with slopes greater than 30 degrees, soils that are deep, and aspects where snow accumulates (Craighead and Craighead 1972, p. 17; Linnell et al. 2000, p. 404; Mace and Waller 1997, p. 39; Podruzny et al. 2002, p. 25). Sloped sites are often selected because they facilitate easier digging and are generally stabilized by trees, boulders, or root systems of herbaceous vegetation. In addition to excavating dens, grizzly bears den in natural caves and hollows under the roots of trees. While individual den sites are rarely reported to be used for more than one winter, numerous researchers have observed that dens rarely occur singly, but are concentrated in areas that apparently possess appropriate environmental conditions (Craighead and Craighead 1972, pp.27- 28).

As discussed in our 2008 biological opinion on Amendment 24 to the Flathead National Forest (USFWS 2008, pages 30 - 44), den abandonment has been documented in association with industrial activity and direct approach (Reynolds et al. 1986, p. 174; Harding and Nagy 1980, p. 278; Jonkel 1980, p. 3; Craighead and Craighead 1972, p. 31). Harding and Nagy (1980, p. 278) found that one grizzly bear abandoned its den after having the den driven over by a seismic vehicle. On the other hand, other events with seemingly similar levels of disturbance have not led to den abandonment (Jonkel 1980, p. 2; Reynolds et al. 1986, p. 174; Mace and Waller 1997, p. 41; Linnell et al. 2000, pp. 407-408). We are not aware of any primary-source reports in the literature of grizzly bear den abandonment directly attributed to snowmobile activity (USFWS 2008, p.33). Nor has other substantive adverse effects on bears from snowmobile use been substantiated (see discussion in USFWS 2008, pp.32-53). In fact, Mace and Waller (1997, p. 41) reported no abandonment of dens by grizzly bear even though snowmobiles were often seen within 2 km of den sites. Likewise, the Interagency Grizzly Bear Study Team has intensively

researched grizzly bear ecology in the Yellowstone Grizzly Bear Ecosystem from the 1970's to present, but this research has never documented den abandonment attributed to snowmobiles.

In our 2008 biological opinion, we agreed with Graves and Reams (2001), that disturbance from snowmobiles may be most consequential shortly before or after den emergence of a female with cubs. Females and their cubs remain in the den site area for several weeks after emergence from dens (Haroldsen et al. 2002, p. 33; Mace and Waller 1997, pp. 37-38). Females with cubs have high energetic needs, and cubs have limited mobility for several weeks after leaving the den. Disturbance levels that cause a female to prematurely leave the den in spring or move from the den area could impair the fitness of the female and safety of the cubs. If cubs attempt to follow their mother, they will likely experience decreased fitness and the family group may be pushed to less suitable habitat. Our conclusion in 2008 remains the same: "In the judgment of the Service, snowmobile-related impacts on post-den emergence females with cubs are more likely to impart serious consequences than any potential impacts to denning grizzly bears."

4. Habitat Fragmentation

Habitat linkage and connectivity are important components of grizzly bear habitat (Servheen et al. 2001, p. 164, USFWS 1993, p. 24). Fragmentation of habitat is particularly relevant to the survival of grizzly bears. Grizzly bears are large animals with great metabolic demands requiring extensive home ranges. Large expanses of unfragmented habitat are important for feeding, breeding, sheltering, traveling, and other essential behavioral patterns. Historically, as human settlements and developments along roads increased in grizzly bear habitat, grizzly bear populations became fragmented. This phenomenon continues today. That is, grizzly bears attempting to move within recovery zones or between recovery zones often encounter high volume roads, concentrated human development, and/or altered vegetation that does not provide foods, cover, or security. These conditions can contribute to human-caused mortality as well as deter movement and hence fragment populations. Maintaining linkage and connectivity between small, isolated grizzly bear populations can benefit grizzly bears in several ways, including (1) allowing immigrant grizzlies to bolster a resident population in an area that has been affected by catastrophic events or negative environmental conditions, and (2) preserving genetic diversity by reducing negative effects from inbreeding. Task 37 in the federal Grizzly Bear Recovery Plan (USFWS 1993, p. 36) called for the evaluation of linkage potential between grizzly bear recovery zones.

5. Grizzly Bear Dispersal, Movements, and Genetic Health

Because grizzly bears live at relatively low population densities and are vulnerable to excessive human-caused mortality, human-caused fragmentation of historically contiguous populations into isolated "remnant" populations is a management reality on the current ecological landscape (Forman and Alexander 1996, p. 207; Proctor et al. 2012, p. 5; Servheen et al. 2001, p. 164). It is a widely accepted tenet in conservation biology that extinction risk of isolated populations is reduced even through minimal levels of connectivity. At greatest risk of extinction are small isolated populations with less than 100 individuals. Such populations are more susceptible to extinction through demographic processes such as human-caused mortality, natural mortality,

and lower population growth rates as well as environmental processes such as poor food years, climate change, and habitat loss. While the CYE and SE grizzly bear populations (at issue in this biological opinion) contain less than 100 individuals each, they are not entirely isolated from Canadian populations. Small populations benefit greatly from both demographic rescue (i.e., the immigration of female bears) and to a lesser degree genetic rescue (i.e., immigration of male bears). Although reconnection of these isolated populations is challenging, metapopulation theory directs that connectivity is the best long-term conservation practice to increase the resiliency, redundancy, representation, and overall probability of persistence of remaining grizzly bear populations in the lower 48 States (Boyce 2000, pp. 6-242-243).

Proctor et al. (2012, p. 10) compiled and analyzed all known genetic and movement data for grizzly bears in 30 different study areas. They assessed the current state of genetic fragmentation within and between these study areas and used genetic assignment testing and movement data from radio-collared animals to compile what is known about current levels of male and female movement.

Samples from coastal British Columbia and the Selkirk Mountains south of Canadian Highways 3 and 3A (i.e., the SE) have unique genetic material that is dissimilar to other grizzly bear populations in southern Canada and the northern U.S. In the Selkirks, this difference is most likely due to genetic drift acting on a small isolated population over several generations because of anthropogenic pressures (Proctor et al. 2012, p. 33).

Although there are differences in heterozygosity values among study areas and recovery zones, there have been no detectable consequences on grizzly bear morphology, physiology, ecology, or biology related to these differences in genetic diversity as evidenced by normal litter size, little evidence of disease, an equal sex ratio, and physical characteristics such as body size and weight (Schwartz et al. 2006, pp. 22-23; Kasworm et al. 2008, p. 67; USFWS 2011b, p. 11).

These genetic differences are not the result of natural selection in varying environments or indicative of historical conditions. Instead, they are artifacts of human pressures (Proctor et al. 2012, pp.27-28). Grizzly bears face high mortality risk when moving between secure blocks of habitat. This mortality risk and very low population sizes resulting from past range contraction and mortality have resulted in genetic fragmentation. Each of these fragmented populations may possess genetic material missing from other populations. Maintenance of this genetic material is important to the long-term ability of this region's grizzly bears to respond to environmental changes.

Because grizzly bears have low reproductive rates (Bunnell and Tait 1981 as cited *In* Proctor et al. 2004, p. 150) long generational times (i.e., 10 years), and are slow to disperse across landscapes (Proctor et al. 2004, p. 148), there can be a lag time between fragmentation and resulting changes in genetic diversity. The genetic data collected by Proctor et al. (2012, pp.16-23) reflect fragmentation occurring on the landscape in the recent past (i.e., last 30-60 years).

Proctor et al. (2012) pp. 27-28 also examined grizzly bear movements between ecosystems that displayed varying levels of genetic separation. These movement data were collected from 1985-2007 and represent a more recent picture of fragmentation than genetic data.

In general, Proctor et al. (2012, p. 35) found males move more frequently and over longer distances than females. This result is expected based on what we know about female home range size and the dispersal process. Females usually establish smaller home ranges than males that overlap with their mother's (Servheen et al. 1983, p.1032). In doing so, they generally disperse over much shorter distances than male grizzly bears (McLellan and Hovey 2001, p. 97; Proctor et al. 2004, p. 154). The majority of migrants that moved from one study area to another were males but a few females were also observed moving between genetically fragmented populations (Proctor et al. 2012, p. 21, 23).

Connectivity must be examined in a genetic (requires males only) and demographic (requires females) framework. While male movements can enhance genetic diversity and reduce genetic fragmentation (Miller and Waits 2003, p. 4348; Proctor et al. 2012, pp.26-27), female movements are necessary to enhance a small population's growth rate (Proctor et al. 2012, pp.26-27). This concept is relevant to grizzly bear recovery in the NCASC, SE, and CYE recovery zones, all of which contain small populations that are demographically and genetically isolated to varying degrees.

Proctor et al. (2012, p. 34) documented increasing genetic and demographic fragmentation across Canada Highway 3. If allowed to continue, this fragmentation could lead to a loss of connectivity between U.S. and Canadian grizzlies. Canada Highway 3 is at least a partial barrier to population connectivity by minimizing female crossings (Proctor et al. 2005; Proctor et al. 2012, p. 35). Maintaining and increasing movements by females (i.e., demographic rescue) from Canadian populations into the small populations (NCASC, SE, and CYE) is critical to the long-term conservation of these populations. Recovery could be accomplished via natural movements or translocating animals.

Another aspect of connectivity that Proctor et al. (2012, p. 17) examined was known habitat use by grizzly bears in intervening habitats between Service-identified recovery zones. This habitat use is relevant to understanding how and where grizzly bears in different ecosystems may be linked in the near future. Proctor et al. (2012, p. 20) found 4 males and 1 female using habitat between the Selkirk and Purcell Mountains in Canada, although there was no evidence indicating any migration between these 2 mountain ranges.

Mace and Roberts (2012, pp. 24-27) documented the distribution of grizzly bears in and adjacent to the NCDE recovery zone based on a compilation of telemetry data, mortality data, and DNA detections and found that a small number of both male and female grizzly bears are occupying habitat a substantial distance from the recovery zone boundary (i.e., greater than 10 miles) (Figure II-3). One female grizzly bear with a cub is known to regularly use habitat between the NCDE and CYE. Prior to dropping her collar in 2006, she and her offspring spent most of their summer in the Salish Mountains of Montana less than 2 miles east of the edge of the CYE while denning within the boundaries of the NCDE recovery zone (Kasworm et al. 2009 p.47). A positive development has been grizzly bears, including females with cubs, being documented in the Tobacco BORZ between the CYE and NCDE over the past several years (Kasworm et al. 2012, p. 16; 2013).

Currently, it is not possible to tell if movements we are observing reflect an increase in bear movements or an increase in detection effort and technology (e.g., radio-transmitter collars; genetic techniques) (Proctor et al. 2012, pp. 36-37). These promising detections of grizzly bear movements should be tempered by the idea that detected movement does not mean migrants are breeding successfully. If there is no successful reproduction, then there is no genetic or demographic rescue occurring. There seems to be high mortality risk associated with migrant bears (Proctor et al. 2012, pp. 35-36). However, these data are helpful when considering how to most effectively manage and conserve the remaining grizzly bear populations in the lower 48 States. For example, these data emphasize the importance of maintaining demographic connectivity with Canadian populations and the small populations of the NCASC, SE, and CYE, while highlighting the importance of recovering these small populations so that they can provide genetic and demographic rescue for the Bitterroot Ecosystem (BE). Of relevance, the NCDE appears to be well connected to Canadian populations genetically and its large population size means female movements from Canada into the NCDE are not absolutely required for demographic health to be maintained, although such female movements are beneficial. Similarly, the Greater Yellowstone Area (GYA), which is inclusive of the YGBE, has a large enough population size that demographic rescue is not required. Instead, 1-2 migrants every generation (i.e. 10 years) is adequate to maintain current levels of genetic diversity in the GYA (Miller and Waits 2003, p. 4338).

6. Range-wide Status

When grizzly bears in the lower 48 States were listed under the ESA in 1975, the vast reduction in range, increase in trail and road construction, increase in recreation, livestock use of National Forest lands, unsustainable human-caused mortality, lack of data regarding populations, and isolation were identified as factors affecting their conservation status (40 FR 31734, July 28, 1975). To date, all of these threats have been addressed to varying degrees in different areas.

New information regarding grizzly bear biology, current status, and threats has become available over the years since listing. This research and information has been valuable in addressing the

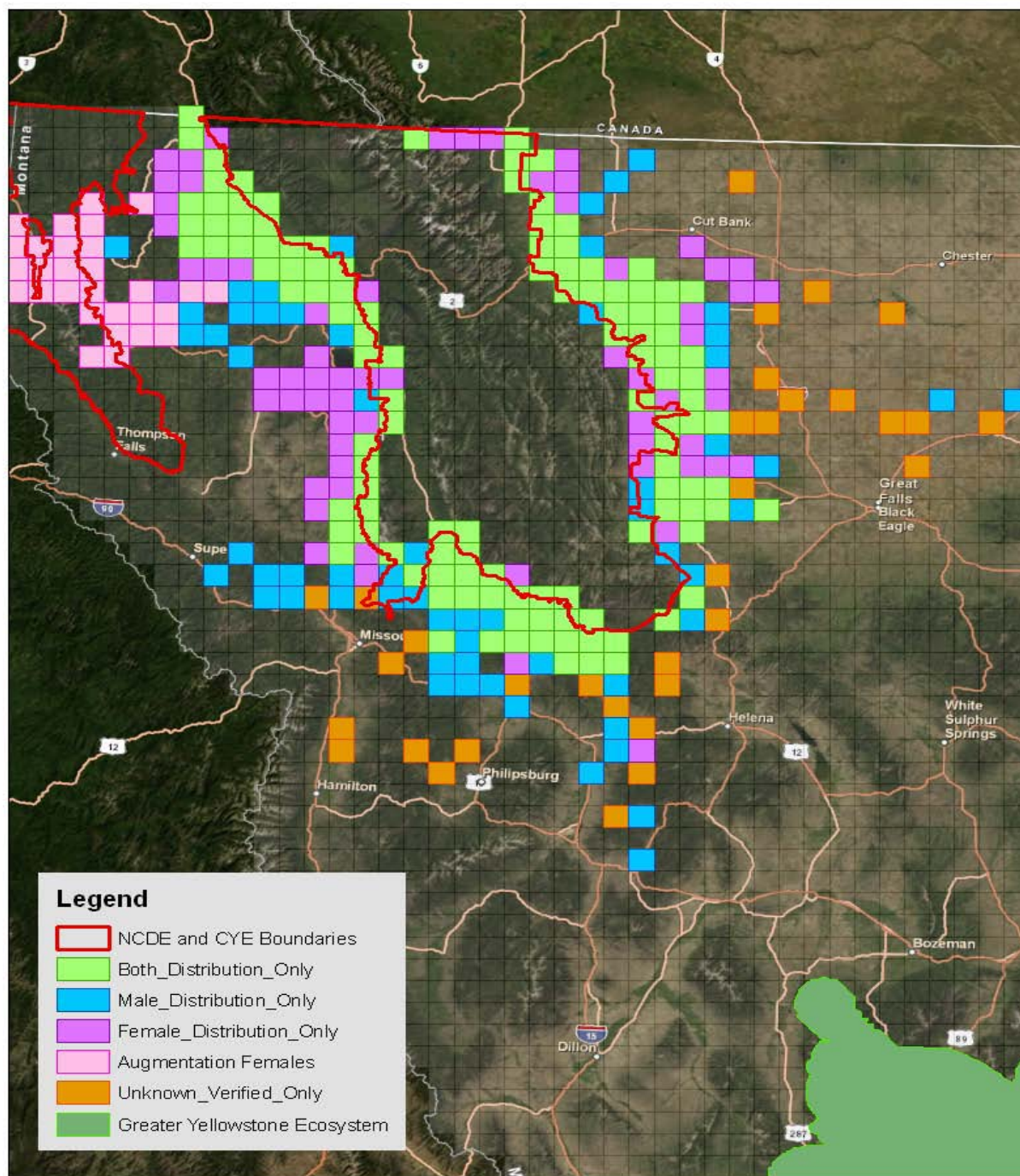


Figure II-3. Distribution of grizzly bears in and adjacent to the NCDE federal recovery zone from 1989 to 2011). Based on telemetry data, mortality data, and DNA detections in 2004 (from Kendall et al. 2009, entire) in Mace and Roberts 2012*. *Occupancy was based on presence within 10 km² grid cells.

impacts and management of roads, trails and recreation and livestock management. It has also indicated the need for public information and assistance programs, along with attractant storage, to limit human-caused mortality of grizzly bears. Proctor et al. (2012) compiled and analyzed all known genetic and movement data for grizzly bears in southern Canada and the NCDE, CYE, SE, NCASC, and YGBE populations. As discussed earlier, genetic data indicate population fragmentation in the recent past (Proctor et al. 2012, pp.27-28). Movement data demonstrated that males move more frequently and over longer distances than females, but it is female movements that are necessary to enhance a small population's growth rate (Proctor et al. 2012, pp.26-27).

Although there are six grizzly bear recovery zones, only five are occupied; the Bitterroot Ecosystem does not have a grizzly bear population at this time. We have recent population data for the GYA, NCDE, CYE and SE. The current range and distribution of grizzly bears in the lower 48 States is fluid, as dispersal is occurring and the specific distribution has not been quantified systematically across all ecosystems. Grizzly bears now occur both within the formally designated recovery zones and in some habitat adjacent to the NCDE, YGBE, SE, and CYE (Wittinger et al. 2002, entire; USFS 2009, entire; Mace and Roberts 2011, pp. 38, 39; 2012 pp. 24-27).

These following population estimates include grizzly bears in the recovery zone and within a 10-mile radius of the recovery zone boundary. There are about 1,500 grizzly bears in the lower 48 States, approximately: 765 in the NCDE; 600 in the GYA; 45 in the CYE; 30 in the SE; and 10 to 20 in the NCASC ([Table II-4](#)). Subadult and adult female survival has the largest influence on population trend in all ecosystems (Mace and Waller 1998, p.1008; Wakkinen and Kasworm 2004, p. 68). Population numbers and trends are described below for each recovery zone.

Portions of two of these recovery zones, the CYE and the SE, are included in the action area (see Environmental Baseline) considered in this biological opinion, and so are discussed in more detail below. The GYA, NCASC, BE, and NCDE recovery zones are not affected by the Proposed Action.

Following is a summary of the status of grizzly bears for the four recovery zones not included in the action area followed by a more detailed discussion for the two recovery zones that are included in the action area.

Table II-4. Most recent estimates of grizzly bear population size and population growth rate by recovery zone.

Recovery Zone	Estimated Population Size	Trend (% change annually)
Greater Yellowstone	593 ^a	+ 2 % ^b
Northern Continental Divide	765 ^c	+3% ^d
Cabinet-Yaak	42 ^e	– 0.8 % ^e
Selkirk	80 ^f	+ 1.9 % ^g
North Cascades	< 20	Unknown
Bitterroot	0	n/a

a. Interagency Grizzly Bear Study Team 2012 annual report; b. Haroldson 2012; c. Kendall et al. 2009; d. Mace and Roberts 2012; e. Kasworm et al. 2012; Kasworm 2013 unpublished data; f. Proctor et al. 2012; Wakkinen 2010; g. Wakkinen and Kasworm 2004.

Yellowstone Ecosystem

The YGBE is located in northwest Wyoming, eastern Idaho, and southwest Montana and encompasses 9,200 sq. mi. It is approximately 240 miles from the BE and at least 75 miles from the grizzly bear population in the NCDE. In 2011, the total population size for the YGBE population was estimated at 593 individuals, with a 95 percent confidence interval between 533 and 652 (Haroldson 2012, p.12 and 15). The YGBE population was increasing in size approximately 4-7 percent annually from 1983 to 2001 (Schwartz et al. 2006 and Haroldson 2012, p.2). Population growth slowed to 0-2 percent from 2002 to 2011 (Schwarz et al. 2006 and Haroldson 2012, p.2). For more details regarding GYA demographic features, please refer to the Yellowstone Final Rule (72 FR 14866, March 29, 2007), the latest Interagency Grizzly Bear Study Team (IGBST) Annual Reports (online at <http://nrm.sc.usgs.gov/products/IGBST>), and Schwartz et al. (2006, entire).

North Cascades Ecosystem

The NCASC of north central Washington (9,500 square miles) is estimated to contain less than 20 bears (Almack et al. 1993, *In* USFWS 2011b, p. 12). The nearest population of grizzly bears is immediately north in Canada with an estimated 25 individuals but populations to the east and west of the Cascades in Canada are considered extirpated (North Cascades Grizzly Bear Recovery Team 2004, p. 7). The distribution of grizzly bears within the NCASC is unknown due to a lack of data (USFWS 2011a, p. A-31). Very few credible sightings and reports exist. A recent confirmed sighting in the U.S. occurred September, 2010. There are a few credible reports from north of the border in the B.C. portion of this ecosystem (USFWS 2011a, p.A-27).

North Continental Divide Ecosystem

The NCDE extends from the Rocky Mountains of northern Montana into contiguous areas in Alberta and British Columbia, Canada. The U.S. portion of the NCDE that makes up the NCDE

recovery zone encompasses over 9,600 square miles (USFWS 2011a, p.A-12) and includes parts of five National Forests (Flathead, Kootenai, Helena, Lewis and Clark, and Lolo), four wilderness areas (Bob Marshall, Mission Mountains, Great Bear, and Scapegoat) and one wilderness study area (Deep Creek North) (Figure 1). Additionally, the NCDE recovery zone includes Glacier National Park (GNP), the Flathead Indian Reservation (Salish-Kootenai tribal land), the Blackfeet Indian Reservation, adjacent private and State lands, and lands managed by the Bureau of Land Management. National Forest System lands encompass 63 percent of the NCDE recovery zone. The Flathead National Forest makes up 40 percent of the NCDE recovery zone and is the majority federal manager of lands within the NCDE recovery zone; wilderness areas (30 percent) and Glacier National Park make up about 47 percent of the recovery zone (USFWS 2011b, p. 38).

Two population studies were designed with the objective to more reliably estimate the number of grizzly bears inhabiting the NCDE. The U.S. Geological Survey (USGS) DNA-based mark-recapture study in the greater Glacier area collected information from 1998 through 2000. The USGS also conducted an extensive DNA-based study to estimate the grizzly bear population size in 7.8 million acres of occupied grizzly bear range in and around the NCDE recovery zone. The Northern Divide Grizzly Bear Project produced a final total NCDE grizzly bear population estimate of 765 grizzly bears for 2004 (USGS 2008; Kendall et al. 2009, p.9; USFWS 2011a, p. A-14). The total population estimate of 765 for 2004 illustrates the conservative nature of the recovery plan minimum population estimate of 304 grizzly bears in 2004. The DNA-based estimate is scientifically robust, and is more than two times the recovery plan estimate.

In 2004, Montana Fish, Wildlife and Parks initiated a NCDE grizzly bear trend monitoring project (Mace and Chilton 2009, p. 1). The purpose of this program is to estimate population trend by monitoring the survival and productive rates of radio-instrumented female grizzly bears. Thus far, a total of 104 individual females have been captured and monitored. Results reveal an annual growth of about 3 percent, indicative of an increasing grizzly bear population in the NCDE (Mace and Roberts 2012, p. 24).

Bitterroot Ecosystem

The BE of east-central Idaho and western Montana (5,600 square miles) is not considered to be occupied by a population of grizzly bears at this time (USFWS 2011b, p. 27).

Cabinet-Yaak Ecosystem

The U.S. portion of the CYE recovery zone is approximately 2,609 square miles in size and is located primarily in northwestern Montana with small portions in northern Idaho. The juxtaposition of the CYE population to the SE and NCDE grizzly bear populations to the east and west, respectively, makes it essential to long-term survival and recovery of grizzly bears throughout a significant portion of its range in the U.S.

Land ownership in the CYE is approximately 90 percent Federal, 5 percent State, and 5 percent private lands. The Kootenai National Forest manages approximately 72 percent of lands within the CYE recovery zone, with the Idaho Panhandle and Lolo National Forests administering the

remaining Federal lands within the recovery zone. Approximately 5.6 percent (94,272 acres) of the CYE recovery zone is designated Wilderness. Major private land owners in the recovery zone include Plum Creek and Stimson Timber Companies. Individual landowners live on various-sized acreage along the major rivers. The relative distribution of grizzly bears across this ownership pattern is unknown, but is believed to be proportionate to land ownership (i.e., approximately 90 percent of the grizzly bear population lives on the 90 percent of public land within this recovery zone).

In Canada, the portion of British Columbia directly north of the Cabinet-Yaak recovery zone is largely Crown land (public) with the exception of the Moyie and Kootenay River valleys.

Population Trend

The CYE is often described in terms of having two portions. The Cabinet Mountains portion forms the southern half of the CYE and is topographically diverse with steep mountain ranges (up to 8,700 feet) and definable seasonal habitats. The Yaak portion has gentler topography and lower elevations (up to 7,700 feet). Seasonal habitats are not as clearly definable. More research and telemetry work has occurred in the Yaak than the Cabinet Mountains. The U.S. portion of the CYE Recovery Zone was estimated to contain at least 42 grizzly bears during 2006 to 2011 (Kasworm et al. 2012 p.2). The Cabinet Mountains lie south of the Yaak River drainage and contain about 60 percent of the recovery zone. During 2006 to 2011, there were approximately 21 individuals in the Cabinet Mountains and 21 individuals in the Yaak portion of the recovery zone (Kasworm et al. 2012, pp.21-22). This population estimate of 42 grizzly bears is similar to our 1999 estimate of 30 to 40 in the CYE (64 FR 26725, May 17, 1999).

Demographic information from bears occurring outside a 10-mile buffer of the recovery zone is not used to assess population status. Therefore, while data may be collected within the portion of BORZ beyond the 10-mile buffer around the recovery zone, it is not used to determine the population status in the CYE. The 1993 Recovery Plan states that habitat within recovery zones, managed for grizzly bear use, is adequate to recover bear populations.

Survival analysis and reproductive data is used to calculate a “rate of change” in the population or “population trend”. Only radio-collared bears are used in this analysis because they typically have known fates. Furthermore, standard methodology includes only female adults and sub-adults plus all yearlings and cubs when calculating trend. As long as there are sufficient males for breeding, males are not as important to the ability of the population to increase. Sub-adults are bears aged 2-4 years.

Survival rates have been calculated for radio collared native grizzly bears in the CYE from 1983-2012. All grizzly bears relocated into the Cabinet Mountain as part of the state’s augmentation program (i.e. bears not native to the CYE) were removed from the sample and almost all of the remaining individuals were from the Yaak River portion of the population. A survival rate of 1.0 means all bears in that category survived and there was no mortality. From 1983-2009, Kasworm (2010a, 2010b) shows the survival rate for adult females in the CYE was 0.93, adult males 0.88, sub-adult females 0.78, sub-adult males 0.75, yearlings 0.85, and cubs 0.58. Kasworm (2013 unpublished data) updates calculated survival rates through 2012 as: adult

females 0.940; adult males 0.895; sub-adult females 0.811; sub-adult males 0.750; yearlings 0.900; and cubs 0.571. Survival rates in all sex and age classes show improvement except cubs. While cub survival is typically low, yearling survival is higher. It also appears that first time mothers are less successful at raising cubs than older, more experienced mothers. Sub-adult survival naturally decreases from yearling survival as bears are on their own without the protection of their mothers.

Reproduction is a measure of female cubs produced per adult female per year. In the CYE area Kasworm (2013 unpublished data) shows the reproductive rate is 0.372. Sex ratio of observed cubs is assumed to be 50:50.

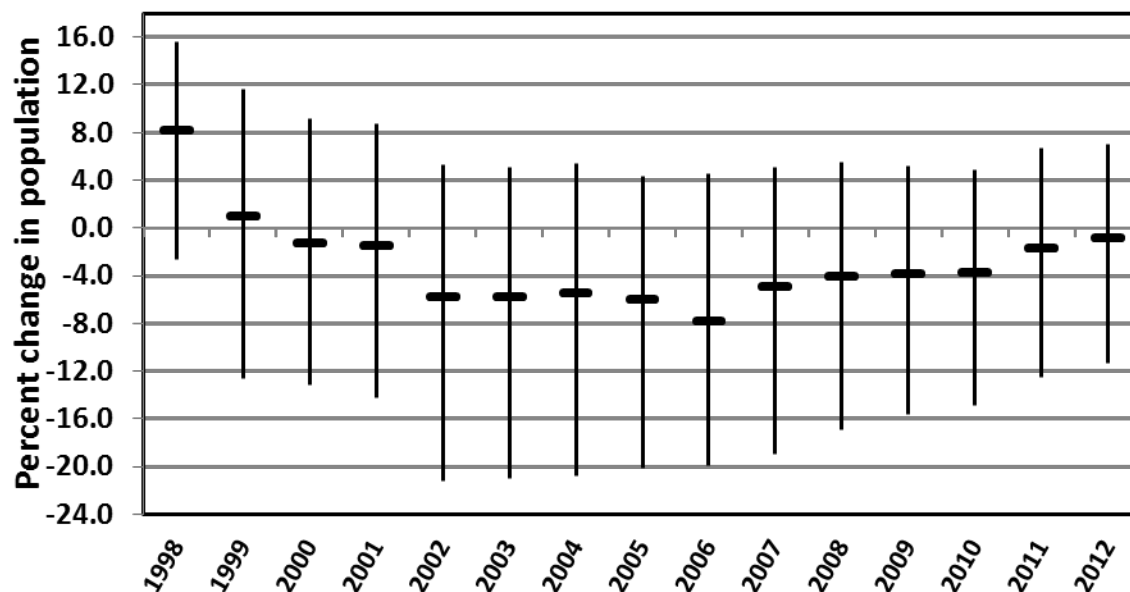


Figure II-4. Point estimate and 95 percent confidence intervals for cumulative annual calculation of population rate of change for native grizzly bears in the Cabinet-Yaak recovery area 1983-2012

The observed rates of survival and reproduction are used to calculate a rate of change in the population (λ). This calculation is essentially births - deaths = population change and is measured against a stable population depicted by λ equaling 1.0. This calculation only involves female adult and sub-adult survival plus all yearling and cub survivals.

In 2006 λ for the CYE grizzly bear population reached its lowest point (0.920) since calculations started, indicating an annual rate of decline of -8.3 percent. However, in 2009, the point estimate of λ for all data (from 1983-2009) had increased to 0.963 (Kasworm 2010a, 2010b). This equates to a population declining at an annual rate of -3.8 percent. In 2012, the updated λ (for 1983-2012) was 0.992, which corresponds to a -0.8 percent annual rate of

change (Kasworm 2013 unpublished data). Thus, lambda has improved and moved closer to stability (1.0); an indication that the CYE grizzly bear population status is improving (see Figure II-4). Each entry represents the annual rate of change from 1983 to that date (Kasworm 2013 unpublished data).

Status of Recovery Criteria

The Recovery Plan estimated that a recovered population in the CYE recovery zone would consist of a minimum of about 100 individual grizzly bears and grizzly bears would also live in and use areas outside the CYE recovery zone. Therefore, Recovery Plan population parameters include bears observed up to 10 miles outside the recovery zone boundary (USFWS 1993, p.83).

Demographic recovery criteria were developed to address overutilization and human-caused mortality (see listing factors) within each recovery zone and a 10 mile surrounding buffer by ensuring a sufficient population size and distribution. These demographic recovery criteria include measures for population size, distribution, and sustainable mortality. The Service is in the process of updating demographic recovery criteria for each ecosystem, based on new science and techniques. However, an update is not complete for the CYE grizzly bear population and so we use the 1993 criteria.

Following are 1993 demographic criteria and the mortality data in recent years for the CYE. The 1993 CYE demographic criteria are: (1) six females with cubs over a running 6-year average both inside the recovery zone and within a 10 mile area immediately surrounding the recovery zone, excluding Canada; (2) 18 of 22 BMUs occupied by females with young from a running 6-year sum of verified sightings and evidence; and (3) known human-caused mortality not to exceed 4 percent of the population estimate based on the most recent 3-year sum of females with cubs. Furthermore, no more than 30 percent of total human-caused mortality shall be females. These mortality limits cannot be exceeded during any two consecutive years for recovery to be achieved. In 1993, grizzly bear numbers were low in the ecosystem, therefore, the goal for human-caused mortality was zero. In reality, the goal of zero human-caused mortality of grizzly bears in the CYE is not likely attainable over time. Nevertheless, recovery programs aim to reduce mortality to the extent possible. The 1993 Recovery Plan demographic criteria and status for the CYE is summarized in [Table II-5](#).

In the CYE, one of the four 1993 demographic recovery criteria were met in 2012 (Kasworm 2013, unpublished data). The population goal of 6 females with cubs has not been met. The 6-year running average was 2.8 females with cubs. The distribution criterion has not been met with only 13 of 22 BMUs occupied by females with young. A positive metric was demographic criteria for human-caused mortality, which was met each year for the past four years (2008-2011) (Kasworm et. al 2012, p.18); but it was not met in 2012. The running 6-year average (2007-2012) of total human-caused mortality was 1.7 animals/year (the limit is no more than 1.6), which includes 0.5 females each year (ibid). Female mortality (0.5), meets the recovery limit of no more than 30% (0.5) of total mortality. However, in 1993, the Recovery Plan stated the mortality *goal* was zero.

Table II-5. Status of the CYE recovery zone during 2006-2011 in relation to the demographic recovery targets from the grizzly bear recovery plan.

Recovery Criteria (USFWS 1993)	Limit	Status - 2006-2011(Kasworm et al. 2012, p.18)
Females with cubs (unduplicated sightings)	6 (6 year average)	2.5 females with cubs
Distribution of females with young (BMUs occupied)	18 of 22	12 of 22 BMUs occupied
Human caused mortality limit (4% of minimum estimate)	1.4 (6 year average)	1.3 bears (6 year average)
Female, human-caused, mortality limit (30% of total mortality)	0.4(6 year average)	0.3 female bears (6 year average)

Grizzly Bear Mortality in the CYE

In the entire CYE (including the 10-mile buffer used to compile demographic information) from 1983 through 2011, there have been a total of 67 known grizzly bear mortalities from all forms, on all ownerships (including Canada) (W. Kasworm 02/04/2013 pers. comm.).

Based on data from 1983 to 2011, total grizzly bear mortality rates in the CYE appear to have increased. During the period 1983 to 1998, the mortality rate was 10 percent (that is 10 percent of bears die from all causes in a given year). From 1999 to 2011 that rate has increased to 15 percent (Kasworm et al. 2012, p.35). Some of the increase in natural mortality is probably related to poor berry production from 1998 to 2004 (ibid). There appears to be a strong relationship between poor huckleberry production and total mortality in the CYE. During this same time period an increase in human-caused mortality on private lands in the U.S. also contributed to the increase in overall mortality. Poor berry production may have caused bears to search more widely for foods that may occur on private lands; several mortalities during this time period were associated with sanitation issues on private lands (ibid). During this same time period, human-caused mortality on public lands in both Canada and the U.S. decreased. As presented in the Access Amendment Biological Opinion (USFWS 2011b, p. 20-27), Kasworm's 2010 synopsis of mortality rates concluded that since 1999, there appears to have been an increase in the numbers of grizzly bears killed on private lands in the CYE recovery area. Also since 1999:

1. natural mortality on U.S. public lands in the CYE recovery area was 53 percent of mortality among radio-collared bears.
2. human-caused mortality on private lands in the U.S. was 23 percent of mortality among radio-collared bears.
3. human-caused mortality on U.S. public lands was 14 percent of mortality among radio-collared bears, and
4. in B.C. human-caused mortality was 10 percent of mortality among radio-collared bears.

Kasworm (2010a) goes on to say “Therefore, mortality on private lands in the U.S. has become the largest source of human-caused mortality in the CYE. Grizzly bears are now being killed by humans at disproportionately higher numbers on private lands than on NFS lands: the CYE is about 90 percent public land, yet human-caused mortality on these lands is only about 14 percent of the mortality among radio-collared bears. The CYE is about 10 percent private land, yet human-caused mortality occurring on private land is 23 percent of mortality among radio-collared bears.” “...To accomplish recovery of the population in the CYE, efforts to reduce the high levels of human-caused mortality on private lands are necessary (ibid).” Since 2010, 5 additional mortalities have occurred in the CYE. All were human-caused and 4 were on NFS lands and one was on private lands in the U.S.

To address hunter-related mortality, Montana and Idaho state agencies have ongoing hunter outreach efforts. Montana Fish Wildlife and Parks (MFWP) has implemented a mandatory bear identification test since 2002 to help educate hunters in distinguishing species in an effort to reduce mistaken identity and grizzly bear mortality. MFWP also runs numerous public announcements in the media prior to and during hunting seasons, reminding hunters to be knowledgeable and use proper precautions in grizzly bear habitat. A grizzly/black bear identification test is available on the Idaho Fish and Game (IDFG) website and informational letters are mailed to black bear and elk hunters in the fall and spring (Wakkinen 2012, Research and Management Update, p. 2).

Selkirk Ecosystem

The SE is located primarily in northern Idaho but includes portions of Washington and Canada also. It encompasses over 2,200 square miles of the Selkirk Mountains of northeastern Washington, northern Idaho, and southern British Columbia. Approximately 47 percent of the recovery zone is in British Columbia with the remainder in the U.S. The 1993 Recovery Plan defined a portion of the SE within Canada so that it was at least 2,000 square miles in size. This size will promote the Recovery Plan’s minimum population goal of 90 grizzly bears in the SE (USFWS 1993 p. 99). In Canada, land ownership is roughly 65 percent Crown (public) land and 35 percent private. In the U.S. portion of the SE, land ownership is approximately 80 percent Federal, 15 percent State, and 5 percent private lands. Within the SE, 3 percent (39,976 acres) is designated Wilderness Area.

Population Trend

Proctor et al. (2012, p.31) compiled data from multiple sources and conducted DNA-based population surveys) to estimate a population size of 83 grizzly bears in the SE, with 25-30 in the U.S. (W. Wakkinen 07/02/2013 pers. comm.), which is based on expert opinion. The Idaho Department of Fish and Game (IDFG) is currently working on a revised population estimate for the U.S. portion of the SE that will present a more scientifically rigorous estimate. As previously discussed, it was estimated in 2004 that the population of grizzly bears in the SE was slowly increasing at a rate of 1.9 percent annually (Wakkinen and Kasworm 2004, p.72). Recently, Wakkinen indicated that there is no evidence that would suggest any major changes from the

2004 population growth rate; however, this will be updated in upcoming years (W. Wakkinen 07/02/2013 pers. comm.).

Status of Recovery Criteria

Table II-6 shows the 1993 demographic criteria and the status of those criteria for the SE. The Service is in the process of updating the 1993 recovery plan as there are new science and techniques available. Regarding mortality, no more than 30 percent of this 4 percent mortality limit shall be females. These mortality limits cannot be exceeded during any 2 consecutive years for recovery to be achieved. Presently, grizzly bear numbers are so small in this ecosystem that the mortality goal is zero human-caused mortality.

Table II-6. Status of the recovery criteria for the SE recovery zone.

Selkirk Recovery Zone Recovery Criteria (USFWS 1993)	Target	Status (In USFWS 2011b, p. A-15)
Females with cubs (unduplicated sightings)	6 females with cubs (6-year average)	0.5 females with cubs (6-year average)
Distribution of females with young (BMUs occupied)	7 of 10	4 of 10
Human-caused mortality limit	not to exceed 4% of the population estimate (6 year average)	Although there was only 1 mortality of a male grizzly bear in 2008, the running 6-year average of total human-caused mortality was 2.5 animals per year including 1.2 females each year.

As shown in Table II-6, none of the 1993 demographic recovery criteria have been met in the SE (USFWS 2011a, p. A-115). Wakkinen (2009 pers. comm.), noted: “that the ability to monitor the population has declined due to funding limitations and the reduction in trapping and radio collaring activities” in the recovery area. The population goal of 6 females with cubs has not been met. In 2008, the 6-year running average was 0.5 females with cubs. In 2009 the 6-year running average dropped to 0.3 females with cubs, but there were no observations of family groups in the BMUs in 2009 due in part to the lack of radio-collared grizzly bears in the U.S. portion of the recovery zone. Since 2012, Kasworm has been working with IDFG to monitor grizzlies in the SE. In 2012, three female grizzly bears were radio collared just north of Priest Lake and in July 2013, an additional three female grizzly bears were radio collared in the same area (Kasworm 2013, p.2). All females are currently being monitored through weekly flights.

Grizzly Bear Mortality in the SE

In the SE from 1989 to present, there have been a total of 55 known grizzly bear mortalities. Based on data from 1989 to present, grizzly bear mortality rates in the U.S. portion of the SE appear to have decreased but mortalities remain moderately high in the Canada portion (W. Wakkinen 07/02/2013 pers. comm.). Most mortality in the U.S. portion of the SE is human-

caused and the result of mistaken identification or intentional poaching during the hunting season. Conversely, in the Canada portion, most mortality is human-caused and the result of sanitation issues or other human-bear conflict issues.

To date, there have been no known mortalities associated with sanitation issues on NFS lands (USFS 2013a, p. 73). The absence of grizzly bear mortalities on NFS lands is likely due to a concerted effort to improve sanitation on NFS lands.

Similar to the CYE, there appears to be a relationship between poor huckleberry production and total grizzly bear conflicts in the US portion of the SE, but the sample size is limited and the conditions that elicit grizzly bear mortalities can be variable (ibid). For example, it is not clear whether grizzly bears are in low elevations because of poor huckleberry production, an expanding population, or because they are drawn by attractants regardless of huckleberry production (ibid).

Additionally, a grizzly/black bear identification test is available on the IDFG website and informational letters are mailed to black bear and elk hunters in the fall and spring (Wakkinen 2012, Research and Management Update, p. 2).

7. Factors Affecting the Status of the CYE and SE Recovery Zones

Habitat Conservation Measures

Habitat conservation includes measures and programs to avoid or reduce habitat loss or displacement of grizzly bears from important seasonal habitats. “Displacement” is used in general terms to describe “under-use” of habitat. It does not necessarily mean that grizzly bears would totally avoid an area, or be excluded in some way from ever using an area. Such measures and programs include acquisition of important lands for grizzly bears to prevent human encroachment and development; agreements for the conservation and protection of grizzly bear habitat by precluding activities that might otherwise displace bears; and comprehensive provisions for access management and secure habitat (core areas) for grizzly bears to limit human disturbance and subsequent displacement or risk of conflict.

Land Acquisitions

Land acquisition and exchange in the CYE has placed additional areas within this recovery zone in the public domain and may benefit the long term conservation of the species. There have been 2 major land exchanges in particular that have been beneficial to grizzly bear habitat within the CYE. In 1997 the Kootenai National Forest completed a land exchange in which 33 square miles of land owned by Plum Creek Timber Company were placed in public ownership. Almost all of this land was within the CYE grizzly bear recovery zone and is now under Forest Service management.

In 2005, the MFWP acquired almost 2 square miles in the Bull River Valley between the East and West Cabinet Mountains in the Bull BMU on the KNF. A conservation easement on an adjacent one square mile was accepted from the Avista Company. The area, now known as the Bull River Wildlife Management Area, provides linkage of public land across the river valley

and will have value for a number of species including bull trout, westslope cutthroat trout, grizzly bear, lynx, and bald eagle.

See discussion of Fragmentation below for information on acquisitions benefitting the SE.

Conservation Plans and Agreements.

In 1995, the British Columbia provincial government developed a grizzly bear conservation strategy for the lands to the north of the CYE (British Columbia Ministry of Environment, Lands, and Parks 1995, entire). A major goal of the Strategy was to ensure effective, enhanced protection and management of habitat through land use planning processes, new protected areas, and the Forest Practices Code. Gilnockie Provincial Park was established in 1995 just north of the international border in the upper Yaak River drainage. The 11 square mile park is managed similarly to U. S. wilderness areas with little road access.

In September 2012, the MFWP secured a 28,000 acre conservation easement with Stimson Lumber Company for land in the City of Troy. These lands are the largest remaining private in-holding in the CYE recovery zone. The Kootenai Valleys Conservation Program protects important fish and wildlife habitat providing linkage and connectivity across Highway 2 in the CYE (see additional information below in Fragmentation and Genetic Isolation).

Additional conservation in the CYE will be achieved through implementation of the State of Montana's recently completed habitat conservation plan (HCP) which addresses the effects of its forest management program on grizzly bears in the CYE. As a result of that plan, open road densities on state lands on the Montana side of the ecosystem will be maintained or improved, lands will be inactive for a period of 8 years following a commercial timber sale (to provide habitat security for grizzly bears), and all State forest management employees and its contractors will adhere to food storage and sanitation requirements.

In the SE, the LeClerc BMU is comprised of checkerboard ownership between the CNF and Stimson Lumber Company. Stimson Lumber Company manages approximately 21,000 acres of the land within the LeClerc BMU and has entered into a Conservation Agreement with CNF and the Service to minimize adverse effects to grizzly bears (USFWS 2001b, pp.53-54). This Agreement requires Stimson and the CNF to leave hiding cover within created openings, along open roads, and within riparian habitats. Stimson is also required to log during the winter in some areas to reduce disturbance and report logging activities and road entries to the CNF annually. The Service's biological opinion (USFWS 2001b, pp.53-54) on that Agreement included an incidental take statement with terms and conditions providing for no net decrease in core area habitat or an increase in TMRD on affected Forest Service lands.

The Idaho Department of Lands (IDL) BMU in the SE encompasses 160,000 square miles and is situated east of Priest Lake and is under state jurisdiction. IDL received Federal funding in 2003 to develop a Habitat Conservation Plan (HCP) for this area. However, this effort did not result in a finalized HCP for the BMU.

Wheeled Motorized Access Management (also influences Human-caused Mortality)

Secure habitat is important to the survival and reproductive success of grizzly bears, (Mattson et al. 1987, pp. 18-19; IGBC 1994, p. 1). Grizzly bear habitat security is primarily achieved by managing motorized access which — (1) minimizes human interaction and reduces potential grizzly bear mortality risk; (2) minimizes displacement from important habitat; (3) minimizes habituation to humans; and (4) provides habitat where energetic requirements can be met with limited disturbance from humans (Mattson et al. 1987, pp.19-20; McLellan and Shackleton 1988, pp.458-459; McLellan 1989, p. 1856; Mace and Manley 1993, pp.24-27; Mace et al. 1996, pp. 1402-3; Wakkinen and Kasworm 1997, pp. 22-26).

In 1998, an IGBC interagency task force examined motorized access management and produced recommendations to standardize definitions and methods (IGBC 1998, pp.3-5). This report recommended three parameters to include as components of access management: 1) open motorized route density (OMRD)¹; 2) total motorized route density (TMRD); and 3) core areas.

In the SE and CYE, the benchmark for the proposed standards was the average levels of access and secure habitat reported by Wakkinen and Kasworm (1997, p. 1) to adequately support a female grizzly bear with cubs:

- On average, 26 percent of a female grizzly bear home range had TMRD greater than 2 miles per square mile.
- On average, 33 percent of a female grizzly bear home range had OMRD greater than 1 mile per square mile.
- On average, 55 percent of a female home range was comprised of core area (i.e., roadless area or areas with barriered roads).

Past management actions on NFS lands related to motorized access (e.g., timber sales and associated road construction, road maintenance, and watershed improvements through sediment reduction from roads – including road decommissioning) led to the existing wheeled motorized vehicle route system on the landscape. The 2011 Access Amendment for the SE and CYE established standards for core area, OMRD and TMRD for each BMU in the Recovery Zones (USFS 2011c, entire). These security measures are calculated on a BMU basis using a GIS and moving-windows routine.

The Access Amendment also established timeframes in which all standards in individual BMUs in the CYE will be met (completion by 2019). Actual accomplishment dates will depend on management priorities, funding, and the completion of required project-level environmental analyses under NEPA. The Access Amendment also established the amount of administrative use that may occur on each individual gated road within the recovery zone, based on the “bear year” (spring, summer and fall). Each Ranger District retains a count of use that occurs by road; this information is reported to the FWS in the spring of each year. Another key feature of the

¹ Includes both roads and trails

Access Amendment was the re-evaluation of BORZ boundaries and limits on linear miles of open and total permanent roads to existing baseline conditions.

There are 22 BMUs in the CYE recovery zone and 10 BMUs in the SE. According to Service calculations (USFWS 2011a, p. A-39), in the CYE recovery zone, there was an increase of approximately 24,230 acres of core area from 2000 to 2010. This translates into an increase from about 56 percent of the CYE recovery zone to more than 57 percent of the CYE recovery zone providing core area habitat. Overall, motorized route densities have been reduced and secure habitat has increased in the CYE since the grizzly was listed.

According to Service calculations (USFWS 2011a, p. A-44) in the SE recovery zone, there was an increase of approximately 13,032 acres of core area from 2000 to 2010. This translates into an increase from 58.1 to nearly 61 percent of IPNF lands in core area from 2000 to 2010 (which includes eight BMUs managed by the IPNF).

The Grizzly Bear Access Amendment standards and their current status are displayed in [Table II-7](#). Attainment of the standards is anticipated by approximately 2019. If successful, core area in the CYE will have increased by 20,756 acres such that 58.5 percent of the CYE will be core area and 20 of 22 BMUs will meet the research benchmark for core area (USFWS 2011a, p. A-60). Additionally, OMRD and TMRD will improve, such that 15 of 22 BMUs will meet or be better than the OMRD research benchmark (currently 15 of 22 meet) and 16 of 22 BMUs will meet or be better than the TMRD benchmark (currently 13 of 22 BMUs meet) (USFWS 2011a, p. A-66).

The Access Amendment maintains the Lakeshore BMU as the only BMU in the SE recovery area managed by the IPNF that does not meet (i.e., is worse than) the benchmarks for TMRD and OMRD (USFWS 2011a, p. A-67). Importantly, the Lakeshore has never been expected to function like the other BMUs due to its small size and proximity to heavily used recreation areas and as such is managed as both MS1 (9,872 acres) and MS3 (8,093 acres). The Access Amendment fulfills one of the two major grizzly bear habitat management needs (the other being a Food Storage Order) for federal lands in the CYE and SE.

Table II-7. Status of standards for core, open motorized route density (OMRD) and total motorized route density (TMRD) for the CYE and SE BMUs. Values in blue reflect standards set in place in November 2011 Grizzly Bear Access Amendment. All or portions of BMUs 18-21 in the Cabinet-Yaak Recovery Zone are within the Action Area, while the remaining BMUs are located on the Kootenai and Lolo National Forests. Portions of Kalispell-Granite, Sullivan Hughes, Salmo-Priest, and Le Clerc BMUs in the Selkirk Recovery Zone are located within the CNF.

Recovery Zone	Bear Management Unit	Percent OMRD >1 mi/mi ² (standard)	Percent TMRD >2 mi/mi ² (standard)	Percent Core Area (standard)	Percent Federal Land
	1 (Cedar)	15 (15)	8 (15)	83 (80)	99

Recovery Zone	Bear Management Unit	Percent OMRD >1 mi/mi ² (standard)	Percent TMRD >2 mi/mi ² (standard)	Percent Core Area (standard)	Percent Federal Land
Cabinet Yaak	2 (Snowshoe)	18 (20)	16 (18)	77 (75)	94
	3 (Spar)	30 (33)	26 (26)	62 (59)	95
	4 (Bull)	38 (36)	29 (26)	62 (63)	84
	5 (St. Paul)	29 (30)	23 (23)	58 (60)	97
	6 (Wanless)	32 (34)	34 (32)	53 (55)	85
	7 (Silver Butte)	24 (26)	23 (23)	63 (63)	92
	8 (Vermilion)	32 (32)	24 (20)	55 (55)	93
	9 (Calahan)	28 (33)	27 (26)	58 (55)	90
	10 (Pulpit)	45 (44)	27 (34)	54 (52)	95
	11 (Roderick)	28 (28)	27 (26)	54 (55)	96
	12 (Newton)	43 (45)	32 (31)	56 (55)	92
	13 (Keno)	33 (33)	25 (26)	59 (59)	99+
	14 (NW Peak)	28 (31)	26 (26)	56 (55)	99+
	15 (Garver)	31 (33)	26 (26)	54 (55)	94
	16 (EF Yaak)	29 (33)	27 (26)	54 (55)	96
	17 (Big Cr.)	31 (33)	16 (26)	56 (55)	99
	18 (Boulder)	34 (33)	35 (29)	49 (55)	92
	19 (Grouse) ³	60 (59)	59 (55)	32 (37)	54
	20 (North Lightning)	35 (35)	19 (20)	64 (61)	94
	21 (Scotchman)	37 (34)	27 (26)	63 (62)	81
	22 (Mt. Headley)	38 (33)	37 (35)	51 (55)	89
Selkirk	Blue Grass	35 (33)	28 (26)	50 (55)	96
	Long-Smith	21 (25)	14 (15)	73 (67)	92
	Kalispell-Granite	36 (33)	27 (26)	52 (55)	96
	Salmo-Priest	30 (33)	24 (26)	67 (64)	99
	Sullivan-Hughes	25 (24)	19 (19)	63 (61)	99
	Myrtle	30 (33)	20 (22)	60 (56)	85
	Ball-Trout	18 (20)	11 (13)	72 (69)	94
	Lakeshore	81 (82)	50 (56)	21(20)	86
	Le Clerc ⁴	46	58	27	64

NOTE: The numbers used for road densities and Core Area include consideration of roads on State and private lands within grizzly bear habitat, even though the standards apply only to NFS lands.

Access management on lands in the SE administered by the CNF is dictated by its 2008 Motor Vehicle Use Map. This map is the culmination of a Travel Planning process that means motorized travel on the forest is now legally restricted to designated roads and trails identified on the Use Map. Off-road travel is prohibited except to access a campsite with 300 feet of a designated route. There are few open roads identified on the Use Map in recovery habitat and no motorized trails or areas identified in recovery habitat. The CNF has been educating the public

about using the Motor Vehicle Use Map, and enforcing the travel restrictions on the map. Use of roads in recovery habitat has declined as a result.

Small Population Size

Currently, small population size is being addressed by an augmentation program in the CYE and efforts to maintain linkage and connectivity with Canada and adjacent recovery zones in the U.S. The latter is discussed below under the heading Fragmentation and Genetic Isolation. To date, no augmentation has occurred in the SE

Augmentation

From 1990 to 1994 four female grizzly bears were captured in the Flathead River Valley of British Columbia and released in the Cabinet Mountains to augment the existing population. One of the transplanted bears and her cub died of unknown causes a year after release (Kasworm et al. 1998, p. 151). The remaining three bears were monitored until their collars fell off. The program was designed to determine if transplanted bears would remain in the target area and ultimately contribute to the population through reproduction. Three of four transplanted bears remained within the target area for more than one year. Though one of the transplanted bears produced a cub, the animal had likely bred prior to translocation and did not satisfy the criteria for reproduction with native males.

In 2005, the MFWP began augmenting the grizzly bears in the Cabinet Mountains. In 2005 and 2006, an adult female grizzly bear and a subadult female, respectively were transplanted from the North and South Fork Flathead River drainages to the Cabinet Mountains. No bears were transplanted in 2007 as no suitable females were captured. Two female grizzly bears were released during 2008. In October 2008 both of these bears were killed. In September 2009 an adult female and in July 2010 two subadult bears, a male and a female, were transplanted from the North Fork Flathead River drainage to the Cabinet Mountains. In 2011, an adult female and two males were moved into the Cabinet Mountains from the NCDE (Kasworm et al. 2011, p.2). It appears that the Cabinet Mountains segment of this population has actually increased in size since the start of augmentation in 1990). This increase is largely due to the reproductive output of a successful augmentation bear and her offspring which have also reproduced (Kasworm et al. 2011, p.2).

Kasworm et al. 2012, reported that fourteen bears have been added to the Cabinet Mountains population since 1990 (11 females and 3 males) through the augmentation effort. Three female bears and one male have left the target area and 4 bears are known to be dead. One of the bears that is known to be dead survived for 16 years in the Cabinet Mountains and produced at least 9 young. Those offspring are known to have produced at least 8 young. Few captures or hair snags of native bears in the Cabinet Mountains since the beginning of the augmentation program in 1990 suggest that the population was probably smaller than originally estimated (much fewer than 15 bears). The information also indicates that the Cabinet Mountains grizzly population would probably have disappeared without augmentation (ibid, pp.22, 25). The MFWP intends to continue the augmentation effort into the future with plans to relocate a young male and female

bear for the coming season (depending on suitability of captured bears) (J. Williams 06/12/2013 pers. comm.).

Fragmentation and Genetic Isolation

The effects of fragmentation and genetic isolation are closely related to the small size of the SE and CYE populations, which is discussed above.

Fragmentation

Presently, there has been limited movement of native bears between the Cabinet Mountains and Yaak portions of the CYE. One subadult male has crossed the Kootenai River moving from the Yaak to the Cabinets and then returning to the Yaak (W. Kasworm 8/24/2013 pers. comm.). However, there is currently no indication of successful movement and breeding activity by native bears resulting in gene flow between the two portions of the recovery zone. Grizzly bears augmented into the Cabinet Mountains have crossed Highway 2 during exploratory movements moving into the Yaak area and east back to the NCDE (ibid). We are encouraged by this recent data on grizzly bear movements in the CYE. In the past 5 years there have been more detections of Yaak grizzly bears (telemetry and hair snags) nearer the Kootenai River on the north side than in previous years (ibid).

Potential isolation from grizzly bears in the Canada portion of the greater CYE is identified as a potential threat to grizzly bears in the U.S. portion of the ecosystem. Conditions in Canada and along the international boundary currently allow movement of grizzly bears between Canada and the Yaak portion of the CYE, but grizzly bear habitat is being affected by highways and associated development in Canada. Kasworm (2013, p.3) reported the movements of an augmented female grizzly bear from the Cabinet Mountains through the Yaak to the NCDE north to Canada and then back to the CYE. The female grizzly has made this trip in two consecutive years.

The Kootenai Valleys Conservation Easement Program described above under Conservation Agreements, protects lands important for linkage and connectivity within the CYE. The MFWP recently secured the Kootenai Valleys Conservation Easement Project on 28,000 acres of Stimson Lumber lands along Highway 2 near the town of Troy. These lands represent the largest in-holding of private lands in the CYE recovery zone and are largely surrounded by KNF lands. Conservation of these lands maintains habitat necessary for linkage and connectivity between the Cabinet Mountain and Yaak River bears in the CYE.

One occurrence of grizzly bear movement between the CYE and SE was documented (Kasworm and Johnson 2008 as cited in USFS 2013a, p. 85) when a subadult male moved from the Purcell-South Yaak area into the southern Selkirks. There was one occurrence of a female migrant from the Canada portion of the SE moving into the US portion of the SE. In 2008 a grizzly bear shot in the Bitterroot Mountains originated from the Selkirk South (ibid). Additionally, linkage occurs between the Yaak bears in the CYE and Canada (USFWS 2011b, p. 11; Kasworm et al. 2010, pp. 47-58). Additional work is ongoing in the CYE recovery zone to further our understanding of linkage and movement (Kasworm et al. 2010, pp. 30-35) as well as the SE (Kasworm et al. 2010, pp. 31-35). Presently, there is no documented movement and reproduction

between grizzly bears in the Cabinet Mountains and Yaak portions of the CYE (i.e., grizzly bears are not moving between the two populations within the recovery zone). Grizzly bears including females with cubs have been documented in the Tobacco BORZ, between the NCDE and CYE ecosystems (Kasworm et al. 2012, p. 16). While bears augmented into the CYE have returned to the NCDE and back again (indicating some level of connectivity between the two recovery zones), no bears have yet been documented to have moved on their own from the NCDE to establish in the CYE (W. Kasworm 02/04/2013 pers. comm.). Recent DNA results show the first documented movement of a grizzly bear between the SE and the CYE (W. Wakkinen 07/02/2013 pers. comm.). The DNA data indicates that a young male grizzly bear that was born in the SE successfully crossed into the CYE. The parents and sibling of the young male remained in the SE. More results from a recent DNA study in the CYE and SE will be available in 2013 or 2014 and will further improve our current understanding of linkages. Additionally, a female grizzly bear augmented into the Cabinet Mountains has moved from to the Yaak, over to the NCDE, north to Canada and back to the CYE in two consecutive years (Kasworm 2013).

Recent DNA results show the first documented movement of a grizzly bear between the SE and the CYE (W. Wakkinen 07/02/2013 pers. comm.). The DNA data indicate that a young male grizzly bear that was born in the SE successfully crossed into the Cabinet Mountains of the CYE. The parents and sibling of the young male remained in the SE.

Because the SE relies on connectivity with Canada for its long-term conservation, the cumulative effects of timber harvest, mining, recreation, and road building in B.C. have the potential to affect the SE grizzly bear population. The Nature Conservancy of Canada recently purchased 213 square miles of private land within the SE recovery zone in Canada. The location of these lands directly connects to an existing network of parks and wildlife management areas. Although many traditional uses will continue (e.g., timber harvest, snowmobile use), it will help create a contiguous area of more than 391 square miles, enough for wide-ranging animals like mountain caribou and grizzly bear to maintain connectivity with U.S. populations of these species.

Genetic Isolation

Proctor et al. (2012, p. 10) compiled and analyzed all known genetic and movement data for grizzly bears in 30 different study areas. The genetic data reflect fragmentation occurring on the landscape in the recent past (i.e., last 30-60 years) and may not reflect current, improved levels of connectivity and recent movement of grizzly bears between areas. In other words, current grizzly bear populations may not be as isolated as the genetic data of this study suggest. Therefore, it is useful to supplement these genetic data with movement data to get a complete picture of current population connectivity.

Proctor et al. (2012) found 4 males and 1 female using habitat between the Selkirk and Purcell Mountains, although there was no evidence indicating any migration between these 2 mountain ranges. Mace and Roberts 2012, Figure 3 - included in this biological opinion as Figure II-3) compiled the distribution of verified records of grizzly bears in and adjacent to the NCDE

recovery zone based on a compilation of telemetry data, mortality data, and DNA detections. They documented both male and female grizzly bears in habitat between the NCDE and CYE. We have documented one female grizzly bear with a cub that regularly uses habitat between the NCDE and CYE. She and her offspring spend most of their summer in the Salish Mountains of Montana less than 2 miles east of the edge of the CYE while denning within the boundaries of the NCDE recovery zone (Kasworm et al. 2008). There have been several different grizzly bears with cubs documented using habitat west of Highway 93, since 2002 (USFWS 2011b, pp.29-30).

Currently, it is not possible to tell if movements we are observing reflect an increase in bear movements or an increase in detection effort and technology (e.g., radio-transmitter collars; genetic techniques) (Proctor et al. 2012). These promising detections of grizzly bear movements should be tempered by the idea that detected movement does not mean migrants are breeding successfully. If there is no successful reproduction, then there is no genetic or demographic rescue occurring. There seems to be high mortality risk associated with migrant bears (Proctor et al. 2002, p. 158, Proctor et al. 2012). However, these data are helpful when considering how to most effectively manage and conserve the remaining grizzly bear populations in the lower 48 States. For example, these data emphasize the importance of maintaining demographic connectivity with Canadian populations and the small populations of the North Cascades ecosystem, SE, and CYE. Recovery of these small populations may eventually provide genetic and demographic rescue such that a grizzly bear population could establish in the Bitterroot Ecosystem.

The MFWP augmentation program is an important component of maintaining the genetic health of the population. Studies demonstrate that inbreeding depression can be reversed through augmentation (Hedrick 1995 and 2001; Keller and Waller 2002 as cited in USFWS 2006, p. A-17). Augmentation of the Cabinet Mountains segment aids in alleviating the isolation within that portion of the CYE. However, interchange of bears is ultimately dependent on creating and/or maintaining effective habitat linkage zones between the Yaak and the Cabinet Mountains (USFWS 2006, p. A-17), as well as between the NCDE and CYE and CYE and SE.

Human-Caused Mortality

Human-caused mortality is the leading source of mortality among radio-collared bears for both the CYE and SE.

Human-caused Mortality in the CYE

In the entire CYE, including B.C., between 1982 and 2012, a total of 67 known mortalities occurred for radio-collared grizzly bears from all forms (Table II-8). Of the known mortalities, 49 were human-caused (ibid) and 37 (76 percent) of these were ascribed a known cause of death. Of these 37 mortalities, 54 percent were attributed to poaching (8), mistaken identity during hunting (6), and self-defense (6) (i.e., involved gunshot wounds). Twelve additional bears were found dead, 9 were killed by gunshot as evidenced by a bullet, but exact cause is unknown and may be related to poaching, mistaken ID, or spiteful killing. All of these deaths occurred during the hunting season (W. Kasworm 02/04/2013 pers. comm.).

Table II-8. Number of known grizzly bear mortalities by cause in the CYE from 1982 through 2012 (W. Kasworm 02/04/2013 pers. comm.)

Type of Mortality	Canada		United States		Total
	BC		USFS	Other ¹	
Natural					
Conspecific predation ²	0		3	0	3
Other	4		9	0	12
Subtotal	4		12	0	15
Human					
Poaching	0		2	6	8
Mistaken Identity	0		6	1	7
Self Defense	1		4	1	6
Management Removal/Sanitation	5		0	1	6
Legal Hunting (BC only)	3		0	0	3
Trapping (incidental)	1		1	0	2
Research	1		1	0	2
Train Collision	0		0	3	3
Motor Vehicle	0		0	0	0
Unknown	2		7	3	12
Subtotal	13		21	15	49
Unknown	0		2	0	2
Total	17		33	15	67

¹ Other = includes private, state, and railroad lands.

² Conspecific = grizzly bears killing grizzly bears.

Human-caused Mortality in the SE

In the SE from 1989 to present, there have been a total of 55 known grizzly bear mortalities (Table II-9). Of the known mortalities, 52 were human-caused and 40 (77 percent) of these were ascribed a known cause of death. Of the 40 known cause mortalities, more than half were the result of management removals due to human-bear conflicts or sanitation issues, primarily in B.C. (n=21). Another 22.5 percent were a result of poaching, mistaken identity during hunting, and self-defense, primarily in the U.S. (W. Wakkinen 07/02/2013 pers. comm.).

Table II-9. Number of known grizzly bear mortalities by cause in the SE from 1989- June 2013 (W. Wakkinen 07/02/2013 pers. comm.).

Type of Mortality	Canada	United States
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	BC	WA and ID	Total
Natural			
Conspecific predation ²	1	0	1
Other	0	0	0
Subtotal	1	0	1
Human			
Poaching	1	5	6
Mistaken Identity	0	2	2
Self Defense	1	0	1
Management Removal/Sanitation	21	2	23
Legal Hunting (BC only)	5	-	5
Trapping (incidental)	0	0	0
Motor Vehicle	2	0	2
Under Investigation	6	6	12
Subtotal	37	15	52
Unknown	1	2	3
Total	38	17	55

As demonstrated by the data, hunting for other species both in Canada and the U.S. in the SE and even more so in the CYE, adds to illegal or mistaken identity mortality of grizzly bears within the greater ecosystems. The province of B.C. and the states of Montana, Idaho, and Washington allow hunting for black bears, as well as other wildlife species, within and around the recovery zone. Legal hunting of grizzly bears no longer occurs² in the U.S. or B.C. but grizzly bears are taken by poachers and are mistakenly killed during the black bear or big game hunting season.

MFWP and IDFG have ongoing hunter outreach efforts. For example, MFWP has implemented a mandatory bear identification test since 2002 to help educate hunters in distinguishing species in an effort to reduce mistaken identity and grizzly bear mortality. MFWP also runs numerous public announcements in the media prior to and during hunting seasons, reminding hunters to be knowledgeable and use proper precautions in grizzly bear habitat. A grizzly/black bear identification test is available on the IDFG website and informational letters are mailed to black bear and elk hunters in the fall and spring (Wakkinen 2012, Research and Management Update, p. 2).

To address mortalities on private lands, the MFWP employs grizzly bear specialists that handle reports of “nuisance” grizzly bears and trap offending bears. In the CYE, the bear specialist works directly with the public to inform residents as to how to live in grizzly bear habitat without conflicts with bears, and assists them with nuisance black and grizzly bear conflicts. Nuisance

² Hunting of grizzly bears was legal in British Columbia until 2008 (British Columbia Ministry of Environment 2008, Mowat 2007, Mowat pers. comm. 2008 as cited in USFS 2013a, p. 66).

grizzly bears are typically habituated to seeking out human-related foods and garbage and pose serious threats to human safety, and often are destroyed. In the CYE, based on anecdotal information, there has been an increase in the number of residents seeking proactive help (e.g. fencing gardens, beehives and other attractants) to prevent conflict prior to an incident and fewer incidents involving problem bears have occurred during recent years (Annis 2013), and this represents notable progress toward reducing the potential for conflicts between people and grizzly bears, and in return reduces grizzly bear mortality.

While IDFG do not currently have full-time bear mitigation specialists like MFWP, there is a conservation officer whose duties are similar in many aspects to the MFWP grizzly bear specialist positions (W. Wakkinen 07/02/2013 pers. comm.). IDFG also employs wildlife biologists whose duties include bear management activities.

To date, there have been no grizzly bear deaths associated with food attractants on NFS lands in the SE or CYE recovery zones. There has been a concerted effort in the SE and CYE to improve sanitation on NFS lands throughout the ecosystem, with many campgrounds retrofitted—or scheduled to be retrofitted—with bear resistant garbage and/or food storage containers to reduce encounters and the potential for habituation. Additionally, all resort and recreation residence special use permits renewals in-or-near the recovery zones boundaries in the CYE and SE include sanitation guidelines as part of the special use permit. Finally, all National Forests that encompass the CYE and SE recovery zones have implemented mandatory food storage orders that assist in minimizing this impact (USFS 2013a, p. 73 and Appendix F). The IPNF Food Storage Order (encompassing the CYE, SE, and BORZ), fulfilled one of the two (the other being Access Management) major grizzly bear habitat management needs for federal lands in the CYE and SE.

Summary of Status of Grizzly Bears in the SE and CYE

In 2006, the Service identified the six priority needs to achieve grizzly bear recovery in the SE and CYE grizzly bear recovery zones (C. Servheen 2006 pers. comm. as cited *In* USFWS 2011a, p. A-32), and they pertain to the action area (see Section C. Environmental Baseline) as well:

1. Augment the Cabinet Mountains and Canadian Selkirks populations;
2. Limit human-caused mortality;
3. Enhance population linkage across Highways 2, 3, 200, 135, and 95;
4. Address the needs of bears outside the recovery zone line;
5. Inside the recovery zone, a) complete access management in most important areas and b) improve sanitation standards on public land;
6. Increase outreach and public involvement.

The following progress has been made since 2006 to address these concerns:

- Ongoing augmentation program in the CYE (need 1)

- Ongoing public education and outreach programs in both recovery zones (needs 2 and 6), including:
 - In Montana, hunter education since 2002; bear specialist programs since 2007 (MFWP 2013); and regular programs of public information and education within the CYE recovery zone by the IPNF and KNF (USFS 2013a, p. 73).
 - In Idaho, hunter education since 2010 (W. Wakkinen 07/02/2013 pers. comm.) and regular programs of public information and education within the SE recovery zone by the IPNF and cooperating agencies (IDFG and IDL) (USFS 2013a, p. 73).
- Implementation of the Kootenai Valleys Conservation Easement Project in the city of Troy (2012) in the CYE (need 3)
- Completion of the Access Amendment for BMUs and BORZ on NFS lands in the CYE and SE on the KNF and IPNF in 2011 (needs 4 and 5a)
- Implementation of food storage orders on all forests overlapping the CYE in 2011 and on the IPNF in the SE (need 5b).

The CYE grizzly bear population has a slightly declining trend, but improved since 2006. Since 2006, lambda (rate of change in the population) has improved and moved closer to stability (1.0) – an indication that the CYE grizzly bear population status is improving. Lands along Highway 2 have recently been secured through a conservation easement to protect important future linkage areas. Additionally, the MFWP continues its augmentation program and hunter education, outreach, and specialist programs. The augmentation efforts have resulted in increasing grizzly bear numbers in the Cabinet Mountains through successful reproduction of a relocated female and her offspring.

Although the SE population may be slowly increasing (Wakkinen and Kasworm 2004, pp.73-74) and reconnecting with adjacent populations, high levels of human-caused mortality and a lack of regulatory mechanisms in B.C. still threaten this population. The grizzly bear access amendment and the INPF and KNF Food Storage Order address the major grizzly bear habitat management needs for federal lands in the CYE and SE.

8. Climate Change

This section describes current climatic conditions, anticipated future conditions, and the anticipated effects on grizzly bears.

Current Conditions

Global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases, causing increases in global average temperatures, and changes in ocean heat content, precipitation, atmospheric moisture, and Arctic sea ice (Karl et al. 2009, p. 9). Analysis of various climate data for the Northern Hemisphere suggest that the rate of warming observed in the 20th century, as well as the magnitude of global temperatures from 1990 to 2004, is unprecedented in the past 2000 years (Moberg et al. 2005, p. 615).

At the national level, over the past 50 years, the U.S. average temperature has risen more than 2 degrees Fahrenheit (°F), precipitation has increased an average of about 5 percent, extreme

weather events, such as heat waves and regional droughts, have become more frequent and intense, and sea level has risen along most of the U.S. coast (Karl et al. 2009, p. 27). In addition, cold-season storm tracks are shifting northward and Arctic sea ice is declining. Ecosystem processes are affected by climate and by the concentration of carbon dioxide in the atmosphere (Janetos et al. 2008, p. 2). The diversity of living things (biodiversity) in ecosystems is itself an important resource that maintains the ability of these systems to provide the services upon which society depends. Many factors affect biodiversity including: climatic conditions; the influences of competitors, predators, parasites, and diseases; disturbances such as fire; and other physical factors. Human-induced climate change, in conjunction with other stresses, is exerting major influences on natural environments and biodiversity, and these influences are generally expected to grow with increased warming (Janetos et al. 2008, p. 2).

In the western U.S., both the frequency of large wildfires and the length of the fire season have increased substantially in recent decades, due primarily to earlier spring snowmelt and higher spring and summer temperatures (Westerling 2006, pp. 942-943). Changes in climate have contributed significantly to several major insect pest outbreaks in the United States and Canada over the past several decades. Drought and hot, dry weather have led to an increase in outbreaks of insects in the Columbia Basin, especially mountain pine beetle (ISAB 2007, p. 91). Even though there are few climate change studies specific to sub-regions, such as western Montana, there is some data available for the state. For instance, the Montana Climate Action Project website reports that warmer springs are making snow melt sooner, and early snowmelt leaves rivers low by summer's end. The website also shows that over the last century, the average temperature in Helena, Montana, has increased 1.3°F, and precipitation has decreased by up to 20 percent in many parts of the state.

Future Regional and Local Climate Conditions

The following information is summarized from the Kootenai and Idaho Panhandle National Forests Planning Zone (KIPZ) Climate Change Report (USFS 2010b) and IPNF Land Management Plan Draft (USFS 2011a).

An assessment on climate change for the planning zone (i.e., the area encompassed by the KNF and IPNF Revised Forest Plans) synthesized the most recent scientific information regarding how future climate change may impact forest resources and disturbance processes on the KNF and the IPNF (USFS 2010b, pp. i-vii). This report concluded the average annual temperatures will increase 2.2°F by the 2020s and 3.5°F by the mid-21st century. The greatest temperature increases are predicted for the summer season. Precipitation predictions are considered less certain, but most of the climate change models project decreases in summer precipitation, increases in winter, and little change in the average. It is also predicted that some extreme events will occur more frequently or with greater magnitude, while others may be less frequent (i.e., more unusually warm periods and fewer really cold spells). Other research for the northern Rockies (Westerling et al. 2006, p. 943; Running 2006, p. 927; Morgan et al. 2008, p. 725) predicts warmer springs, earlier snowmelt, and hotter, drier summers with longer fire seasons and larger, more intense fires.

The report also concludes climate changes are likely to increase the frequency of large fire years in the Northern Rockies and that fire seasons will be longer. Some of the climate change modeling efforts has suggested that by the 2080s, the amount of area burned by wildfires in the Pacific Northwest region (including Idaho and western Montana) would double or triple. However, as explained in more detail in the KIPZ Climate Change Report, there are a number of key sources of uncertainty regarding this issue.

The potential influence of climate change on some of the key forest insects and diseases of the Northern Rockies is discussed in the KIPZ Climate Change Report (USFS 2010b, pp. i-vii). In addition, a literature review of climate change and forest diseases of Western North America is presented in Kliejunas et al. (2009, p. 2). These documents conclude that climate change will lead to reductions in tree health and will improve conditions for some insects such as bark beetles and damaging pathogens such as root diseases.

Over the last 50 years, average spring snowpack (April 1 snow water equivalent) has declined and average snowmelt runoff is occurring earlier in the spring. These trends are observed for northwestern Montana, the entire Pacific Northwest, and much of the western U.S. Since the available data is limited to the last 50 years, it is not clear whether these trends are persistent long-term trends or reflect short-term decade-to-decade variability that may reverse in coming years. Several recent studies of the same trends across the entire western U.S. have concluded that natural variability explains some, but not all, of the west-wide trend in decreasing spring snowpack and earlier snowmelt runoff.

Climate Change Effects to Grizzly Bears

Climate change trends in the Pacific Northwest region will be important to grizzly bears with respect to how these trends may affect denning behavior, foraging habitat availability, and fire-regimes.

Predicted decreases in snowpack levels may shorten the denning season as foods are available later in the fall and earlier in the spring. Spring and fall encounters between grizzly bears and people may therefore increase; escalating the mortality risk to bears during these times.

An additional effect of climate change could be changes in the availability of and distribution of foraging areas due to increasing temperatures and seasonal changes in precipitation. The extent and rate to which plant species and communities would be affected is difficult to predict. Changes in vegetative distributions may also influence other mammal distributions, including prey species like ungulates.

As described earlier, grizzly bears are opportunistic feeders and will consume almost any available food. Because grizzly bears are such successful omnivores, climate-induced vegetative changes may not have detectable, negative effects on grizzly bear populations in the lower 48 States.

An increase in the frequency of large-scale wildfires may result in reductions in forest cover and some types of foraging habitat, while potentially creating other types of foraging habitat, e.g. shrub, berry, and grassland forage areas.

Grizzly bears are habitat generalists and opportunistic omnivores, able to find resources in a wide variety of habitat conditions. It is difficult to predict how this large, wide-ranging species would respond to environmental changes associated with climate change. At this time, the scope and scale of such changes are unknown, and the effects (positive or negative) on grizzly bears would likely be variable across the landscape.

Through IPNF's participation in the IGBC, it is made aware of new findings relative to grizzly bears in the action area. If climate change affects the status of the grizzly bear such that we have new information relevant to our effect analysis below, reinitiation of the consultation may be necessary.

9. Analysis of the Species Likely to be Affected

Grizzly bears are a wide-ranging species requiring large, interconnected areas of suitable habitat. The preponderance of grizzly bear habitat in recovery zones in Montana and Idaho occurs on NFS lands. Grizzly bears on the IPNF occur in the CYE and SE recovery zones. Both recovery zones support small populations of grizzly bears. The IPNF Revised Plan Forest-wide direction describes the framework under which lands will be managed for the next 10 to 15 years on the Forest. This biological opinion considers the effects of implementation of the Revised Plan as well as the effects of Plan elements specific to the conservation of grizzly bears and grizzly bear habitat.

C. ENVIRONMENTAL BASELINE

The environmental baseline section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat, if applicable), and ecosystem, within the "action area" (USFWS and NMFS 1998, p. 4-22).

The "environmental baseline" includes:

- the past and present impacts of all Federal, State, or private actions and other human activities in an "action area,"
- the anticipated impacts of all proposed Federal projects in an "action area" that have already undergone formal or early section 7 consultation,
- and the impact of State or private actions that are contemporaneous with the consultation in process.

1. Action Area

As described in Section A., this biological opinion addresses the effects on grizzly bears related to the revision of the Forest Plan for the IPNF. Therefore, the action area is the entire IPNF. Currently, grizzly bears on the IPNF are most often using habitat within BMUs and BORZ - adjacent areas on the Forest identified as having recurring use by grizzly bears outside of the recovery zone. However, bears are also observed infrequently on other areas of the Forest and given the 10 to 15 year timeframe this plan will be in place, it is reasonable to assume that grizzly bears may occur in additional areas of the Forest during the life of the plan.

Within the action area, there are 6 BMUs in the SE recovery zone that are wholly within the IPNF and 2 BMUs with shared ownership between IPNF and CNF. Within the CYE recovery zone there are 4 BMUs that are wholly within the IPNF, and 2 BMUs with shared ownership between the IPNF and KNF (Table II-10). Additionally, there is 1 BORZ area associated with the CYE and 2 BORZ areas associated with the SE on IPNF lands (Table II-11). Within the SE recovery zone, the action area does not include the LeClerc BMU which is almost entirely located in and managed by the CNF, Washington, and the IDL BMU, which is primarily owned and managed by the state of Idaho. Figure II-2 shows the location of the IPNF, BMUs and BORZ associated with the CYE and SE.

Table II-10. CYE and SE BMUs, acreage, status of and standards for open motorized route density (OMRD), total motorized route density (TMRD) and core area as of bear year 2011, and percent federal land in the action area.

BMU Name (ID)	Total Size (Acres)	Percent OMRD>1mi/mi ² (standard)	Percent TMRD>2mi/mi ² (standard)	Percent Core Area (standard)	Percent Federal Land
CYE BMUs					
Keno (13)	51,235	33 (33)	25 (26)	59 (59)	99+
NW Peak (14)	83,027	28 (31)	26 (26)	56 (55)	99+
Boulder (18)	62,379	34 (33)	35 (29)	49 (55)	92
Grouse (19)	65,086	60 (59)	59 (55)	32 (37)	54
North Lightning (20)	68,724	35 (35)	19 (20)	64 (61)	94
Scotchman (21)	62,288	37 (34)	27 (26)	63 (62)	81
Total	392,739				
SE BMUs					
Blue Grass	57,325	35 (33)	28 (26)	50 (55)	96
Long-Smith	65,735	21 (25)	14 (15)	73 (67)	92
Ball-Trout	57,907	18 (20)	11 (13)	72 (69)	96
Myrtle	63,781	30 (33)	20 (22)	60 (56)	99
Salmo-Priest	87,115	30 (33)	24 (26)	67 (64)	99
Sullivan-Hughes	78,210	25 (24)	19 (19)	63 (61)	85
Kalispell-Granite	85,641	36 (33)	27 (26)	52 (55)	94
Lakeshore	17,972	81 (82)	50 (56)	21(20)	86
Total	513,686				

Data provided reflect on-the-ground access conditions during the 2011 “bear year” (i.e. April 1 – November 30 in the Cabinet-Yaak ecosystem and April 1 – November 15 in the Selkirk ecosystem).

2. Status of the Species within the Action Area

Within the action area, the status of grizzly bears is the same as that described above for the overall status of the grizzly bear populations in the CYE and SE (see Section B. Status and Distribution).

3. Factors Affecting Species Environment within the CYE and SE Portions of the Action Area

As discussed under Status of the Species, the primary factors affecting the SE and CYE in the action area include inadequate habitat conservation measures; human-caused mortality; small population size; and fragmentation and genetic isolation. Below, we summarize the status of these factors within the action area. For any other factors, the conditions in the action area are the same as those described for the entirety of the recovery zone and are largely outside the jurisdiction of the IPNF.

Habitat Conservation Measures

The primary factor affecting habitat conservation in the action area includes access management.

As reported under Status of the Species, the IPNF recently completed a Forest Plan amendment providing direction for access management in grizzly bear BMUs within the CYE and SE recovery zones. The current and anticipated status of the BMUs in the action area relative to the Access Amendment is in [Table II-10](#).

Once the standards are attained (anticipated by approximately 2019), 5 of the 6 BMUs in the CYE action area will meet the research benchmark for core area (USFWS 2011a, p. A-60). Additionally, OMRD and TMRD will improve or be maintained such that 5 of the 6 BMUs in the CYE will meet (or be better than) the OMRD research benchmark (Northwest Peak) and 5 of 6 BMUs will meet (or be better than) TMRD benchmark: N. Lightning ([Table II-10](#)).

Similarly, 7 of 8 BMUs in the SE would have at least 55 percent core area, increasing core area in the affected area by about 4,111 acres to 315,378 acres or 61.4 percent of the affected BMUs. This would represent an increase of 17,143 acres of core area since 2000 (USFWS 2011a, p. A-61). Under the Access Amendment, just one BMU in the SE would continue to exceed the OMRD and TMRD research benchmarks and not achieve desired core (Lakeshore BMU) (USFWS 2011a p. A-67).

Another key feature of the Grizzly Bear Access Amendment was the re-evaluation of BORZ boundaries. There are three BORZ areas on the IPNF: two (Priest and Pack River) near the SE and one (Mission-Moyie) near the CYE. In BORZ, the Access Amendment limits linear miles of open and total permanent roads to no more than the existing baseline as displayed in [Table II-11](#).

Table II-11. Motorized access conditions for BORZ associated with the CYE and SE (USFS 2013a, p. 75)

Bears Outside Recovery Zone	Grizzly Bear Recovery Zone	Total Size (Acres)	IPNF Lands			Private and State Lands		
			Total Area (Acres)	Total Roads (Miles)	Open Roads (Miles)	Total Area (Acres)	Total Roads (Miles)	Open Roads (Miles)
Priest Lake	Selkirk	80,733	75,793	319	317	4,940	36.1	33.6
Pack River	Selkirk	33,869	28,097	44	39	5,772	6.9	6.9
Mission-Moyie ¹	Cabinet-Yaak	71,545	58,472	231	203	13,073	112.8	105.7

1. Formerly called 'Deer Ridge.'

In 2004, the Service issued a biological opinion on the IPNF's original Access Amendment (USFWS 2004). We determined that the amendment was not likely to jeopardize grizzly bears. The amendment's Record of Decision and the Service's biological opinion were challenged in court. The biological opinion was upheld in the District Court. However, the court remanded the decision back to the Forests for further consideration of requirements under NEPA. In 2011, the Forests proposed a revised access amendment. The Service found the revised amendment was more conservative (good for bears) than the 2004 access amendment. In 2011, we issued a biological opinion on the revised amendment and determined that it was not likely to jeopardize grizzly bears. We expect that eventual achievement of the motorized access and security standards in the amendment will create conditions that are conducive to supporting adult female grizzly bear home ranges across the SE and CYE recovery zones. We determined that the amendment would contribute to recovery of the grizzly bear population(s) in the CYE and SE. The amendment is now being implemented by the Forest.

The grizzly bear access amendment fulfills one of the two major grizzly bear habitat management needs for federal lands in the CYE and SE (the other being a Food Storage Order). The recent implementation of the Grizzly Bear Access Amendment, which incorporates road density and core area standards based on the research by Wakkinen and Kasworm (1997, pp. 6-8), is expected to reduce the potential for both displacement of grizzly bears from key habitat and human-caused mortality on IPNF lands. This will be achieved by generally moderating the miles of road in grizzly bear habitat and providing large blocks of habitat where motorized use of roads and trails is prohibited.

The population-level effects of the amendment will require time to become evident because of the low reproductive rate of grizzly bears, which results in a population that increases or decreases slowly over time. Long term monitoring of the population will continue to verify trends. Even with implementation of the amendment, some level of human-caused mortality is likely to persist on private and to a lesser extent, public lands.

Small Population Size

Within the action area, the Access Amendment will reduce the risk of human-caused mortality on IPNF lands.

Fragmentation and Genetic Isolation

Highways, railroads, and private land uses contribute to fragmentation and increase the risk of isolation. Ongoing concerns in the action area include U.S. Highway 1, 2, and 5. Highways 1 and 5 bisect the Cabinet and Selkirk Mountain ecosystems, and Highway 2 bisects the Yaak and Cabinet Mountains ecosystem.

Servheen et al 2003, (p. 13) identified the main areas for concern associated with linkage corridors between the SE and CYE. Primarily these are associated with vehicle transportation corridors and include U.S. Highways 2 and 95, and Idaho State Highways 1 and 57. Namely U.S. Highways 95 and 1 completely separate the two recovery zones. Also, significant amounts of public and private development have occurred in the Purcell Trench and the communities of Sandpoint and Bonners Ferry, Idaho. Additional fragmentation is occurring in the area surrounding Priest Lake, Idaho (Servheen et al 2003, p. 26).

In 2013, the first movement of a grizzly bear between the SE and the CYE was documented. Based on DNA data, a young male grizzly bear who originated in the SE had successfully crossed into the CYE (W. Wakkinen 07/02/2013 pers. comm.). The parents and sibling of the young male still remain in the SE. Grizzly bears augmented into the Cabinet Mountains have made exploratory movements across Highway 2, and one male from the Yaak has crossed to the Cabinet Mountains. However, to date, there is no movement and reproduction between bears in the Yaak and Cabinet Mountains (Kasworm 08/23/2013 pers. comm.). As discussed above (Status), augmentation moderates the effects of this isolation. The recent purchase of the Kootenai Valleys Conservation Easement Project also conserves important lands in the corridor for efforts to maintain connectivity.

The 2011 access amendment limits new road construction in the BORZ and limits linear miles of road to no more than the existing baseline open and total permanent roads to prevent additional impacts of road densities on grizzly bears between the CYE and NCDE and between the CYE and SE.

Human-caused Mortality and Other Factors

Other factors affecting grizzly bears on IPNF lands in the action area as described in the Revised Plan terrestrial biological assessment (USFS 2013a) include attractants (which can lead to human-caused mortality), recreation, grazing, motorized over snow routes, and mining.

Attractants

Attraction of grizzly bears to improperly stored food and garbage is identified as one of the principal causes of grizzly bear mortality, especially on private lands. Information and education as well as food storage programs can reduce human-bear conflicts contributing to grizzly bear mortality (USFWS 2011b, p. 106). The IPNF and cooperating agencies (including Idaho

Department of Fish and Game, Idaho Department of Lands) maintain and financially support a regular program of public information and education within the SE and CYE recovery zones (USFS 2013a, p. 73).

To date, there have been no grizzly bear deaths associated with food attractants on NFS lands in the SE or CYE (USFS 2013a, p. 73). There has been a concerted effort to improve sanitation on NFS lands throughout the ecosystem, with many campgrounds retrofitted—or scheduled to be retrofitted—with bear resistant garbage and/or food storage containers to reduce encounters and the potential for habituation. Additionally, all resort and recreation residence special use permits renewals in-or-near the recovery zones boundaries include sanitation guidelines as part of the special use permit. Most significantly, on September 29, 2011 the IPNF implemented a mandatory food storage order to assist in minimizing this impact (USFS 2013a, Appendix F).

Recreation

The IPNF received an estimated 855,000 visits between October 2002 and September 2003 (USFS 2009, p. 161). Approximately half of these total visits occurred in the Forest's north zone, which includes the SE and CYE recovery zones. As noted above, the access management program is expected to reduce the potential for human-caused grizzly bear mortality on the Forest by moderating the miles of road in grizzly bear habitat and providing large blocks of habitat where motorized use of roads and trails is prohibited.

Many visitors to NFS lands remain fairly close to motorized access routes according to the Revised Plan Draft EIS analysis (USFS 2011b, pp. 213, 265). To reiterate the information presented in the section above, *Grizzly Bear Mortality in the CYE*, recreational use such as hiking on trails or driving scenic routes does not appear to result in conflicts leading to mortality of grizzly bears. Most grizzly bear deaths on the CYE and SE on NFS lands are hunting related or occur during the hunting season (W. Kasworm 02/04/2013 pers. comm.; W. Wakkinen 07/02/2013 pers. comm.). Further, MFWP and IDFG have hunter education and public outreach programs and bear specialist positions to reduce the potential for conflict between grizzly bears and hunters and recreationists, in an effort to reduce grizzly bear mortality. Refer to Cumulative Effects section for details on hunter education and public outreach programs and bear specialist positions.

Grazing

There are two cattle grazing allotments covering 14,328 acres of grizzly bear habitat situated in two BMUs within the SE portion of the action area. Portions of two additional cattle grazing allotments (approximately 3,930 acres) are situated in the Priest River BORZ within the IPNF Proposed Action Area. There are no sheep allotments. There are no allotments on IPNF lands in the CYE. To date, there have been no grizzly bear/livestock conflicts associated with livestock use of IPNF lands.

Motorized Over-the-Snow Routes

As discussed above under section B. Status, 3. Habitat Requirements, our primary concern related to motorized over-snow routes as it relates to grizzly bears is that disturbance from

snowmobiles may be most consequential shortly before or after den emergence of a female with cubs. Females and their cubs remain in the den site area for several weeks after emergence from dens (Haroldson et al. 2002, p. 33; Mace and Waller 1997, pp. 37-38). Females with cubs have high energetic needs, and cubs have limited mobility for several weeks after leaving the den. Disturbance levels that cause a female to prematurely leave the den in spring, or move from the den area, could impair the fitness of the female and safety of the cubs. If cubs attempt to follow their mother, they will likely experience decreased fitness and the family group may be pushed to less suitable habitat. To date, litter abandonment by grizzlies due to snowmobiling activity has not been documented in the lower 48 States (Hegg 2010, pp. 26-27; Servheen 2010 pers. comm. *In* USFWS 2011a) nor has other detectible or measurable adverse effects on grizzly bears from snowmobile use been substantiated (Mace and Waller 1997, p.41; USFS 2006, pp.3-263, 3-373).

There are 14 miles of groomed routes located in approximately 118,200 acres of available modeled grizzly bear denning³ habitat within the SE portion of the Action Area. Additionally, there are 26 miles of groomed trails within 74,750 acres of modeled grizzly bear denning habitat within the CYE portion of the IPNF. Off-route use occurs on approximately 7,440 and 14,250 acres of the IPNF portion of the SE and CYE recovery zones, respectively. Both on and off-route snowmobile travel combined occurs on about six and 19⁴ percent of modeled denning habitat on the IPNF portion of the SE and CYE, respectively. However, the actual magnitude and location of this use during the post-emergence period (i.e. after April 1) is greatly reduced due to a combination of limited public participation in the sport after April 1, and deteriorating snow conditions (USFS 2013a, p. 77). [Table II-12](#) summarizes the existing over-the-snow motorized access within BMUs and denning habitat on the IPNF. Snowmobiling also occurs on approximately 95 miles of groomed trails in the Priest and Pack River BORZ. There are no groomed trails within the Mission-Moyie BORZ.

The IPNFs is in the process of preparing a Winter Travel Plan that addresses over-the-snow motorized use in the SE. It is anticipated that this will be completed in the next two-to-four years.

³ Grizzly bear denning habitat was modeled separately for the two ecosystems using local research data

⁴ Over-the-snow motorized use occurs on approximately nine percent of the entire Cabinet-Yaak recovery zone (USFS 2013a, p. 76).

Table II-12. Current motorized over-the-snow access within grizzly bear recovery zones on the IPNF (USFS 2013a, p. 77).

Type of Allowed Access	Selkirk Recovery Zone		Cabinet-Yaak Recovery	
	BMU	Denning	BMU ¹	Denning
Total Area with the IPNF (acres)	384,560	118,200	247,460	74,760
Total Area where Over-the-Snow Use is Allowed	320,700	99,960	246,400	74,760
Groomed Over-the-snow Routes (miles)	130 ³	14 ³	86	9
Over-the-snow Motorized Use (acres)²	19,930 ^{3,4}	7,440 ^{3,4}	47,740	14,250

¹Includes IPNF data from the Boulder, Grouse, North Lightning, Northwest Peaks, Keno, and Scotchman BMUs only. Total recovery zone=1,649,300 acres; total denning=489,720 acres.

² Many of these areas have limited accessibility for snowmobiling off-route due to tree densities and topography (USDA Forest Service 2011).

³ The Selkirk Recovery Zone includes the 2007 federal court order to protect woodland caribou, which will be lifted once winter travel planning is complete (likely 2014-15). The current use reflects this closure.

⁴Motorized over-the-snow activity is precluded on 95 percent of these acres from March 15 – 30 or April 1 – June 30 under closure orders.

Mining

There are no major mining operations on the IPNF at this time. There are currently 1,232 Plans of Operations for locatable minerals on the IPNF. Of these, 17 are located in grizzly bear recovery zones (SE=4; CYE=13) and 14 are located in BORZ (SE=3 – Priest and Pack River; CYE=11 – Mission-Moiye). The majority of on-going activities are related to maintenance of existing facilities and most locatable mineral operations are less than five acres in size.

There are approximately 434 active mineral material (sand, rock, gravel) pits and quarries within the IPNF and of these 62 sites are located in the recovery zones (SRE=26; CYE=36) and 19 are located in the BORZ (SE=8; CYE=11). Sites are typically from less than one acre to five acres in size.

There are no leasable minerals located on the IPNF at this time and potential is considered “low”.

Overall, there are limited existing effects on grizzly bears from material mining operations on the IPNF and effects are similar to those related to roads since most sites are adjacent to access routes (L. Allen 08/21/2013 pers. comm.).

D. EFFECTS OF THE ACTION

The effects of the action are considered along with the status of the species, the environmental baseline, and cumulative effects (defined and analyzed below) for purposes of preparing a biological opinion on a proposed Federal action (USFWS and NMFS 1998, p. 4-23).

“Effects of the action” refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, and that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. [50 CFR §402.02]

1. Factors to be Considered

This section considers the effects to grizzly bears from implementation of the Revised Plan direction as guided by the Revised Plan elements (goals, objectives, desired condition, standards, and guidelines). It also considers how the Revised Plan direction is moderated by elements specific to the conservation of grizzly bears and grizzly bear habitat.

The Revised Plan proposes direction for the management of NFS lands across seven MA ([Table II-2](#)): Wilderness; Eligible Wild and Scenic Rivers; Special Areas; Established/Proposed Research Natural Areas, Backcountry; General Forest; and Primary Recreation Areas. Allocation to a specific MA is not intended to mandate or direct the IPNF to propose or implement any action; rather the themes provide an array of allowed and prohibited activities regarding: timber harvest; commercial use; personal use; fire and wildfire; grazing; recreation; motorized use; road construction/reconstruction; and mineral activities. In our analysis of effects of the Revised Plan, we will discuss the effects of the revised plan and application of the elements in the MAs relative to BMUs or BORZ, which are the units of analysis commonly used to describe effects on grizzly bears.

Notably, the Revised Plan also implements the previously consulted-on Access Amendment (USFS 2011c). The contents, data, analyses, and conclusions of the *Biological Opinion Forest Plan Amendments for Motorized Access Management within the Selkirk and Cabinet-Yaak Grizzly Bear Recovery Zones on the Kootenai, Idaho Panhandle, and Lolo National Forests* (USFWS 2011a) are incorporated in this analysis in their entirety. In subsequent sections of this analysis we cite page numbers from the Access Amendment that support a particular conclusion; however, we considered the entirety of that document for the purposes of our analysis of the Revised Plan.

Except in the case of the motorized route densities and over-snow motorized use, this biological opinion does not provide an analysis for effects of specific actions. Rather, this analysis is a broad-scale examination of the types of projects and activities conducted or contemplated under the Revised Plan that could potentially occur in grizzly bear habitat and result in effects on grizzly bears. The IPNF is responsible for section 7 consultation (if applicable and appropriate) on all future projects conducted under the Revised Plan that may affect the grizzly bear or its habitat, even if those projects are consistent with Revised Plan.

As mentioned, the exception to this broad-scale analysis is motorized route densities and over-snow motorized use. For motorized route densities, the science is clear that above prescribed average densities, bears may suffer adverse effects that can lead to significant impairment of grizzly bears' ability to feed, breed, or shelter. Further these densities have been carefully examined, monitored and reported by the USFS. Hence, we are able to ascertain the level of adverse effects on grizzly bears related to road densities, and that analysis, previously conducted in our consultation on the 2011 Access Amendment, is brought forward in this analysis as is the associated incidental take statement. For over-snow motorized use (i.e. snowmobile use) the Forest examined, monitored, and reported the amount of denning habitat that was impacted by late season snowmobile use. The best available science and information suggests that recently emerged females with cubs would be vulnerable to adverse disturbance effects of snowmobile use near den sites during late spring. Thus, we are able to ascertain the level of adverse effects and provide surrogate measures of incidental take of grizzly bears related to late-season snowmobile use.

Our analysis will be used to determine the potential for the Revised Plan direction and effects from motorized access and snowmobile use in grizzly denning habitat to jeopardize the affected populations of grizzly bears (CYE and SE). In our analysis of effects of the Revised Plan, we will discuss the effects of the revised plan and application of the elements in the MAs relative to BMUs, subunits, or BORZ, which are the units of analysis commonly used to describe effects on grizzly bears (see Section A.1).

2. Analysis of Effects of the Action

The following sections analyze the direct and indirect effects of the implementation of the elements of the Revised Plan on grizzly bears. The effects will be discussed by broad categories of risk factors as identified in the Environmental Baseline section (above) and in the BA for the action area. The effects of the Revised Plan are discussed under the following, often overlapping categories:

- **Access management** including: roads, secure habitat, and motorized over-snow use.
- **Habitat management** including vegetation management, fire management, and linkage.
- **Human-caused mortality risk to grizzly bears** including attractant/food storage and information and education programs and grazing allotments.
- **Other Potential Effects** such as mining proposals, collection of forest products, and special uses.

For each category of effect, we begin with a general summary of what the science currently tells us about the potential impacts on grizzly bears and grizzly bear habitat. This is followed by an analysis of the specific effects of the proposed action on grizzly bears and grizzly bear habitat.

Effects of Access Management on Grizzly Bears Under the Revised Plan

Grizzly bear habitat security is primarily described in terms of availability of secure habitat. Grizzly bear habitat security is primarily achieved by managing motorized access which — (1) minimizes human interaction and reduces potential grizzly bear mortality risk; (2) minimizes

displacement from important habitat where energetic requirements can be met with limited disturbance from humans; and (3) minimizes habituation to humans (Mattson et al. 1987, pp.19-20; McLellan and Shackleton 1988, pp.458-459; McLellan 1989, p. 1856; Mace and Manley 1993, pp.24-27; Mace et al. 1996, pp. 1402-3; Wakkinen and Kasworm 1997, pp. 22-26). This section addresses effects of roads; secure habitat; and motorized over-snow use on grizzly bears under the Revised Plan.

Effects of Roads on Grizzly Bears Under the Revised Plan

General Effects of Roads on Grizzly Bears

The presence of roads and human activity associated with roads creates some of the most pervasive and chronic effects on grizzly bears and their habitat.

Grizzly bears generally respond to (or are affected by) roads and human presence in four ways. First, they may be disturbed by human presence, responding with a relatively short term – short distance response (Mueller et al. 2004, pp. 44-45). Second, they may be displaced from highly roaded areas and areas near roads (McLellan and Shackleton 1988, p.456; Mace et al. 1996, p. 1403), responding with a longer term avoidance response and movement to another area. When grizzly bears avoid roaded areas, they forgo the resources in these areas, which may result in under-use of key habitats. They may also be displaced into competition with other grizzly bears, or conflicts with humans. Third, grizzly bears may become habituated to human activities and roads but then expose themselves to a greater probability of encounter with humans (and hence mortality) (Schwartz et al. 2010, p.661-662). And fourth, roads facilitate human access into grizzly bear habitat, which directly or indirectly increases the risk of mortality to grizzly bears (McLellan and Shackleton 1988, p.459; Mace et al. 1996, pp. 1402-1403). The relationship of grizzly bears and roads is further described in detail in our biological opinion on the Access Amendment (USFWS 2011a pp. A-48 through A-55).

Effects of Roads on Grizzly Bears in the Action Area

In November 2011, the Kootenai, Idaho Panhandle, and Lolo National Forests completed the Access Amendment which set standards and guidelines for motorized access within the CYE and SE recovery zones (USFS 2011a). That direction is summarized in the proposed action and described in detail in Appendix E of the USFS Terrestrial BA (2013a) and in the USFS 2010 Biological Assessment and associated Supplement (USFS 2010a, 2011d). The Access Amendment established standards for core area, OMRD, and TMRD for each BMU in the affected recovery zones (SE and CYE) (USFS 2011a). These standards are calculated on a BMU basis using a GIS and moving-windows routine. The status of BMUs related to the amount of core area and OMRD and TMRD within each BMU are reported to the Service annually.

The Access Amendment established timeframes within which all standards in individual BMUs in the SE and CYE will be met. The Revised Plan will not alter these timeframes. The BMUs will be in compliance with all standards by 2019. Actual accomplishment dates will depend on management priorities, funding, and the completion of required environmental analyses under NEPA. The current status of these standards by BMU is presented in [Table II-10](#) above. The Access Amendment also established the amount of administrative use that may occur on each

individual gated road within the recovery zone, based on the bear year (spring, summer and fall). Each Ranger District retains a count of use that occurs by road and reports that information to the Service in the spring of each year. Lastly, the Access Amendment updated the BORZ boundaries and limits linear miles of open and total permanent roads to the existing baseline condition in BORZ. The status of roads in BORZ is included in [Table II-11](#).

Forest-wide desired condition FW-DC-AR-07 trends the forest towards: “A transportation system is in place that provides safe and efficient public and administrative access to the Forest for recreation, special uses, other forest resource management, and fire management activities....The transportation system and its use have minimal impacts on resources including threatened and endangered species....Unauthorized roads and trails are no longer created.” The Proposed Action reduces the amount of area where wheeled motorized access can occur within the grizzly bear recovery zones by approximately 34,758 acres in the SE and 29,682 acres in the CYE ([Tables II-13 and II-14](#)).

Forest-wide desired conditions FW-DC-WL-01, 02, 03, and 04, and 05 and Geographic-wide desired conditions GA-DC-WL-PR-02, GA-DC-WL-LK-03, and GA-DC-WL-PO-02 emphasize the need for large remote areas with low levels of disturbance so that grizzly bears have the necessary space and habitat unhampered by human activities.

Any proposed roads under the Revised Plan will adhere to the requirements of the Access Amendment or require an amendment to the Plan. Hence, we anticipate that the Revised Plan’s effects of roads on bears will be the same as previously analyzed in our Access Amendment Biological Opinion (USFWS 2011a, pp. A-48-55 and A-66-68).

Table II-13. Acres (percent) of grizzly bear habitat by allowable uses and activities under the Existing Plan versus the Proposed Action Management Area Direction. (The magnitude of actual use and activity is regulated by the 2011 Access Amendment design criteria in regards to motorized access (USFS 2011a) as well as other management direction and available budgets.)

Allowable Uses Under Forest Plan Management Area Direction	Existing Forest Plan		Proposed Action	
	Selkirk	Cabinet-	Selkirk	Cabinet-
	Recovery Zone Acres (% of Total ¹)			
Timber Harvest	296,966 (77)	219,540 (88)	291,066 (76)	217,146 (87)
Timber Production	232,261 (60)	142,349 (57)	0	0
Commercial Use – Special Forest Products & Firewood	384,556 (100)	248,582 (100)	284,031 (75)	215,822 (87)
Personal Use – Special Forest Products & Firewood	384,556 (100)	248,582 (100)	314,605 ² (83)	221,305 (xx)
Planned Fire Ignition	377,260 (98)	245,315 (99)	379,895 (99)	245,845 (99)
Natural, Unplanned Fire Ignitions to meet Resource Objectives	54,726 (14)	23,352 (9)	374,081 (97)	241,245 (97)
Grazing	323,825 ³ (84)	225,230 ³ (91)	290,227 (75)	216,705 (87)
Wheeled Motor Vehicle	320,706 (83)	246,387 (99)	285,948 (74)	216,705 (87)
Over-the-snow Motor Vehicle ⁴	320,706 (83)	246,387 (99)	303,595 (79)	216,405 (87)
Road Construction (permanent or temporary)	284,143 (74)	188,930 (76)	284,082 (74)	216,793 (87)
Minerals – Leasable	158,587 (41)	94,194 (38)	374,664 (97)	248,582 (100)
Minerals – Materials	348,180 (91)	214,278 (97)	165,353 (43)	133,986 (54)

¹Based on total amount of habitat available on NFS lands in the respective recovery zones, i.e. Selkirk-384,556 acres; Cabinet-Yaak=248,582 acres (Table 18).

²With no motorized equipment allowed on 65,320 acres in the Selkirk RZ (wilderness/recommended wilderness MAs).

³With no increase in existing allotments and no sheep on 37,935 of the Selkirk RZ and 138,494 acres of the Cabinet-Yaak RZ.

⁵Does not include the current court-ordered snowmobile closure in the calculations.

Table II-14. Summary of the changes between the existing plan and revised plan in allowable uses in grizzly bear recover zones.

Allowable Uses	Selkirk Recovery Zone (Acre)			Cabinet-Yaak Recovery Zone (Acres)		
	Existing Plan	Proposed Action	Difference	Existing Plan	Proposed Action	Difference
Timber Harvest	296,966	291,066	-5,900	219,540	217,146	-2,394
Timber Production	232,261	0	-232,261	142,349	0	-142,349
Commercial Use	384,556	284,031	-100,525	248,582	215,822	-32,760
Personal Use	384,556	314,605	-69,951	248,582	221,305	-27,277
Planned Fire Ignition	377,260	379,895	+2,635	245,315	245,845	+530
Natural, Unplanned Fire	54,726	374,081	+319,355	23,352	241,245	+217,893
Grazing	323,825 ³	290,227	-33,598	225,230	216,705	-8,525
Wheeled Motor Vehicle	320,706	285,948	-34,758	246,387	216,705	-29,682
Over-the-snow Motor Vehicle ⁴	320,706	303,595	-17,111	246,387	216,405	-29,982
Road Construction	284,143	284,032	-61	188,930	216,793	+27,863
Minerals – Leasable	158,587	374,664	+216,077	94,194	248,582	+154,388
Minerals - Materials	348,180	165,353	-182,827	214,278	133,986	-80,292

In summary, the Access Amendment established the following standards for the action area (pp. A-55-56):

1. Just one BMU in the SE will not meet research benchmark for core, TMRD, and OMRD: Lakeshore.
2. OMRD standards for 5 of 6 BMUs in the CYE will meet or be better than the research benchmark.
3. TMRD standards for 5 of 6 BMUs in the CYE will meet or be better than the research benchmark.

4. Core standards for 5 of 6 BMUs in the CYE will meet or be better than the research benchmark.

For the BMUs that will not achieve OMRD and/or TMRD benchmarks in the CYE and SE, we determined that maintenance of good quality core areas within the BMUs may lessen the overall displacement impacts to grizzly bears related to the relatively high OMRD and TMRD outside the core by providing ample amounts of relatively secure habitat within home ranges (USFWS 2011, p.A-67). Nevertheless, varying degrees of adverse effects are anticipated in any BMU not meeting the research benchmark for core area, OMRD, or TMRD (USFWS 2011b, p.83-84), depending upon how far or near the benchmark each parameter lies.

One of eight BMUs in the SE (Lakeshore) and one of the six BMUs (Grouse) in the CYE action area may never be capable of providing the conditions that research has indicated needed to support an average female home range. These BMUs are affected by small size and/or private ownership and /or other constraints. Therefore, for these BMUs, the Access Amendment established grizzly bear habitat management standards at levels that may not be capable of providing the full suite of home range needs of the average adult female grizzly bear.

Another key feature of the Access Amendment was the re-evaluation of BORZ boundaries, which limits linear miles of open and total permanent roads to the existing baseline condition for BORZ areas (USFWS 2011a, p. A-71-73). The status of motorized routes in BORZ is presented in [Table II-11](#). The requirements of the Grizzly Bear Access Amendment related to BORZ will continue under the Proposed Action through implementation of FW-STD-WL-02.

The presence of grizzly bears in BORZ indicates that some bears have apparently acclimated to what research indicates would be less-than-optimal conditions as far as road management, and at least in the short-term, seem able to find and secure the resources necessary for their needs and avoid human encounters resulting in mortality. However, our analysis of effects of roads in BORZ on grizzly bears remains the same as that presented in our Access Amendment Biological Opinion (USFWS 2011a, pp. A-71 to A-72, A-84). Briefly, we determined that while bears are using BORZ, we expect some ongoing adverse effects on grizzly bears attempting to use some portions of these areas as a result of the existing roaded conditions. We also stated that we expect that a number of grizzly bears will use these areas despite some level of adverse conditions, including females, albeit at lower densities than grizzly bears in the recovery zones. We based this expectation upon our knowledge of grizzly bears currently using these areas, along with the potential for bears to expand their range into other similarly roaded habitat outside the CYE and SE as is occurring in roaded habitat outside the NCDE (Mace and Roberts 2011, p.38-39; 2012, p. 24, 25, and 27).

Effects on Grizzly Bear Secure Habitat Under the Revised Plan

General Effects of the Availability of Secure Habitat on Grizzly Bears

Because grizzly bears can conflict with humans and their land uses, grizzly bear populations require a level of safety from direct human-caused mortality and competitive use of habitat such

as settlement, roading, excessive recreation, logging, mining, and livestock grazing. Ideal grizzly bear habitat provides some areas isolated from excessive levels of human impact.

The IGBC Taskforce (IGBC 1994) recognized the importance of secure areas to grizzly bears. The Taskforce defined "core areas" as those areas with no motorized access (during the non-denning period) or heavily used foot/livestock trails, providing some level of secure habitat for grizzly bears. Motorized use, such as snowmobiling or that associated with timber harvest, could occur within core areas during the denning (winter) period. The Taskforce recommended the establishment of core areas in all subunits, the size of core area should depend on ecosystem-specific habitat conditions, and that a core area remain intact on the landscape for at least 10 years. As previously discussed, research suggested core areas in the CYE and SE be at least 55 percent of the land area in a BMU. Based on the findings of Wakkinen and Kasworm (1997, pp. 22-26), this level and distribution of core area is likely to provide levels of secure habitat that provide for breeding, feeding, and sheltering activities for grizzly bears, including females (USFWS 2011b, p. 65).

Effects of the Availability of Secure Habitat on Grizzly Bears in the Action Area

The requirements of the Access Amendment will continue under the Proposed Action through implementation of FW-STD-WL-02. The current and proposed status of core under the Access Amendment is displayed in [Table II-10](#). Under the Access Amendment, all but two BMUs in the action area, one in the CYE (Grouse) and one in the SE (Lakeshore), would meet the research benchmark for core area. Several (8) BMUs would exceed (provide more than) the research benchmark for core. When the access amendment is fully implemented (anticipated by 2019), core area on the SE will increase to 62 percent of the IPNF BMUs in the SE providing core areas and on the CYE will have increased to 58.5 percent of the CYE recovery zone providing core areas (including IPNF and KNF ownerships) (USFWS 2011a, p. A-60 to A-61).

The requirements for core under the Access Amendment are supported by the Revised Plan through Forest-wide, MA, and GA desired conditions for large, remote areas with low disturbance that will contribute to habitat security for grizzly bears: FW-DC-WL-02, 04, 07, FW-DC-WL-05, FW-DC-AR-07; MA3-DC-WL-01, MA1a,b,c,e-DC-WL-01, MA5-DC-WL-01; GA-DC-WL-PR-02, GA-DC-WL-LK-01, GA-DC-WL-LK-02, GA-DC-WL-LK-03, and GA-DC-LW-PO-02. Under the Revised Plan, desired conditions, guidelines and standards that limit roads, reconstruction and motorized use ([Table II-12](#)) also decrease the risk of human-bear interactions. These include: MA1a-STD-AR-02 and 04; MA1b-STD-AR-01, 04, and 05; MA1c-STD-AR-01, MA1e-STD-AR-0; MA3-STD-AR-01, MA5-GDL-AR-03.

These elements of the Revised Plan compliment the Access Amendment and decrease the risk of human-bear interactions. Core areas provide an abundant amount of grizzly bear habitat (usually over half of each BMU) that bears can exploit, free from the disturbance associated with roads. Further, because motorized access is prohibited the chance of encounters with people and therefore poaching will be less in these areas compared to those with open roads. Under the Access Amendment, two BMUs in the action area would not meet the research benchmark for core area: Lakeshore in the SE and Grouse in the CYE. The BMUs in the action area that either meet or provide more than the research benchmark for core area are not expected to have adverse

effects on bears. Hence, we anticipate that the effects of core areas (secure habitat) as proposed in the Revised Plan on grizzly bears would be the same as previously analyzed in our Access Amendment Biological Opinion (USFWS 2011a, see pp. A-60 through A-65 and A-71 to A-73).

As described in the Access Amendment Biological Opinion (USFWS 2011a, p. A-69) and clarified in the Errata to the Biological Opinion (USFWS 2012), there is one additional form of potential adverse effect that may occur on grizzly bears associated with core areas on the IPNF. “The proposed Access Amendment allows for a one-time entry into core area on such roads for the sole purpose of hydrologically stabilizing the roads. To minimize the impact of such entry, the proposed Access Amendment requires that such work be completed in one bear season or less and the road is not to be entered for at least 10 years. As noted earlier, the duration of activity is limited and the activity is limited to the road prism. Therefore, we do not expect these activities to cause adverse effects to grizzly bears in most cases, although the potential cannot be ruled out entirely. We expect only female grizzly bears with cubs would be adversely affected, as they tend to be more sensitive to human disturbance. However these adverse effects would be short term only. Further, as stated, not all female grizzly bears affected by the one-time entries would be adversely affected, nor would all adverse effects rise to the level of significant impairment of breeding, feeding or sheltering. To prevent the need for such entries into core areas in the future, the proposed Access Amendment requires that roads that are closed to provide for core grizzly bear habitat be stabilized immediately and before the underlying habitat qualifies as core.”

Under the Access Amendment, there are no provisions for core areas in BORZ and the Revised Plan does not change this. Habitat security will primarily be achieved by limiting linear miles of open and total permanent roads to the existing baseline condition (under which bears are using the habitat); the Revised Plan allows no net increase in linear miles of open and total permanent roads. The fact that grizzly bears are using these areas indicates that some bears have apparently habituated to the conditions within them, and seem able to find and obtain the resources necessary for their needs and avoid human encounters resulting in mortality. As stated in our previous analysis (USFWS 2011a, pp. A-72 to A-73), we expect some ongoing adverse effects on grizzly bears attempting to use these areas as a result of the existing roaded conditions and lack of secure habitat. We also expect that some grizzly bears will use these areas despite some level of adverse conditions, including females, albeit at lower densities than grizzly bears in the recovery zones. We base this expectation upon our knowledge of grizzly bears currently using these areas and the large number of grizzly bears expanding their range into other similarly roaded habitat outside the NCDE (Mace and Roberts 2012, pp. 24-28).

Effects of Motorized Over-snow Vehicles on Grizzly Bears Under the Revised Plan

General Effects of Motorized Over-snow Use on Grizzly Bears

In general, effects on grizzly bears from snowmobiles may occur during denning, after den emergence, and in spring habitat (USFWS 2010a, pp. A-26 through A-28). As summarized above under section B. *Status of the Species*, available information regarding the effects of snowmobiles on grizzly bears is generally anecdotal, based on grizzly bear responses to various

stimuli other than snowmobiles collected during research. Such reports typically lack information related to the timing of disturbance, type of den, winter conditions or other important factors necessary to assess the significance of disturbance to grizzly bears, if any. Some information collected on black bears or other *Ursids* may have some relevance, but even the data on these species is incidental and largely theoretical. Regarding effects on bears during denning, snow is an excellent sound barrier (Blix and Lentfer 1992, p. 22) and impacts to denning bears would likely be less in deep snow situations than in shallow snow conditions. It is likely that hibernating bears exposed to meaningless noise, with no negative consequences to the bear, habituate to this type of disturbance (Knight and Gutzweiler 1995).

As discussed above, we believe that disturbance from snowmobiles may be most consequential shortly after den emergence of a female with cubs. Females and their cubs remain in the den site area for several weeks after emergence from dens (Haroldsen et al. 2002, p. 33; Mace and Waller 1997, pp. 37-38). Females with cubs have high energetic needs, and cubs have limited mobility for several weeks after leaving the den. Disturbance levels that cause a female to prematurely leave the den in spring or move from the den area could impair the fitness of the female and safety of the cubs. If cubs attempt to follow their mother, they will likely experience decreased fitness and the family group may be pushed to less suitable habitat.

After den emergence in spring, grizzly bears seek sites that melt snow early and produce green vegetation (Kasworm et al. 2010, p. 65). There is limited potential for snowmobiles to occur in these areas and overlap spring grizzly bear habitat for a short period of time after den emergence. The portion of the population using these habitats in early spring is most likely to be males and lone females (W. Kasworm 02/03/2013 pers. comm.). These bears are mobile and can move from disturbance (ibid).

To summarize, we have found no primary-source reports in the literature of grizzly bear den abandonment directly attributed to snowmobile activity (Hegg 2010 pp. 26-27; Servheen 2010 pers. comm. as cited *In* USFWS 2011b, p. 34) nor has other substantive adverse effects on bears from snowmobile use been substantiated (Mace and Waller 1997, p.41; USFS 2006, pp.3-263 3-373).

Effects of Motorized Over-snow Use on Grizzly Bears in the Action Area

Currently, over-snow motorized use is allowed on 83 percent of the SE recovery zone. Under the Revised Plan, this would be reduced to 79 percent. There are 14 miles of groomed routes located in approximately 118,200 acres of available modeled grizzly bear denning⁵ habitat within the SE portion of the Action Area. Off-route use occurs on approximately 7,440 acres of the IPNF portion of the SE recovery zone; both on and off-route snowmobile travel combined occurs on about six percent of modeled denning habitat on the IPNF portion of the SE.

⁵ Grizzly bear denning habitat was modeled separately for the two ecosystems using local research data

Snowmobiling also occurs on approximately 95 miles of groomed trails in the Priest and Pack River BORZ.

In the IPNF portion of the CYE, over-snow motorized use is allowed on 99 percent of the recovery zone in the action area and this would be reduced to 87 percent under the Revised Plan. Additionally, there are 26 miles of groomed trails within 74,750 acres of modeled grizzly bear denning habitat within the CYE portion of the IPNF. Off-route use occurs on approximately 14,250 acres of the IPNF portion of CYE recovery zone; both on and off-route snowmobile travel combined occurs on about six and 19⁶ percent of modeled denning habitat on the IPNF portion of the CYE. Including over-snow motorized use in the KNF portion of the CYE recovery zone, approximately 9 percent of the denning habitat in the entire CYE recovery zone currently overlaps with motorized over-snow use. There are no groomed trails within the Mission-Moyie BORZ.

The actual magnitude and location of this use in both recovery zones during the post-emergence period (i.e. after April 1) is reduced from the acres presented due to a combination of limited public participation (decreasing interest by snowmobilers as spring emerges and trail grooming is ceased) and snow conditions (decreasing snowpacks and increasing avalanche danger in April and lack of snow or the lack of drivable access with wheeled vehicles to areas containing sufficient snow due to soft roadbed conditions in May).

[Table II-12](#) summarizes the existing over-the-snow motorized access within BMUs and denning habitat on the IPNF.

The Revised Plan MA direction would result in a decrease in the acres of grizzly bear habitat where over-the-snow motorized access would be allowed by 17,111 acres in the SE and 29,982 acres in the CYE on the IPNF ([Tables II-13 and II-14](#)). Additional elements of the Revised Plan that may reduce the acres of over-snow motorized use and may further reduce the amount of over-snow motorized use include desired conditions that state that dens for threatened and endangered species are relatively free of human disturbance when they are in use (FW-DC-WL-01); that all BMUs have low levels of disturbance to facilitate bear use such as denning, etc. (FW-DC-WL-04); guideline (FW-GDL-WL-01), which restricts management activities during spring emergence (4/1-5/1) where predicted denning habitat occurs; and standard (FW-STD-WL-04), which states that no grooming of snowmobile routes in grizzly core habitat would occur in the spring after April 1 of each year. All elements of the Revised Plan would be considered in the development of future winter travel plans.

We acknowledge that some denning habitat in both the SE and CYE on the IPNF occurs in grizzly bear core areas. There is no winter season ending date for motorized use on the IPNF. Therefore, snowmobile use of roads, trails, and open areas is allowed as long as the snow persists. Snow conditions within the action area are often suitable for snowmobiling to continue

⁶ Over-the-snow motorized use occurs on approximately nine percent of the entire Cabinet-Yaak recovery zone (USFS 2013a, p.76).

beyond April 1, the beginning of the grizzly bear non-denning period. Therefore, some level of motorized use (snowmobile only) will likely occur within core habitat and on restricted roads during the non-denning period, compromising the effectiveness of core areas and OMRD for a short period of time.

Effects on Denning Habitat. The potential for disturbance to denning grizzly bears on the IPNF does exist but is probably low due to the low probability of a direct encounter of a snowmobile to a den and even in that unlikely case, the excellent insulative properties of snow to mitigate noise. As stated previously, off-route snowmobile use occurs on 19 percent (14,250 acres) of denning habitat in the IPNF portion of the CYE and 6 percent (7,440 acres) in the SE. Currently, there are 14 miles of groomed routes and 11 miles of ungroomed routes in modeled grizzly bear denning⁷ habitat within the SE and 26 miles of groomed trails and 26 miles of ungroomed routes in six CYE BMUs within the Action Area. As such, typical high-use snowmobile areas and potential den sites have a limited likelihood of overlap. This is because grizzly bears generally den in either timbered habitat or very steep slopes, including the slopes of open basins (USFWS 2010, p. 26). Most of the heavy snowmobile use occurs on trails, roads, or open basins, and meadows – although some snowmobile riders use steep open basins for “high marking”, in which case there is potential for direct overlap between denning habitat and steep open slopes favored for “high marking” by snowmobiles (ibid). However, most denning habitat - except for “high-marking” areas - is less favorable for snowmobile use and as such there is a reduced chance of adverse overlap between grizzly bear den sites and snowmobile traffic (ibid).

Therefore, there is a low likelihood that some grizzly bears in the CYE and SE may be affected during the denning season, but the Service believes that the magnitude of impacts during this time in both the recovery zone and BORZ would be insignificant and unlikely to adversely affect grizzly bears.

Effects on Emerging Females with Cubs of the Year. Disturbance from snowmobiles may adversely affect grizzly bears shortly before or after den emergence of a female with cubs. Females and their cubs remain in the den site area for several weeks after emergence from dens (Mace and Waller 1997, p. 37). Females with cubs have high energetic needs, and cubs have limited mobility for several weeks after leaving the den. Disturbance levels that cause a female to prematurely leave the den in spring or move from the den area could impair the fitness of the female and safety of the cubs. If cubs attempt to follow their mother, they will likely experience decreased fitness and the family group may be pushed to less suitable habitat. To date, litter abandonment by grizzlies due to snowmobiling activity has not been documented in the lower 48 States (Hegg 2010, p. 26-27; C. Servheen 2010 pers. comm. as cited *In* USFWS 2011b) nor has other measurable or detectable adverse effects on grizzly bears from snowmobile use been substantiated (Mace and Waller 1997, p. 41; USFS 2006, pp.3-263 3-373). Based on a sample size of 10 bears, radio-collared female bears with cubs in the CYE emerged between the third

⁷ Grizzly bear denning habitat was modeled separately for the two ecosystems using local data (USDA Forest Service 2011 project file data).

week of April and third week of May (W. Kasworm 02/21/2013 pers. comm.). In the SE, den emergence dates have not been identified (W. Wakkinen 07/01/2013 pers. comm.), but are likely similar to those in the CYE given the similarity in weather patterns between the two recovery zones (Wakkinen and Kaworm 2004, p. 61). The active bear year in the SE is described as beginning on April 1. The IPNF states that snowmobile use after April 1 is greatly reduced due to a combination of limited public participation at that time of year and deteriorating snow conditions.

Under the Revised Plan, less temporal and spatial overlap of grizzly bears and snowmobiles would occur on the IPNF due to the decrease in acres where over-snow motorized use is allowed (Table II-12). These changes would not be realized until winter travel plans are completed. Until such time, several mitigating factors are in place: 1) a winter closure remains in effect in the SE; 2) restrictions on grooming of snowmobile routes after April 1 (which is expected to deter most access and use by all but the most hard-core snowmobilers); 3) guideline (FW- GDL-WL-01) which restricts management activities in predicted denning habitat between April 1 and May 1 which includes any activity that is carried out or authorized by the Forest that would result in impacts on natural resources or change human use of the Forest; and 4) standard (FW-STD-WL-04) which states that no grooming of snowmobile routes in grizzly core habitat will occur in the spring after April 1 of each year. These mitigating factors would reduce the likelihood of overlap of snowmobilers and females with cubs during den emergence (thereby improving the baseline condition).

Nevertheless, winter motorized use could occur in a small proportion of denning habitat during the den emergence period under the Revised Plan, resulting in disturbance of females with cubs that could impair the fitness and safety of the female and cubs. The Service believes that the likelihood of impact from snowmobiles on emerging females with cubs is low. This is because:

- There is a low estimated number of grizzly bears in the U.S. portion of the CYE (42) and SE (25 to 30);
- the low proportion of female grizzly bears with cubs of the year (averaging 2.5 unduplicated observations from 2006 to 2011 in the CYE [Kasworm et al. 2012, p. 14]) (averaging 0.5 females with cubs in the SE [USFWS 2011a, p. A-15]);
- the overlap of just 19 percent of modeled denning habitat in the CYE (9 percent for the entire CYE including both IPNF and KNF) and 6 percent for the SE where snowmobile use currently occurs
- the seasonally-declining numbers of snowmobilers by April of each year (USFS 2013a, p. 84; USFWS 2011a, p.A-44);
- restrictions on grooming snowmobile routes after April 1 (which may affect the ability of off-route users to access areas at higher elevations) (FW-STD-WL-04).
- the limited ability to access higher elevations with snowmobiles since road closures are in effect after April 1; snowpack is breaking up at lower elevations; and trails are no longer groomed.

- the late den exit dates for females with cubs in the CYE (beginning the third week of April [W. Kasworm 02/21/2013 pers. comm.] at which time snowmobiles are less likely to be able to access the area due to poor snow conditions at lower elevations)

Additionally, GA-DC-WL-LK-03, GA-DC-WL-PO-02 GA-DC-WL-PR-02 in the Lower Kootenai, Pend Oreille, and Priest geographic areas will reduce the probability that disturbance could occur during spring emergence due to snowmobile use. These elements specifically identify areas where the desired condition is for low levels of human disturbance during grizzly bear spring emergence (April 1 – May 1) and would be considered in the development of site-specific winter travel plans.

However, we cannot entirely dismiss that a disturbance would occur or that it would not result in adverse effects on a female with cubs. However, we believe an individual female would not likely be affected for more than one denning season. Grizzly bears typically do not reuse den sites. Thus, if a female grizzly bear suffers significant disturbance at or near her den site, it is probable that she would locate a new site to den in the future and would have options for denning elsewhere.

A component of the recovery of the CYE and SE may in the future include occupation of BORZ, including denning. To date, there are no records of female bears denning in BORZ. We also expect that this realization will take time to occur (see Section A.5). Therefore, we do not anticipate adverse effects on females with cubs in BORZ under the Revised Plan.

Effects on Spring Habitat. After den emergence in spring, grizzly bears seek sites that melt snow early and produce green vegetation (Kasworm et al. 2010, p. 65). These sites can often overlap with ungulate winter range and provide winterkill carrion. Spring habitat use in the CYE (April and May) indicated use of low elevation sites (ibid). The portion of the population using these habitats in early spring is most likely to be males and lone females (W. Kasworm 01/28/2013 pers. comm.). These bears are mobile and can move from disturbance (ibid). Females with cubs are more vulnerable, but are likely to remain at the higher elevation denning habitat in the early spring (effects described above). The potential for disturbance or displacement of grizzly bears from spring feeding habitat in the action area (CYE and SE) is influenced by the variability in snowpack and the rate of spring melt. It is likely that some level of motorized (snowmobile only) use occurs during the spring period within core habitat and on restricted roads during the non-denning period, which will likely compromise security of core habitat and OMRD for a short period of time. However, these areas remain designated as core habitat and continue to provide secure core habitat during the remainder of the non-denning period. The risk of such a compromise within spring habitat is likely lessened due to the fact that if the area is accessible to snowmobiles then it is not likely providing spring habitat for grizzly bears at the same time (as described above).

The Revised Plan will reduce the total acres available to over-snow motorized use, and prohibit grooming of snowmobile trails after April 1. For these reasons and based on the discussion above, the Service expects impacts to spring habitat and foraging grizzly bears is low in both the recovery zone and BORZ and the magnitude of impacts during this time would be insignificant and unlikely to result in adverse effects.

Effects of Habitat Management on Grizzly Bears Under the Revised Plan

This section describes the general effects and effects specific to the action area on grizzly bears from vegetation management, fire management, and linkage.

General Effects of Vegetation Management on Grizzly Bears

Vegetation management activities include timber harvest, salvage, planting, thinning, prescribed burns, and mechanical fuel treatment. Vegetation management may impact grizzly bears by affecting food resource availability, proximity to escape cover, human access and conflicts, or temporarily shifting grizzly bears into less secure areas.

A study by Zager (1980, p. 35) in the Flathead National Forest in northwestern Montana found 81.8 percent of collared grizzly bears used harvested stands in proportion to their availability in the home range. The use of harvested stands increased in the summer, when huckleberry productivity was high and decreased in the fall, as bears moved to higher elevations or unharvested areas, likely related to the opening of hunting season (ibid, p. 36). Harvested stands produced the most food resources for grizzly bears approximately 8-15 years after harvest (Zager 1980, Martin 1983). Similarly, Lindzey and Meslow (1977) documented abundant food resources for black bears in harvest units 15 years after harvest.

Another factor to consider with regards to vegetation management is the availability and proximity of escape cover (Zager and Jonkel 1983, p. 131). A decrease in the amount of escape cover may result in different effects on grizzly bears and their habitat. If cover is limiting in the project area, either by the amount or distribution, timber harvest would likely result in negative impacts (Zager 1980, pp.75-76). However, if cover is not limiting in a project area, timber harvest may have either no effect or a positive effect in those situations where food abundance or distribution is improved. By removing or reducing overstory vegetation through harvesting, slashing and/or burning, grizzly bear food production may be increased during summer (Mace and Waller 1997, p. 120; Waller 1992, p. 36). This includes food resources such as berries and succulent forbs.

Harvest unit size and shape may have an indirect effect on grizzly bear use in that they determine the proximity of escape cover (Zager et al. 1983, p.131). Zager, in northwestern Montana, found that nearly half of the harvest units used by grizzly bears were less than 40 hectares; however grizzly bear sign was also documented in units larger than 160 hectares (ibid, p. 131). In Yellowstone, Mealey et al. (1977) documented spring grizzly bear use in harvested stands less than 20 hectares that included leave trees and did not document use in larger units without leave trees, presumably due to the lack of cover.

If food production or distribution is improved with timber harvest but human activity is not controlled after the completion of harvest activities, negative impacts on grizzly bears may occur due to an increase in the potential for conflicts between humans and grizzly bears. Adequate motorized access management can support the exploitation of rejuvenated food resources in older harvested units by grizzly bears. Reduced cover may increase the visibility of grizzly bears, which could increase their vulnerability to illegal human-caused mortality. Harvested stands that are easy to access may receive an influx of berry pickers during the berry season

which may limit grizzly bear use or increase human-caused mortality (Zager 1980). Waller (1992, p. 37) found that of the harvested stands that he studied in the Swan Mountains of Northwestern Montana, those with the highest grizzly bear use had limited access due to closed gates and/or over-grown roads. Grizzly bears within his study area that used harvested stands were found at higher elevations and spent little time in lower elevation harvested stands where harvest was most common (ibid, p. 37). Waller attributed this to human use of those lower, more accessible harvested stands. Waller also found that grizzly bears avoided stands where the vegetation had not recovered enough to provide security cover and preferred to use stands that were 30 to 40 years post-harvest (ibid, p. 39).

Most timber harvest activities that will occur during the grizzly bear denning season are not likely to impact grizzly bears. Snow is an excellent sound barrier and impacts to denning bears will likely be less in deep snow situations than in shallow snow conditions. However, the type, depth, and moisture content of the snow can determine how sound is transmitted through snow (Blix and Lentfer 1992, p. 22). It is likely that hibernating bears exposed to meaningless noise, with no negative consequences to the bear, habituate to this type of disturbance (Knight and Gutzweiler 1995, p. 133).

Fuels reduction is not expected to adversely affect grizzly bears. These projects remove cover for the purpose of fire prevention near residential development. These stands may be treated again to retain them as fuel breaks, and not allowed to regenerate. Given the proximity to residential developments, many fuel reduction projects occur in or very near areas where management should discourage use by grizzly bears and focus on preventing conflicts between people and grizzly bears (e.g. MS-3 habitat).

Often, temporary roads are constructed in order to access harvest units. Temporary roads built for timber harvest may remain on the landscape for several years and receive a substantive amount of use. Such roads may also cause adverse effects to grizzly bears, such as displacement from key habitats. The impacts of temporary roads were considered in our analysis of effects related to the Access Amendment.

Helicopters may also be used in vegetation management projects. Helicopter use has advantages for grizzly bears in that it can often reduce the need for road use and road construction. Thus there are no lingering effects of roads on the landscape. Helicopter use in occupied grizzly bear habitat may elicit a response in grizzly bears, but the response is variable depending on several variables. Effects may range from a simple awareness of the helicopter, short-term disturbance or flight response or displacement from an area. In timbered habitats, McLellan and Shackleton (1989, p. 378) found that an overt avoidance or displacement response required high intensity helicopter activity, such as carrying equipment within 200 meters of a grizzly bear. If helicopter use is short in duration and low in frequency, it is not likely to result in significant impacts on grizzly bears (USFWS and USFS 2009, p. 4). Extended use with multiple passes could interfere with the normal behavior patterns of grizzly bears. The effects to grizzly bears of repeated, low altitude flight paths that follow open roads may partially offset the existing under-use of habitat in the immediate vicinity of the roads due to the “avoidance” by the grizzly bears of habitat in close proximity to open roads. In many cases, the effects of helicopter logging that occurs in

roaded habitat will have insignificant effects to grizzly bears as long as all roaded areas and roadless habitat provide adequate secure habitat for grizzly bears. However, helicopter logging in areas that are not highly roaded could result in adverse effects similar to adverse effects caused by roads.

Effects of Vegetation Management in the Action Area

Timber Harvest – [Table II-13](#) illustrates the degree of allowable use activities under current management direction versus the Proposed Action. The Revised Forest Plan will decrease the acres identified as suitable for timber production (timber stands with planned, scheduled entries for the purpose of generating commercial timber products) in the recovery zones from 232,261 acres to 0 acres in the SE and 142,349 acres to 0 acres in the CYE. Timber harvest (timber cutting for wood fiber utilization and other multiple-use purposes, including resource benefits and fuels management) in the recovery zones will also decrease under the Revised Plan. The Proposed Action reduces the area where timber harvest activities may occur within the SE by 5,900 acres and in the CYE by 2,394 acres (Table II-14).

As described above, timber harvest has varying effects on foraging opportunities for grizzly bears. The primary effect of timber harvest on grizzly bears is the disturbance resulting from people and equipment operating in grizzly bear habitat as well as the effects of roads used to access the timber stand. The effects of roads are addressed above. Timber harvest may result in temporary disturbance of bears during the time period the harvest takes place. During this time period bears would move away from the disturbance to access necessary resources. Since some commercial harvest occurs in winter, some effects on grizzly bears from displacement would be reduced in those cases. Additionally, the Access Amendment also indirectly limits the amount of grizzly bear habitat in BMUs (and subunits) affected by vegetation management activities during the active bear year that generate noise and other disturbance (e.g. timber harvest and recreation) by limiting the road access needed for these activities. Given the healthy condition of core areas and adequate open and total route density management under the Revised Plan, we do not anticipate that this disturbance would result in adverse effects on grizzly bears that cause impairment of the ability to feed, breed, or shelter. Presently, approximately 56 to 57 percent of the CYE recovery zone serves as core areas and this would increase to approximately 59 percent under the Access Amendment (USFWS 2011a, p. A-39, A-60). Approximately 60.6 of the IPNF portion of the SE recovery zone serves as core area and this would increase to approximately 61.4 percent under the Access Amendment (USFWS 2011a, p. A-61)

Based on our history of consultation on vegetation management projects, information in our files, and the exclusion of core areas from timber production (i.e., commercial timber harvest with planned regular entries) we do not anticipate that vegetation management activities (not including associated roads) by themselves would result in effects to grizzly bears that would significantly impair breeding, feeding, or sheltering. Large core areas in each BMU and other land allocations (MA1-wilderness- no timber harvest and MA5-backcountry-limited timber harvest) with limited human disturbance would still be available for grizzly bears to meet their resource needs. Similarly, due to the availability of wilderness and core areas, nor do we anticipate significant impairment of grizzly bears' ability to feed, breed, or shelter as a result of

incidental harvest outside the suitable timber base for other resource objectives such as fuels management or habitat restoration (allowed in MA2 (except wild river segments), MA3, MA5, MA6, and MA7).

In BORZ, grizzly bears would have fewer options providing undisturbed areas to select from if disturbed by timber harvest. However, we do not anticipate significant impairment of grizzly bears' ability to feed, breed, or shelter as a result of timber production or timber harvest for resource benefit. This is attributed to the occupation of these areas by grizzly bears despite the sub-optimal conditions (including existing, ongoing levels of timber harvest), the elements of the Access Amendment that limit open, total, and temporary roads, and the Access Amendment requirement in BORZ to schedule timber harvest activities that will occur within multiple watersheds in a manner to minimize disturbance of grizzly bears resulting from road use during project level consultation.

Fuels management projects in the WUI that remove vegetative layers in order to reduce fire risk may or may not affect bears. Grizzly bears may forage in the WUI where there is sufficient cover and security or distance from human developments. Projects in the WUI that remove various forest canopy layers may reduce or increase foraging opportunities for bears depending on site-specific conditions. However, because the WUI occurs in proximity to communities and other human developments, we are less concerned about providing habitat for grizzly bears in these areas. Reduced foraging opportunities and hiding cover for grizzly bears in the WUI may help reduce the risk of grizzly bears becoming attracted to anthropogenic food sources on adjacent private lands and/or reduce the risk of grizzly bears encountering people, leading to grizzly bear mortality.

Opening Size / Proximity of Cover – This section addresses the effects of the desired vegetative conditions on the IPNF as it relates to opening size. The Revised Plan desired condition is for a greater range in patch sizes (openings). Of concern to the Service is that opening sizes on the IPNF under the Revised Plan could be increased (Table 1, Appendix A USFS 2013a) from those typically occurring as a result of vegetation management (including prescribed fires) under the Existing Plan. Larger opening size would potentially create more grizzly bear foraging habitat but at the same time these larger openings may be underused by grizzly bears due to lack of cover. Larger opening sizes may also increase the visibility of grizzly bears, which may potentially increase their vulnerability to human-caused mortality and/or contribute to displacement from preferred habitats. Lastly, larger openings may contribute to an overall reduction in cover within grizzly bear habitat on the Forest.

The IPNF states that desired conditions for larger openings are based on natural disturbance processes, which are the conditions grizzly bears evolved with in this area, and that security for grizzly bears is maintained or improved by implementing the Access Amendment (FW-STD-WL-02) and through public information and education programs that reduce the risk of human/bear conflicts. The KIPZ Planning Team also states that often in a timber harvest design leave patches, thickets, riparian corridors, and/or other areas of unique habitat features are retained in the harvest unit, dependent upon site conditions and that these features may interrupt line of sight; reduce visibility; and provide cover for bears (J. Anderson 03/12/2012 pers.

comm.). Cover is abundant in grizzly bear habitat in the KIPZ planning area (J. Anderson 07/15/2013 pers. comm.). For example, where LAUs overlap the grizzly bear recovery zones there would be an influence from the NRLMD on “cover” for grizzly bears due to the limits on treatments in multi-story foraging and stand initiation stage snowshoe hare habitat. Generally, if a stand has a high stem density and horizontal cover to provide snowshoe hare habitat, it likely is capable of providing cover for grizzly bears. Further, timber harvest activities are expected to be small when measured against the total size of the Forest; acres of regeneration harvest are anticipated to total approximately 16,830 acres over the first decade on the IPNF (this amounts to 0.6 percent of the entire IPNF). Including the acres of intermediate harvest (27,850 acres total in the first decade on the IPNF) increases the total timber harvest to 44,680 acres on the IPNF, which is 1.8 percent of the entire IPNF. Also grizzly bear core areas are not included in the suitable timber base and are not part of the 1.8 percent that is anticipated to have regeneration or intermediate harvest over the first decade. Hence, opening sizes from timber harvest are not expected to contribute to measureable reductions in cover under the Revised Plan.

Of primary concern to the Service is effect of large openings adjacent to open roads or seasonally-managed roads allowing public access into recently harvested areas. In these situations, foraging opportunities may be avoided or under-used due to the presence of human use (Waller 1992, p.37). This condition may persist for some period of time post-harvest (Waller 1992, p.39) based on site conditions and stand cover types. Additionally, grizzly bears that select these areas may be at higher risk of human detection, conflict, and resulting grizzly bear mortality. These types of effects would be site-specific depending on site conditions. The Forest states that larger openings are more likely to result from natural disturbances than from planned vegetation management activities. Additionally, the effects from larger openings may be reduced, depending on site conditions, by measures included during site-specific project development such as:

- Retention of riparian corridors (FW-DC-RIP-04; FW-STD-RIP-04).
- Retention of untreated patches that provide for structural diversity and these may provide vegetative screening or cover in openings
- Closure of roads for public use during and immediately after vegetation management activities.
- Ensuring adequate closure devices (i.e., gates, barriers, full or partial recontouring/ripping of road) are in place and functioning properly.

The IPNF states that large openings are more likely to result from natural disturbances rather than project activities. Still, vegetation management projects proposing large opening sizes that would have adverse effects on bears may be proposed under the Revised Plan. Security for bears in these situations may be included in the site-specific project design and would be provided by the Access Amendment (FW-STD-WL-02) and through public information and education programs that reduce the risk of human/bear conflicts. Therefore, adverse effects resulting in impairment of breeding, feeding, and sheltering would be infrequent and we do not expect substantial negative effects on the population. Any such proposals would be subject to project-specific consultation regarding effects to grizzly bears so long as the grizzly bear remain listed.

In BORZ, there are fewer limitations on timber harvest and more human presence. Also, MS1 designation does not apply. However, there are also fewer bears in BORZ, and security for bears in these situations would be provided by the Access Amendment (FW-STD-WL-02) and through public information and education programs that reduce the risk of human/bear conflicts. Therefore, adverse effects resulting in impairment of breeding, feeding, and sheltering would be infrequent and we do not expect substantial negative effects on the population. Future site-specific consultations may also apply.

Helicopter Harvest - The Revised Plan allows the use of helicopters for vegetation management projects. All helicopter operations on the IPNF are designed using the *Guide to Effects Analysis of Helicopter Use in Grizzly Bear Habitat* developed by the Montana/Northern Idaho Level 1 Terrestrial Biologists Team (USFWS and USFS 2009) in order to avoid, limit, or minimize the potential for adverse effects (S. Dekome 08/13/2013 pers. comm.). The effects of helicopter use on grizzly bears are highly site-specific and variable. Nevertheless, projects using helicopter harvest with adverse effects on bears may be proposed under the Revised Plan. Based on our history of consultation on vegetation management projects with the IPNF, helicopter harvest is infrequent. In general, helicopter harvest accounts for less than 10 percent of timber harvest on the IPNF (S. Dekome 08/13/2013 pers. comm.). Additionally, the Revised Plan implements the IGBC guidelines for MS 1 (see Section A.2), which encompasses the entire CYE and SE recovery zones. Under MS1 designation the needs of grizzly bears are favored when grizzly habitat and other land use values compete. Revised Plan desired conditions would also moderate effects of helicopter harvest in grizzly bear habitat (FW-DC-WL-01, 03, 04); and effects of helicopter harvest are mostly temporary - ending after the harvest is complete (versus using permanent roads which remain on the landscape). Therefore, adverse effects resulting in impairment of breeding, feeding, and sheltering would be infrequent and we do not expect substantial negative effects on the population. Project-specific consultation will apply in the future, when appropriate.

Prescribed Fire – The effects of prescribed fire on bears would be similar to that of timber harvest. Prescribed fires may result in disturbance and displacement impacts to grizzly bears through presence of humans, temporary camps, and use of motorized equipment for fire containment. During this time period bears would move away from the disturbance to access necessary resources. Given the healthy condition of core areas and adequate open and total route density management under the Revised Plan, we do not anticipate that this disturbance would result in adverse effects on grizzly bears that cause impairment of the ability to feed, breed, or shelter. Presence of humans implementing prescribed fires are not expected to contribute to conflicts given the likelihood that bears would be displaced from the area; a food storage order is in place on all IPNF lands north of the Clark Fork River, Lake Pend Oreille, and Pend Oreille River (encompassing the CYE, SE, and BORZ), and there is no history of conflicts from such activities on the Forest.

Prescribed fires would reinvigorate and increase the amount or quality of grizzly bear forage species such as grasses and berry-producing shrubs. We expect the only potential adverse effect on grizzly bears from prescribed fire would be those creating large opening size. The effects would be the same as those described above. Since 1987, 600 acres in 3 BMUs have been

treated with prescribed fire, mostly associated with post-harvest treatments (USFS 2013a, p.77). This is substantially less than 1 percent of the total acreage available in the BMUs.

The Revised Plan implements the IGBC guidelines for MS 1 (see Section A.2), which encompasses the entire CYE and SE recovery zone. Under MS1 designation the needs of grizzly bears are favored when grizzly habitat and other land use values compete. Security for bears in these situations would be provided by the Access Amendment (FW-STD-WL-02) and through public information and education programs that reduce the risk of human/bear conflicts. Also, a very small proportion of available BMU acres are treated with prescribed fire. Therefore, adverse effects resulting in impairment of breeding, feeding, and sheltering would be infrequent and we do not expect substantial negative effects on the population. Project-specific consultation will apply, when appropriate.

In BORZ, grizzly bears would have fewer options providing undisturbed areas to select from if disturbed by prescribed fire activities. However, we do not anticipate significant impairment of grizzly bears' ability to feed, breed, or shelter. This is attributed to the relatively few acres of BORZ treated with prescribed fire (just 3,573 acres or less than 1 percent of the available acres in the SE and CYE BORZ since 1987), the occupation of these areas by grizzly bears despite the sub-optimal conditions (including existing, ongoing levels of timber harvest), the elements of the Access Amendment that limit open, total, and temporary roads, and the Access Amendment requirement in BORZ to schedule timber harvest activities that will occur within multiple watersheds in a manner to minimize disturbance of grizzly bears resulting from road use during project level consultation (prescribed fire is often implemented as a post-harvest activity [USFS 2013a, p.77]).

Effects of Fire Management on Grizzly Bears Under the Revised Plan

Fire management is the process of deciding which fires to allow to burn and which to suppress along with the physical activities of suppressing wildland fires.

General Effects of Fire Management on Grizzly Bears

Fire maintains the mosaic of openings and varying vegetative successional stages on the landscape that provide the diversity of foods required by bears. Natural fire often stimulates the understory and/or increases the vegetative diversity in high quality grizzly bear habitat, benefitting grizzly bears in the long-term. Fire suppression alters the natural development of forests and species composition and can render forests susceptible to large-scale disturbance due to increased fuels and denser stands. Higher intensity stand-replacing fires may also occur requiring longer to recovery or requiring active management to restore.

Fire management may result in disturbance and displacement impacts to grizzly bears through presence of humans and use of motorized equipment for fire suppression. Generally, grizzly bears would leave an area on their own, in advance of an approaching fire, and therefore, be out of the area associated with fire suppression activities. However, if suppression activities were to take place prior to an approaching fire, a grizzly bear may be affected before leaving the area. There may be some effects from disturbance caused by the overall increase in human activity in

a particular area. These activities may include increased vehicular traffic, aerial support, and fire camps, any of which may cause disturbance or displacement of a grizzly bear prior to or when they are moving from the area. Similarly, there may be a concentration of human activities associated with fire suppression or fire clean-up, assessment, and restoration activities that result in disturbance and open roads that displace bears, or increase the risk of human food and attractants luring grizzly bears into the area.

Indirect, long-term effects from fire suppression activities may result from opening previously closed roads, constructing new roads or temporary roads, constructing firebreaks or constructing machine lines. These actions may contribute to the open and total road densities which are limited in certain areas to protect grizzly bears or result in effects to grizzly bears similar to effect of roads on grizzly bears. The adverse impacts of roads on grizzly bears are described above (see *Effects of Roads* section above).

Wildland fires for resource benefit are typically allowed to burn with some degree of certainty that the fire would go out naturally or could be contained within predefined lines. Wildfires, when allowed to burn, can result in short-term negative effects and/or long-term beneficial effects depending on the vegetation species and fire severity. Some foraging habitat and/or cover may be lost in the short-term. However, natural fire often stimulates the understory and/or increases the vegetative diversity in high quality grizzly bear habitat, benefitting grizzly bears in the long-term as long as these areas are not also subject to human access or pressure from collection forest products (huckleberries and mushrooms).

Effects of Fire Management on Grizzly Bears in the Action Area

To reiterate, the effects of wildland fire on bears include short-term displacement, loss of forage, and alteration of habitat use patterns. In the long-term, bears are expected to benefit from fires from stimulated understory growth and increased vegetative diversity. The Revised Plan includes an emphasis on the use of fire to trend vegetation towards the desired condition (FW-DC-FIRE-03; MA1abc-DC-VEG-01, MA1abc-DC-FIRE-01, MA1abc-GDL-FIRE-01, MA2-DC-FIRE-01, MA5-DC-VEG-01, MA5-DC-FIRE-01, and MA5-GDL-FIRE-01). The IPNF states that the use of fire to trend towards the desired conditions for vegetation and restoring habitats would provide the approximate types and amounts of habitats that grizzly bears would have evolved with on the IPNF (USFS 2013a, p.106). Early successional grasses and forbs would provide forage for grizzly bears, and the following successional stages in habitat types preferred by bears would also provide food and cover. Thus, the effects on grizzly bears of allowing unplanned ignitions to burn may result in temporary displacement of grizzly bears, a temporary reduction in foods and cover within the burned perimeter. Grizzly bears evolved with wildfire and so while the displacement effects may be adverse to individuals in specific instances, these negative effects would be offset beginning soon after the burn in many locations as regrowth of vegetation begins.

Under the Revised Plan, undesirable wildfires will continue to be suppressed where necessary to protect life, property, and key resources (FW-DC-FIRE-03). Fire suppression activities introduce a concentration of human activity into the affected area. Even when a decision is made to allow a fire to burn, it is typically controlled within a predetermined boundary. The effects of fires

suppression and fire containment activities on grizzly bears include increased vehicular traffic, aerial support, and fire camps, any of which may cause disturbance or displacement of a grizzly bear prior. However, we do not anticipate adverse displacement effects on bears from these types of fire suppression activities. This is because bears would leave an area on their own, in advance of an approaching fire, and therefore be out of the area associated with fire suppression activities. There may also be human activities associated with fire clean-up, assessment, and restoration activities that result in open roads that displace bears or increase the risk of human food and attractants luring grizzly bears into the area. All fire suppression activities would comply with the Food Storage and Sanitation Special Order. Still other activities associated with wildfire suppression (such as fire breaks, temporary roads, changes in open or total road densities) are variable and may result in adverse effects on grizzly bears. These types of actions are planned and conducted under emergency situations and so the effects to grizzly bears would be analyzed in emergency consultation during and after the activities are complete (50 CFR 402.05).

Effects of Habitat Management on Linkage for Grizzly Bear Under the Revised Plan

The following description of habitat linkage is largely excerpted from Servheen et al. (2003).

General Effects of Habitat Management on Linkage for Grizzly Bears

Linkage zones are areas of habitat connectivity within or between populations of animals that foster the genetic and demographic health of the species. Often, these are specific locations on the landscape where conditions foster movement. Connectivity refers to the arrangement of habitat that allows animals to move across the landscape; patches of similar habitats are either close together or linked by corridors of vegetation. Linkage zones may be connected on the greater landscape only to be fragmented by major highways, railroads, high road densities, and human developments (i.e., fracture zones).

Habitat linkage and connectivity are important components of grizzly bear habitat (Servheen et al. 2001, 2003; USFWS 1993). The main factors generally considered to affect the quality of linkage zones are major highways, railroads, road density, human site development, availability of hiding cover, and the presence of riparian areas (USFS 2005). Factors affecting connectivity of habitat include vegetative cover, adjacency of habitat, and habitat security. Actions that fragment habitat, either temporarily (timber harvest) or permanently (developments), or alter species composition or stand characteristics, or decrease habitat security (access) also compromise habitat connectivity and linkage zones.

For the discussion of linkage zones, we note that these areas must be maintained through consideration of three areas: 1) the highways, railroads, and developments that create the fracture zones; 2) the private lands in the valley bottoms; and 3) the public lands that serve as approach areas on the side-slopes of the valleys (Servheen et al. 2003).

Linkage areas for grizzly bears between recovery zones and Canada are critical to the long-term survival and recovery of bears, particularly in the CYE and SE since it influences population size and genetic health of populations in the U.S. portion of the recovery zones (Servheen 2006, Proctor et al. 2004). According to Proctor et al. (2012) north-south movements within mountain

ranges are more common than east-west movements across mountain valleys. Our knowledge of grizzly bear movements between the recovery areas and Canada is detailed in Section B. 7.

Effects of Habitat Management on Linkage for Grizzly Bears in the Action Area

The main areas of concern associated with the CYE and SE for establishing long-term linkage for movement of bears between Canada and U.S. recovery zones as identified in Servheen et al. (2003) are as follows: 1) CYE 1) CYE – SR-2 and SR-56 and the railway lines that parallel SR-2; 2) SRE – B.C. Highway 3 (in Canada); 3) Between the SRE and CYE – SR-95 and the parallel railway; 4) Between the CYE and the Bitterroot Mountains – SR-200 and the parallel railway; and 5) Between the CYE and the NCDE – SR-2 and SR-93. Of these, SR-95 and portions of SR-2 are located within the action area of the Proposed Action.

Servheen et al. 2003, (p. 13) identified SR 95 and Highway 1 as completely separating the two recovery zones. Also, significant amounts of public and private development have occurred in the Purcell Trench and the communities of Sandpoint and Bonners Ferry, Idaho. Additional fragmentation is occurring in the area surrounding Priest Lake, Idaho (Servheen et al. 2003, p. 26). At some future date, connecting these two bear populations across highways through the use of wildlife crossing structures (above or below ground culverts or passages where animals can cross high volume roads without risk of being struck by a vehicle) may become necessary to maintain linkage for this wide-ranging species. Wildlife crossing structures may also be considered in other fracture zones in the future.

If warranted in the future, the development of crossing structures for linkage is dependent on future interagency coordination and collaboration with the public, primarily because the highways and railroads that may be barriers for wildlife are not under the jurisdiction of the IPNF. However, the IPNF may manage lands near future crossing structures (i.e., approach areas) and have thus identified the need to manage lands near those features to maintain the effectiveness of those features. Because of the importance of linkage for grizzly bears, it is likely that they would be one of the species considered in the design of future crossing structures or maintenance or enhancement of lands near crossing areas to link blocks of habitat important to grizzly bears.

The Forest does have the capacity to ensure habitat conditions in the approach areas to linkage zones support continued use of existing areas of linkage and at future crossing structures. The IPNF also manages lands on either sides of highways and can enhance the potential for bears to cross by maintaining high quality habitat, including cover, for grizzly bears. The Revised Plan includes direction for linkage on the Forest through FW-DC-WL-18, which states that Forest management contributes to wildlife movement within and between national forest parcels; movement between parcels separated by other ownerships is facilitated by management of the NFS portions of linkage areas identified through interagency coordination; and Federal ownership is consolidated at approach areas to highway and road crossings to facilitate wildlife movement. This condition would be achieved through implementation of guidelines FW-GDL-WL-15 through 17. Specifically, FW-GDL-WL-15 through 17 require that IPNF coordinate with others on the development of crossing structures when major highways are reconstructed, and

that they manage lands near future structures to maintain the effectiveness of the structure and maintain Federal ownership in identified linkage areas.

To support and maintain connectivity across the Forest, the desired conditions for wildlife for MA1-wilderness and MA5-backcountry (MA1a,b,c,e-DC-WL-01 and MA5-DC-WL-01) state that these areas serve as large, remote areas with little human disturbance and habitat conditions that contribute to wildlife movement. Lastly, the GA direction and MA3-DC-WL-01 (in Special Areas) aids in maintaining grizzly habitat and connectivity across the Forest in those areas where it would have been found under natural disturbance processes (historical conditions) (USFS 2013a, p. 102). Specifically, the desired conditions in GAs that will facilitate grizzly bear linkage and habitat connectivity include:

GA-DC-WL-PR-01. NFS lands provide habitat conditions for wildlife movement, especially woodland caribou, throughout the Selkirk recovery zone.

GA-DC-WL-PR-03. Habitat conditions for wildlife movement on the divide between Idaho and Washington, from the Canadian border south are retained.

GA-DC-WL-LK-01. National Forest System lands contribute habitat conditions for wildlife movement between the Yaak and the Selkirk Mountain range and between the Cabinet and the Selkirk mountain ranges.

GA-DC-WL-LK-02. Use of the area along the divide between Idaho and Montana from Northwest Peaks south to the Kootenai River is retained.

GA-DC-WL-PO-01. Habitat conditions are retained for wildlife movement along the divide between Idaho and Montana from the Kootenai River south to Scotchman Peaks and across the Clark Fork River and for wildlife movement between the Cabinet-Yaak ecosystem and the Selkirk Ecosystem.

GA-DC-WL-SJ-02. Use of the area for wildlife movement along the Idaho/Montana divide between the Salmon and Selway/Bitterroot Wilderness Areas is retained.

Existing levels of fragmentation attributed to roads in BMUs would continue under the Revised Plan, and some proposed projects may cause localized adverse effects on connectivity for individual bears. However, we do not anticipate substantial negative effects on the population. This is attributed to the Access Amendment, which reduces or maintains moderate densities of open and total roads and provides large blocks of secure habitat where motorized use of roads and trails is prohibited. Notably, the IPNF took into consideration connectivity issues when setting the individual BMU access management parameters (USFS 2010a, p.50; Kaiser 2003 *In* USFWS 2011a, p. A-76). Additionally, the Revised Plan includes numerous provisions for linkage areas on the IPNF, including MA and GA direction for wildlife movement; and the Food Storage Order would reduce risk of human-bear conflicts in lower elevations with higher concentrations of human development. Therefore, we conclude that Forest Plan elements would support linkage conditions on NFS lands that are likely to foster movement of subadult and male

grizzly bears which are required for genetic recovery, (see *Status of the Species* section) and in time will also likely support linkage for females with cubs needed for demographic recovery.

More recently, the importance of BORZ in linking the recovery zones has been highlighted for the CYE and NCDE on the adjacent KNF. Females with cubs are regularly using the habitat and moving between NCDE and CYE (Kasworm et al. 2010, p.47; 2012, p. 16).

Because there are more allowable uses and higher road densities in BORZ, there are more existing effects on the baseline condition of linkages and connectivity. Under the Revised Plan, we expect that these areas will support grizzly bear movement and linkage on the whole, while causing some adverse effects on individual bears from site-specific projects. However, we do not anticipate substantial negative effects on the population. This is because the allowable uses under the Revised Plan are already occurring in the BORZ and yet bears are meeting resources needs, albeit at lower densities than in the recovery zones. Additionally, the Revised Plan implements the Access Amendment in BORZ which limits open and total road miles to no more than the existing baseline conditions, which supports some use by grizzly bears, including females with cubs. Notably, the IPNF took into consideration connectivity issues when setting the individual BMU access management parameters (USFS 2010a, p.50; Kaiser 2003 *In* USFWS 2011a, p. A-76) as well as the development of the BORZ polygons (USFS 2010a: Appendix F *In* USFWS 2011a, p. A-76). Lastly, the food storage order in BORZ will further facilitate connectivity between the recovery zones (and Canada) by limiting risk of conflicts between bears and humans.

These provisions to maintain baseline motorized access conditions in the BORZ and implement food storage orders would provide for continued use of these areas by grizzly bears and eventual linkage of the CYE and SE to other recovery zones, albeit at lower densities than areas within the recovery zones.

Effects of Sanitation/Food Storage and Information and Education Programs on Grizzly Bears Under the Revised Plan

Human-caused mortality of grizzly bears in the CYE and SE occurs disproportionately on non-federal lands than on NFS lands. To date, there have been no grizzly bear deaths associated with food attractants on NFS lands in the CYE and SE. There appears to be a strong relationship between poor huckleberry production and total grizzly bear mortality in the CYE and SE (see discussion above under *Status of the Species*).

General Effects of Sanitation/Food Storage and Information and Education Programs on Grizzly Bears

Improperly stored garbage, livestock or pet foods can lure grizzly bears to areas near people and pose a significant risk of habituating bears to human presence and/or conditioning grizzly bears to seek out anthropogenic foods and attractants. Food conditioned grizzly bears enter unsecured garbage receptacles, sheds and other buildings in search of a reward. Accessibility to human related attractants and conditioning to those rewards can lead to management removal of grizzly bears and additionally, mortality of grizzly bears by people defending their life and property. Bears are particularly susceptible to anthropogenic foods and attractants during years of poor

natural food production. The increase in total known mortality beginning in 1999 in the CYE is thought to be linked to poor food production during 1998 to 2004. Huckleberry production during these years was about half the 20-year average (Kasworm et al. 2012, p.33). Similar to the CYE, there appears to be a relationship between poor huckleberry production and total grizzly bear conflicts in the U.S. portion of the SE, but the sample size is limited and the conditions that elicit grizzly bear mortalities can be variable (W. Wakkinen 07/02/2013 pers. comm.).

Information and education programs, and food storage orders are particularly important during years of poor berry production and in seasons of high nutritional and energy needs for bears. On the Montana side of the CYE ecosystem, the MFWP has stated that perhaps the greatest advancement in the management of problem bears has been the development of dedicated bear management specialist positions (MFWP 2001 *In* USFWS 2011a, p. A-75).

To demonstrate the effectiveness, in the CYE, based on anecdotal information, there has been an increase in the number of residents seeking proactive help (e.g. fencing gardens, beehives and other attractants) to prevent conflicts prior to an incident and fewer incidents involving problem bears have occurred during recent years (Annis 2013). This represents notable progress toward reducing the potential for conflicts between people and grizzly bears, and in return reduces grizzly bear mortality. We believe the importance of these types of programs is often underestimated, as the effects of these programs work over time, in some cases many years as the attitudes and behavior of local residents and visiting public change. Through information and education, people can learn to live in a way that is more compatible with the needs and behaviors of grizzly bears. Education programs can reduce grizzly bear mortalities by instructing people to avoid situation where self-defense becomes necessary and prevent habituation of grizzly bears to unnatural foods. While the described program is specific to Montana, its implementation in the CYE portion of the KNF, benefits the CYE population as a whole.

While IDFG does not currently have full-time bear mitigation specialists like MFWP, there is a conservation officer whose duties are similar in many aspects to the bear management specialist positions. This position is funded for 3 months per year and primary duties include bear and caribou law enforcement and education projects (W. Wakkinen 07/02/2013 pers. comm.).

Further, the IPNF and cooperating agencies (Idaho Department of Fish and Game, Idaho Department of Lands) maintain and financially support a regular program of public information and education within the SE and CYE recovery zones.

Effects of Sanitation/Food Storage and Information and Education Programs on Grizzly Bears in the Action Area

The presence of food or other attractants may result in bear/human encounters that often lead to the relocation or the death of the bear. To date, there have been no grizzly bear deaths associated with food attractants on NFS lands in the action area (USFS 2012, p. 71). There has been a concerted effort to improve sanitation on NFS lands throughout the action area as a whole, with many campgrounds now having bear-resistant garbage and/or food storage containers to reduce

such encounters and the potential for subsequent habituation. Currently, all resort and recreation residence special use permits renewals in-or-near the recovery zones boundaries incorporate sanitation guidelines as part of the special use permit. Finally, all four Forests that encompass the CYE and SE recovery zones have implemented mandatory food storage orders that assist in minimizing this impact. The Service affirms these programs as key to avoiding conflicts associated with attractants on the IPNF.

Currently, the IPNF is a member of the Selkirk/Cabinet-Yaak Subcommittee of the Interagency Grizzly Bear Committee. Through this committee, the IPNF has participated in and implemented several information and education programs on the Forest. For example, in 2012 the Selkirk Grizzly Bear Law Enforcement and Education Project emphasized information and education programs by giving 45 grizzly bear presentations throughout northern Idaho and 2 grizzly bear workshops to the U.S. Border Patrol covering bear biology and conflict avoidance strategies. The Project also used an IGBC grant to obtain 3,000 grizzly bear coloring books for future education and outreach (Selkirk LE & Education Accomplishments 2012, accessed June 24, 2013, <http://www.igbconline.org/index.php/selkirk-cabinet-yaak-subcommittee>). The IPNF and cooperating agencies (Idaho Department of Fish and Game, Idaho Department of Lands) maintain and financially support a regular program of public information and education within the SE and CYE. Under the Revised Plan, these programs will continue through guideline FW-GDL-WL-18, which implements the elements of the most recent “Interagency Grizzly Bear Guidelines.”

We expect that implementation of the Food Storage and Sanitation Special Order coupled with IPNF’s other efforts to inform and educate the public as well as elements of the Revised Plan (FW-STD-WL-03 and FW-GDL-WL-18) would ensure that the risk of conflicts on the Forest remains low. We do not expect adverse effects to grizzly bears on the IPNF as a result of inadequate food and attractant storage.

Under the Revised Plan, Forest-wide desired conditions for recreation state that food and garbage storage do not contribute to recreation user/wildlife conflicts (FW-DC-AR-01; standard FW-STD-WL-03 requires permits and operating plans (e.g., special use, grazing, mining) to specify sanitation measures to reduce human/wildlife conflicts and mortality by making wildlife attractants (ex: garbage, food, livestock carcasses) inaccessible through proper storage or disposal. Additionally, the Revised Plan implements guideline FW-GDL-WL-18, which implements the elements of the most recent “Interagency Grizzly Bear Guidelines” that address attractants and other sources of sanitation issues on the forest (i.e., recreation and grazing).

We expect that implementation of the Food Storage and Sanitation Order coupled with IPNF’s other efforts to inform and educate the public as well as elements of the Revised Plan (FW-STD-WL-03 and FW-GDL-WL-18) will ensure that the risk of conflicts on the Forest remains low. We do not expect adverse effects to grizzly bears on the IPNF as a result of inadequate food and attractant storage.

Effects of Grazing on Grizzly Bears Under the Revised Plan

General Effects of Livestock Grazing on Grizzly Bears

Grizzly bears may be attracted to grazing operations and facilities to forage on newborn animals or carcasses of dead livestock. Grizzly bear predation on livestock can result in risks to human life, property damage, or indirectly, in mortality through habituation and removal of a bear to protect human safety. Grizzly bears can benefit from feeding on livestock carcasses in remote locations away from people. However, when dead livestock occur near human dwellings or other areas with high levels of human activity, the potential for human/bear encounters may be high, which can eventually lead to the death of the bear through management actions. Less frequently, grizzly bears learn to prey on livestock on more remote grazing lands and become repeat offenders, removed from the population through management action.

Effects of Livestock Grazing on Grizzly Bears in the Action Area

To date, no grizzly bear/livestock conflicts have occurred on the IPNF.

The desired condition for grazing under the revised plan is that grazing occurs at sustainable levels in suitable locations while protecting resources (FW-DC-GRZ-01). Therefore, under the Revised Plan, grazing allotments will continue to be permitted within suitable areas but no changes in existing allotments are expected (USFS 2011a, p. 388-389). Cattle grazing is currently permitted in two allotments that overlap BMUs in the SE (14,328 acres) on the Forest. Grazing will be reduced in the SE and CYE under the Revised Plan by 33,598 acres in the SE and 8,525 acres in the CYE (Table II-14). However, the IPNF anticipates the number of allotments and number of AUMs to remain the same over the next 10-15 years.

Notably, the Revised Plan states that for wildlife the long-term desired condition is recovery of threatened and endangered species (FW-DC-WL-03). Therefore, changes to existing allotments and new requests for grazing allotments will be evaluated at the site-specific level in adherence with the elements of the Revised Plan. Additionally, FW-DC-GRZ-01 states that grazing occurs at sustainable levels while protecting resources and all permits will include sanitation measures to reduce attractants that will cause a human/livestock/bear conflict (FW-STD-WL-03). Additionally, the IGBC Guidelines for grazing will be applied (FW-GDL-WL-18). These elements of the Revised Plan along with the expectation that current use levels would be maintained reduce the likelihood of new grazing allotments where conflicts with bears might occur or that existing allotments might contribute to conflicts in the future.

We do not anticipate that implementation of the Revised Plan will result in habituation of grizzly bears leading to conflicts in the CYE and SE because few acres are subject to livestock grazing, current use is expected to continue (USFS 2011a, p.389), the Revised Plan includes measures to address potential risks to bears from livestock grazing, and there is no history of grizzly bear human-grizzly bear conflicts from grazing allotments in the CYE and SE on NFS lands. While grazing occurs in BORZ, these allotments have existed for several decades with no history of conflicts with grizzly bears. We expect that grizzly bear numbers in BORZ will grow relatively slowly over time, and so we expect the likelihood of conflicts associated with these allotments to

remain low. Hence, we do not consider this type of land use, at its current or anticipated levels, to result in adverse effects on grizzly bears.

Effects of Other Potential Actions on Grizzly Bears Under the Revised Plan

Other actions on the forest with the potential to affect grizzly bears include mining, collection of forest products, and operations associated with special use permits.

Effects of Mining on Grizzly Bears Under the Revised Plan

Mining encompasses: 1) the location and extraction of mineral materials (e.g., sand, gravel, rock), 2) the location and extraction of locatable minerals (e.g. gold, silver, copper), and 3) mineral leasing for oil, gas, coal, geothermal resources, potassium, sodium, phosphates, oil shale, and sulfur, which includes exploration and surface occupancy (extraction).

As discussed previously, there are no major mining operations on the IPNF at this time. There are currently 1,232 Plans of Operations for locatable minerals on the IPNF. Of these, 17 are located in grizzly bear recovery zones (SE=4; CYE=13). The majority of on-going activities are related to maintenance of existing facilities. Most locatable mineral operations are less than five acres in size. The IPNF considers the potential for future mineral discovery to be “low”. There are approximately 434 active mineral material pits and quarries within the IPNF and of these 62 sites are located in the recovery zones (SE=26; CYE=36). Sites typically range from less than one acre to five acres in size. There are no leasable minerals located on the IPNF at this time and potential is considered “low”. As such, little commercial interest in leasing for such resources is anticipated. Therefore, even though the number of acres of grizzly bear habitat where leasable mineral activities⁸ will be allowed increases under the Proposed Action in both recovery zones (216,077 acres in the SE and 154,388 acres in the CYE (Tables II-13 and II-14), this is not expected to have a significant effect on grizzly bear habitat. Conversely, the acres of grizzly bear habitat where mining of locatable and materials will be allowed will be reduced by approximately 182,827 acres in the SE and 80,292 acres in the CYE (Tables II-13 and II-14). However, future mining activities could occur in grizzly bear habitat under the Revised Plan.

Such activities may result in loss of habitat within the footprint of the mine, disturbance to grizzly bears from road use and mining activities, displacement from habitat from road use or mine development, or impacts to habitat connectivity. The range of effects of future mining activities on grizzly bears is expected to be similar to those occurring at existing mining sites (Troy Mine and Rock Creek Mine in the CYE on the KNF). The extent of these effects will be limited by elements of the Revised Plan. Any mining proposal on the Forest would be considered in terms of Forest-wide desired conditions that trend the Forest toward providing remote areas for species with large home ranges, recovering Federally-listed species, facilitating

⁸ A leasable analysis was completed for the 1987 plan and areas were identified where no leasing could take place. However, because the potential is so low for the IPNF, the Proposed Action did not complete such an analysis. Hence, ‘on paper’ there appears to be an increase in mineral leasing capability when in reality this is not the case.

denning and habitat use through low levels of disturbance, and managing motorized access to promote recovery (FW-DC-WL-01 through 05). At the project level, Forest-wide guidelines and standards would address potential effects of mining proposals on connectivity and linkage areas (FW-GDL-WL-15 through 17), food storage and attractants (FW-STD-WL-03, Food Storage Order), disturbance of grizzly bears (FW-GDL-WL-01), and access management (FW-STD-WL-02). Effects would also be limited through site-specific project development, mitigation, and site-specific consultation.

Combined, this direction will reduce or limit the potential impacts of mining activities on grizzly bears. Some adverse effects on bears are anticipated if future mining activities are proposed, but we expect that the potential for adverse effects will be reduced or minimized through Revised Plan requirements and standards and guidelines applied at the project level. Any additional effects from mining will be related to site- and plan- specific details and will be identified and addressed at the project level. Combined, the Revised Plan elements and required mitigation plans (such as those developed for the Troy and Rock Creek mines on the KNF) would reduce or limit the impacts of mining activities on grizzly bears such that adverse effects are not anticipated for the population.

Effects of Collection of Forest Products on Grizzly Bears Under the Revised Plan

Special forest and botanical products may be collected Forest-wide, unless an area has been closed for a specific reason. The acres of grizzly bear habitat where commercial and personal collection of other forest products will be allowed are reduced under the Proposed Action in both recovery zones on the IPNF. The acres of grizzly bear habitat where commercial and personal collection of other forest products will be allowed are also reduced under the Proposed Action in both recovery zones on the IPNF ([Tables II-13 and II-14](#)).

Commercial use of special forest and botanical products is not allowed in designated wilderness; recommended wilderness; wilderness study area; wild, scenic and recreational rivers; special areas; or RNAs. The opportunity for collecting special forest and botanical products is also affected by the amount of motorized access to the Forest. Areas with no motorized access (i.e., core areas) limits opportunities and reduces the ability to collect products. Existing uses are often tied to historical knowledge and patterns of use. The most popular special forest and botanical products on the Forest include huckleberries, firewood, Christmas trees, and boughs. Mushroom picking is a popular activity following wildfires.

The primary effect on bears associated with collection of forest products is disturbance and risk of human/grizzly bear conflicts, and we expect that these risks are low. Generally, the collection of forest products occurs in close proximity to roads and the density of people engaged in this activity diminishes with increasing distance from a road or trail. Areas adjacent to roads are typically avoided by bears (McLellan and Shackleton 1988, p.456; Mace et al. 1996, p. 1403). Human presence for collection of forest products may disturb or displace bears, but we anticipate this effect will likely be short-term, temporary and for the most part, relatively low in intensity. We expect that grizzly bears will avoid the area while people are collecting products, but are likely to return after people leave the area. The Revised Plan adequately manages roads and core area, so if displaced by human presence and activity, grizzly bears will have options to find

needed food and shelter elsewhere. There will be areas on the Forest that will have very little or no collection of forest products due to limited accessibility. As discussed above, we anticipate that the information and education programs, Food Storage Order, IGBC Guidelines, and access management will reduce the risk of conflicts. Forest-product collection activities are subject to these measures and so we expect no adverse effects to grizzly bears as a result of Forest-product collection.

Effects of Special Uses on Grizzly Bears Under the Revised Plan

Special use authorizations permit occupancy and use on NFS lands by federal, state and local agencies, private industry, and individuals. Non-recreation special uses vary from low-intensity, often short-term actions such as filming or locations for scientific instruments, to larger developed facilities such as roads, communication sites, dams, and utility/energy transmission infrastructure. Special use permits may allow activities that cause disturbance to grizzlies due to human activities or risk of human/grizzly bear conflicts, resulting in grizzly bears avoiding the area. The IPNF currently has 190 recreation Special Use Permits and agreements. Outfitter and Guides also operate on NFS lands under special use permit. Currently, there are two outfitter and guides which operate within the SE with one of these extending their operations into the Priest Lake BORZ. Three additional outfitter and guides operate in the CYE. Three of these Outfitter and Guides are allowed to use snowmobiles as part of their permit (i.e. two in the SE; one in the CYE). The permitting of special uses will not be changed with implementation of the Proposed Action, including the requirement for a permit specific analysis for any renewals or modifications to existing permits or proposed new permits to insure compliance with the Forest Plan.

Special uses can also alter some habitat, such as a ski area or utility corridor. There are no existing proposals that will remove or alter large areas.

Under the Revised Plans, future proposals will be considered in terms of Forest-wide desired conditions that trend the forest toward providing remote areas for species with large home ranges, recovering Federally-listed species, facilitating denning and habitat use through low levels of disturbance, and managing motorized access to promote recovery (FW-DC-WL-01 through 05, FW-DC-AR-07). From a disturbance perspective, the Proposed Action will have more of areas (i.e., areas available with a lower likelihood of human disturbance (wilderness, roadless, etc.) available for bears, compared to existing conditions. FW-STD-WL-02, MA1a-DC-WL-01, MA1b-DC-WL-01, MA1c-DC-WL-01, MA1e-DC-WL-01, MA3-DC-WL-01, and MA5-DC-WL-01 create and maintain large, remote security habitats that are likely to have a lower amount of human use due to the difficulties of access.

At the project level, Forest-wide guidelines and standards will address potential effects of special use permits on connectivity and linkage areas, food storage and attractants (FW-STD-WL-03) and Food Storage Order), disturbance of grizzly bears (FW-GDL-WL-01), and access management (FW-STD-WL-02).

Special uses are less likely in MA1a or MA1c. Additionally, some Special uses authorizations are less likely to be considered in MA1, MA2, MA3, or MA4 (USFS 2013a, p. 292) because

these areas are managed to protect their special values. National Forest System lands that provide secure habitat or contribute as linkage areas are also less likely to be considered for disposal or exchange (USFS 2013a, p. 292). Therefore, special uses are less likely to occur inside BMUs in the action area.

Combined, the Revised Plan direction and extensive areas where special uses are less likely to be authorized will reduce or limit the potential impacts of special uses on grizzly bears. We anticipate no adverse effects to grizzly bears as a result of most special use permits. However, large-scale permitted activities such as ski areas or utility corridors may result in habitat loss or other adverse effects, but we expect these effects to be lessened by measures detailed above. Exceptions would be infrequent and related to large scale activities and would be addressed at the project level.

However, in the 10-15 year term of the Revised Plan, large-scale proposals may arise that result in adverse effects on individual grizzly bears. However, for the reasons described above, and the fact that the Revised Plan implements the IGBC guidelines for MS 1 (see Section A.2), which encompasses all of the CYE and SE recovery zones and favors the needs of grizzly bears when grizzly habitat and other land use values compete, we do not expect substantial negative effects on the population.

3. Species' Response to the Proposed Action

Species' Response in the CYE Portion of the Action Area

The CYE grizzly bear population has a slightly declining trend, but improved since 2006 (Figure 11-4). Beginning in 2006, the rate of change in the population (λ) has improved and moved closer to stability (Kasworm 2013 unpublished data); this is an indication that the status of the CYE grizzly bear population is improving. Telemetry data and sightings, including females with cubs, confirm occupancy of some BORZ by grizzly bears (Kasworm et al. 2012, p. 16, Table 2).

The overwhelming majority of adverse effects from Forest management projects arises from roads and associated high road densities and motorized access resulting in disturbance and displacement of grizzly bears. High motorized route densities provide people with easy access into grizzly bear habitat, which contributes to potential increased risk of human-bear conflicts resulting in human-caused grizzly bear mortality – one of the primary factors affecting the CYE population. We conclude that the Revised Plan, grizzly bear Access Amendment, and food storage order would continue to substantially reduce adverse impacts to grizzly bears from Forest management activities within the action area.

Grizzly bears are given high priority in Forest management inside the Recovery Zone; grizzly bears are not the primary management consideration in Forest land management in the action area outside of the recovery zone. Grizzly bears outside the recovery zone probably experience a higher level of adverse impacts due to land management actions than do grizzly bears inside. However, a number of grizzly bears, including females, regularly occur in habitat outside of the

recovery zone (USFWS 2011a, p. A-72). We expect this occupancy to continue, albeit at lower densities than expected in fully functioning habitat.

Existing and proposed road densities authorized under the Revised Plan have the potential to adversely affect some grizzly bears in some portions of the action area. However, the Access Amendment moderates effects of roads on bears by limiting the density of open and total roads and maintaining core areas within the recovery zones on the IPNF over time (standards expected to be achieved by 2019). In the CYE, all but 2 BMUs would achieve the research benchmark for core areas, OMRD, and TMRD. Of these 2 BMUs one would also meet the research benchmark for core, thereby reducing the effects where OMRD/TMRD research benchmarks would not be met. The maintenance of good quality core areas within these BMUs may lessen the overall displacement impacts to grizzly bears related to the relatively high OMRD and TMRD outside the core by providing ample amounts of relatively secure habitat within home ranges (USFWS 2011a, p. A-67). Grouse BMU does not meet research benchmark for core and may never be capable of providing the full suite of home range needs of the average adult female grizzly bear due to small size and/or private ownership and /or other constraints. Thus, sub-optimal conditions may persist in the long-term for this BMU. We expect some bears to continue using BORZ, including females, despite suboptimal conditions, albeit at lower densities than grizzly bears in the recovery zones.

As described in detail earlier in this biological opinion, the primary adverse effect that may result in impairment of feeding, breeding, and sheltering activities by grizzly bears under the Revised Plan is attributed to the effects of high road densities. The implementation of the Access Amendment through 2019 would lessen these adverse effects including those that are likely to impair breeding, feeding and sheltering. As characterized in the Access Amendment biological opinion and reiterated in this biological opinion, the Access Amendment significantly reduces incidental take attributed to high road densities but does not reduce the possibility of incidental take in all BMUs.

Over the life of the plan, adverse effects may result from displacement of a very few female grizzly bears with cubs by snowmobile activities during the den emergence period. The Revised Plan would not increase this adverse effect, and overtime, it may decrease the adverse effects. As characterized in the effects analysis above, there is a low likelihood of effect on 14,250 acres (19 percent on the IPNF and 9 percent on the KNF and IPNF combined) of denning habitat in the CYE and the risk of effect would be limited to the period of time from female and cub den emergence (third week of April) and spring snow melt (these dates would vary year to year). Once winter travel plans are in place, the Revised Plan could decrease the acres of overlap between grizzly bear denning habitat and snowmobile activities.

Under the Revised Plan, other, site-specific projects may result in adverse effects to individual grizzly bears primarily associated with vegetation management activities (timber harvest or prescribed fire) creating larger opening sizes; potential mining proposals; large-scale special use permits; and use of helicopters during vegetation management activities. As discussed in the analysis of effects, we expect these activities to occur infrequently and associated adverse effects to be reduced by the elements of the Revised Plan such that we do not anticipate substantial negative effects on the population.

As stated, the grizzly bear population is slightly declining, but trend is now approaching stability (Figure II-4). Since 2006, the rate of decline in the CYE grizzly bear population has slowly, steadily improved. Further, the number of grizzly bears in the Cabinet Mountains has increased through augmentation and reproduction, and a number of grizzly bears are occupying habitat in the BORZ. Since 2011, the IPNF has fully addressed two of the three primary forms of mortality on NFS lands: access and road densities and attractant/food storage conflicts. There have been no grizzly bear mortalities on the IPNF related to the third primary source of mortality: livestock grazing conflicts. Hence, the anticipated adverse effects of the Revised Plan may affect a few individual bears but are not expected to have appreciable negative effects on the CYE population of bears.

Species' Response in the SE Portion of the Action Area

It was estimated in 2004 that the population of grizzly bears in the SE was slowly increasing at a rate of 1.9 percent annually (Wakkinen and Kasworm 2004, p.72). Recently, Wakkinen indicated that there is no evidence that would suggest any major changes from the 2004 population growth rate; however, this will be updated in upcoming years (W. Wakkinen 07/02/2013 pers. comm.).

The overwhelming majority of adverse effects from Forest management projects arises from roads and associated high road densities and motorized access resulting in disturbance and displacement of grizzly bears. High motorized route densities provides people with easy access into grizzly bear habitat, which contributes to potential increased risk of human-bear conflicts resulting in human-caused grizzly bear mortality – one of the primary factors affecting the SE population. We conclude that the Revised Plan, grizzly bear Access Amendment, and Forest-wide food storage order would continue to substantially reduce adverse impacts to grizzly bears from Forest management activities within the action area.

Grizzly bears are given high priority in Forest management inside the Recovery Zone; grizzly bears are not the primary management consideration in Forest land management in the action area outside of the recovery zone. Grizzly bears outside the recovery zone probably experience a higher level of adverse impacts due to land management actions than do grizzly bears inside. However, a number of grizzly bears are apparently using habitat within the BORZ. We expect this occupancy to continue albeit at lower densities than expected in fully functioning habitat.

Existing and proposed road densities authorized under the Revised Plan have the potential to adversely affect some grizzly bears in some portions of the action area. However, the Access Amendment moderates effects of roads on bears by limiting density of open and total roads and maintaining core areas within the recovery zone over time (standards expected to be achieved by 2019). In the SE, 7 of the 8 BMUs would achieve the research benchmark for core areas, OMRD, and TMRD. The Lakeshore BMU does not meet research benchmark for core, OMRD, or TMRD and may never be capable of providing the full suite of home range needs of the average adult female grizzly bear due to small size and/or private ownership and /or other constraints. Thus, sub-optimal conditions may persist in the long-term for this BMU. Importantly, the Lakeshore has never been expected to function like the other BMUs due to its small size and proximity to heavily used recreation areas and as such is managed as both MS1 (9,872 acres) and MS3 (8,093

acres). Additionally, we expect some bears to continue using BORZ, including adult females, despite suboptimal conditions, albeit at lower densities than grizzly bears in the recovery zones.

As described in detail earlier in this biological opinion, the primary adverse effect that may result in impairment of feeding, breeding, and sheltering activities by grizzly bears under the Revised Plan is attributed to the effects of high road densities. The implementation of the Access Amendment through 2019 would lessen these adverse effects including those that are likely to impair breeding, feeding and sheltering. As characterized in the Access Amendment biological opinion and reiterated in this biological opinion, the Access Amendment significantly reduces incidental take attributed to high road densities but does not reduce the possibility of incidental take in all BMUs.

Over the life of the plan, additional adverse effects may result from displacement of a very few female grizzly bears with cubs by snowmobile activities during the den emergence period. The Revised Plan would not increase this adverse effect, and overtime, it may decrease the adverse effects. As characterized in the effects analysis above, there is a low likelihood of effect on 7,440 acres (6 percent) of denning habitat in the SE and the risk of effect would be limited to the period of time from female and cub den emergence (third week of April) through spring snow melt (these dates would vary year to year). Once winter travel plans are in place, the Revised Plan could decrease the acres of overlap between grizzly bear denning habitat and snowmobile activities.

Under the Revised Plan, other, site-specific projects may result in adverse effects to individual grizzly bears primarily associated with vegetation management activities (timber harvest or prescribed fire) creating larger opening sizes; potential mining proposals; large-scale special use permits; and use of helicopters during vegetation management activities. As discussed in the analysis of effects, we expect these activities to occur infrequently and associated adverse effects to be reduced by the elements of the Revised Plan such that we do not anticipate substantial negative effects on the population.

E. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Past and present impacts of non-Federal actions are part of the “environmental baseline” as are the impacts of Federal activities that have undergone section 7 consultation.

Due to the broad geographic scope of the Revised Plan and, therefore, the action area, it is difficult to comprehensively assess all of the future, non-Federal activities reasonably certain to occur in the action area that may affect the grizzly bear populations in the CYE and SE. This analysis of cumulative effects is based on an assessment of land ownership and use patterns, and the patterns of grizzly bear mortality caused by non-Federal activities, as discussed above in the Status of the Species and Environmental Baseline sections.

State and private lands comprise approximately 10 percent of the CYE recovery zone. In the U.S. portion of the SE, land ownership is approximately 80 percent Federal, 15 percent State, and 5 percent private lands. Within the SE, 3 percent (39,976 acres) is designated Wilderness Area. There are approximately 370,000 acres of private, state and corporate timber land inholdings within the IPNF boundary. In terms of BMUs and BORZ, approximately 74,050 and 23,785 acres of private, state and corporate timber lands occur, respectively, within these two boundaries on the IPNF. In the SE, private and state land includes approximately 24,980 acres in BMUs and 10,712 acres in BORZ. In the CYE, private and state land includes approximately 49,070 acres in BMUs and 13,073 acres in BORZ. Timber harvest, road construction, and fuels reductions efforts occurring on private or State, lands may impact the distribution, amount, and quality of grizzly habitat within the recovery zones and may impact connectivity between NFS lands in the action area. Impacts from these activities may also impact recurring use by grizzly bears within the BORZ. Human activities may cause avoidance of these areas, or conversely, increase the potential for habituation and subsequent removal or death of these bears for public safety. Decisions made by non-Federal landowners regarding management of their lands could potentially result in cumulative disturbance, displacement, or increased risk of human/grizzly bear conflicts. Timber harvest and developments on private or State lands may also affect connectivity within the action area.

The LeClerc BMU in the SE is comprised of checkerboard ownership between the Colville National Forest and Stimson Lumber Company. Stimson Lumber Company manages approximately 21,000 acres of the land within the LeClerc BMU and has entered into a Conservation Agreement with Colville National Forest and the Service to minimize adverse effects to grizzly bears (USFWS 2001c, pp.53-54). This Agreement requires Stimson and the Colville to leave hiding cover within created openings, along open roads, and within riparian habitats. Stimson is also required to log during the winter in some areas to reduce disturbance and report logging activities and road entries to the Colville National Forest annually. The Service's biological opinion (ibid) on that Agreement included an incidental take statement with terms and conditions providing for no net decrease in core area habitat or an increase in TMRD on affected Forest Service lands.

Recreation is likely to increase on all land ownership types, if for no other reason than human population growth. From 1980 until 2009 the human population increased in all of the counties that overlap the IPNF, (USFS 2012, p. 94). Increases in human population and new or improved technologies (e.g. mountain bikes, ATVs, snowmobiles, etc.) have led to more crowded recreation experiences during peak use times and increased levels and range of demands on resources on the IPNF and adjacent state and private lands, particularly those providing access or similar recreational experiences. Increases in recreational use in the action on non-federal lands area may contribute to disturbance and cause the portions of NFS lands that have lower human disturbance to become more important for grizzlies. Additionally with increased human presence on all land ownerships, along with progress toward our goal of increasing grizzly bear numbers in the CYE and SE, there is potential for an increase in human/bear conflict, which may result grizzly bear mortality.

The State of Idaho continues to allow hunting for black bears, as well as other wildlife species, within and around the SE and CYE. This has the potential to result in grizzly bear mortality as a result of mistaken bear identification or self-defense within the action area.

Idaho began a voluntary black bear hunter testing and certification program in 2011 to help educate hunters in distinguishing species and reducing mistaken identity and reducing grizzly bear mortalities. The IPNF and cooperating agencies (Idaho Department of Fish and Game, Idaho Department of Lands) maintain and financially support a regular program of public information and education within the SE and CYE. These programs reduce and contribute to offsetting the risks of bear/human conflicts and human-caused mortality of grizzly bears. .

The Grizzly Bear Access Amendment established management direction for roads and secure habitat on NFS lands within the action area. However, the BMUs in the action area also include some state and private lands and decisions made on State and private lands could potentially result in cumulative disturbance or displacement effects on grizzly bears. The calculations used for determining road densities and core areas on NFS lands include roads on state and private lands within the BMUs considered in this action, even though standards set by the Access Amendment apply only to NFS lands. Therefore, activities on non-federal lands may in some cases limit discretion for road use on federal lands in order to meet standards (USFWS 2011a, p. A-75). In other words, this will partially offset or moderate cumulative effects of road densities and core areas on state and private lands.

Climate change could have varied impacts on grizzly bears and their habitats, especially when combined with fire (or fire suppression), insects, and disease effects on habitat. Past fire suppression has led to an increase in fuels, denser forests that are more susceptible to insects and disease, and forests that are less resilient and sustainable. Large, stand-replacing disturbance will be more likely and may be exacerbated as the climate changes. All lands in the action area will be susceptible to these events, although non-Federal landowners are unlikely to allow these areas to burn and will likely aggressively attempt to control such fires. Large-scale disturbances could convert a large area of grizzly habitat from forested to open in one event. This will alter the availability of grizzly bear foods and cover, potentially changing how bears use the landscape.

In summary, developments, timber activities, recreational use and roads on state and private lands in the action have the potential to result in cumulative effects on grizzly bears in the action area. Potential effects include disturbance and displacement, fragmentation of habitat and human/grizzly bear conflicts resulting in mortality of bears. The vast majority of the CYE and SE recovery zones are NFS lands, yet a disproportionate number of bears are killed on private lands. The implementation of the Access Amendment on Federal lands, which takes into account actions on private lands; hunter education programs, and grizzly bear outreach programs; and the Stimson (LeClerc BMU) Conservation Agreement with Colville National Forest all address other conservation needs for the species and contribute to offsetting cumulative effects of mortality on private lands. At this time, the cumulative effects on grizzly bears on state and private lands contribute to the inability to meet the demographic criteria for human-caused mortality and mortality of female bears in the CYE. However, both the CYE and SE populations are increasing and the programs described above to offset the effects of human-caused mortality

appear to be helping stabilize the populations. Therefore, the cumulative effects are not expected to result in substantial negative effects on the population.

F. CONCLUSION

After reviewing the current status of the grizzly bear, the environmental baseline for the action area, the effects of the action and the cumulative effects, it is the Service's biological opinion that the effects of the proposed Revised Plan are not likely to jeopardize the continued existence of the grizzly bear. No critical habitat has been designated for this species therefore none will be affected.

Regulations implementing section 7 of the Act define "jeopardize the continued existence of" as: "to engage in an action that reasonably will be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." (50 CFR 402.02).

The best information suggests that implementation of the Revised Plan will not appreciably reduce the likelihood of survival and recovery of grizzly bears in the CYE or SE. Our conclusion is based on the literature and information referenced in this document, meetings and discussions with IPNF, discussions with grizzly bear experts, the information in the biological assessment prepared for the Revised Plan (USFS 2013a), the information in the Draft EIS (USFS 2011b), and information in our files. The *Effects of the Action* section analyzed and summarized key factors in detail.

The Service's section 7 handbook explains that adverse effects on individuals of a species generally do not result in jeopardy determinations unless that loss when added to the environmental baseline, is likely to result in an appreciable reduction of the likelihood of both survival and recovery of a listed species in the wild by reducing the reproducing, numbers, or distribution of that species. In our analysis for grizzly bears, we first conduct such an analysis relevant to the CYE and SE grizzly bear populations, and then use those determinations to determine the impact of the proposed action on the species.

The proposed Revised Plan incorporates the 2011 Access Amendment. This direction results in an increase in core area and reduces motorized route densities. Thus, the proposed action will reduce adverse effects on grizzly bears, including significant impairment of breeding, feeding and sheltering of female grizzly bears, related to displacement of grizzly bears from roads. In the CYE and SE, Revised Plan management of core area and motorized access also indirectly limits the amount of grizzly bear habitat in BMUs (and subunits) affected by Forest management activities that generate noise and other disturbance (e.g. timber harvest and recreation) by limiting the road access needed for these activities. Motorized access management also reduces the potential for conflicts between grizzly bears and people by limiting motorized access into grizzly bear habitat. In the CYE and SE recovery zones, the Revised Plan would result in an overall improvement in motorized access conditions in grizzly bear habitat, and would avoid or minimize incidental take of grizzly bears related to displacement from roads; support and sustain habitat for female home range use and reproduction; limit disturbance from project related activities; and reduce mortality risk to grizzly bears, benefitting the grizzly bear population. As a result, overall, the adverse effects of roads prior to and remaining once the access direction is

fully implemented are substantially outweighed by the benefits of access management to grizzly bears, and so are likely to have only negligible effects on the CYE and SE grizzly bear populations. Thus, we conclude that Forest Plan direction supports recovery and survival in both ecosystems.

The Revised Plan limits linear miles of open or total permanent roads to the existing baseline condition in areas outside of the recovery zones but inhabited by grizzly bears (BORZ). Therefore, the level of adverse effects related to displacement from roads in these areas, including impairment of breeding, feeding, and sheltering of females, would not increase in the BORZ. In addition, the recent Forest-wide Food Storage Order would reduce the potential risks of habituation and human-caused mortality of bears in the BORZ. Outside of the 10 – mile buffer around the recovery zone, demographic information from grizzly bears in the BORZ is not used to assess CYE or SE grizzly bear population status, and the Recovery Plan states that habitat within recovery zones, managed for grizzly bear use, is adequate to recover bear populations. Further, even at low densities, grizzly bear use of areas between recovery zones, including females with cubs, would promote the likelihood of both genetic and demographic recovery of the CYE and SE grizzly bear population in the future. Even with the existing high road densities that likely result in adverse effects, grizzly bears are still using these areas. Therefore, we conclude that the Revised Plan direction for access management would support continued use of the area by grizzly bears.

The Revised Plan motorized access direction thus increases conditions that support and sustain female home range use for reproduction in the recovery zone, maintains conditions supporting grizzly bear use in the BORZ, reduces mortality risk to grizzly bears in both areas in combination with the food storage order, and promotes linkage between the CYE and SE, so benefitting both populations. Thus, Forest Plan direction supports recovery and survival of grizzly bears.

Snowmobile use in the CYE and SE subunits may result in adverse effects, including the potential for a low amount of impairment of breeding, feeding, and sheltering of a very few females. Adverse effects resulting in such impairment are expected to occur only infrequently, affect very few females, and would be limited to a short period during spring in limited areas where late season snowmobile use currently overlaps with denning habitat. This overlap where denning habitat is available for snowmobiling could decrease under the Revised Plan as Winter Travel Plans are completed; the desired condition calls for a Forest-wide decrease in of 47,093 acres available to snowmobiling. Our analysis indicates that Revised Plan direction would not increase adverse effects associated with snowmobiling. Adverse effects on grizzly bears under the Forest Plan, prior to completion of the Winter Travel Plan, are very limited and further reduced by guidelines and standards that are immediately in place and limit grooming of snowmobile routes after April 1 and restrict management activities in denning habitat from April 1 to May 1. Therefore, any effects from snowmobiling during the den emergence period are unlikely to result in substantial adverse effects to the CYE or the SE grizzly bear populations.

The biological opinion also analyzed a number of other project or activity types allowed under the Revised Plan, some of which could result in adverse effects and less frequently, impairment

of breeding, feeding and sheltering. These include the creation of larger opening sizes, mining proposals, large-scale special use permits, and use of helicopters for vegetation management activities. As detailed in the opinion, Revised Plan desired condition trends the forest toward a system of large, remote areas with limited human disturbance for wildlife, and trends the forest toward the recovery of listed species over the long-term. The Revised Plan would also reduce the likelihood of adverse effects from these actions, and/or would minimize the impacts of many adverse effects on grizzly bears. As such we conclude that although some individual bears may be adversely affected, these effects (including potential take), would not rise to the levels that would have substantive impacts on either the CYE or SE grizzly bear populations.

Thus, when added to the environmental baseline, and considering the status of the species and cumulative effects in the action area, the Revised Forest Plan would not appreciably diminish the likelihood of survival and recovery of the CYE or the SE grizzly bear populations.

Our non-jeopardy conclusion is further supported by the following factors, as detailed earlier in this biological opinion

Factors Related to Access Management

It is the Service's opinion that the level of open and total road densities, and security core area within the action area, as directed by the Access Amendment and incorporated into the Revised Plan, adequately conserves effective grizzly bear habitat and promotes the recovery and survival of the CYE and SE grizzly bear populations. It is our opinion that the Revised Forest Plan direction for access management does not appreciably reduce the likelihood of both the survival and recovery of grizzly bears in the CYE, SE or BORZ.

- In the CYE, motorized access management under the Revised Plan conserves and/or increases habitat for female home range use in the majority of BMUs, and so supports the distribution and reproduction of grizzly bears. Four of the 6 BMUs in the CYE would meet (or be better than) the research benchmarks for OMRD, TMRD, and core area. These BMUS each would provide levels of secure habitat adequate to support breeding, feeding, and sheltering activities for grizzly bears, including females (USFWS 2011b, p. A-65). Adverse effects of road densities would be avoided.
- In the SE, motorized access management under the Revised Plan conserves and/or increases habitat for female home range use in the majority of BMUs, and so supports the distribution and reproduction of grizzly bears. Seven of the 8 BMUs in the CYE would meet (or be better than) the research benchmarks for OMRD, TMRD, and core area. These BMUS each would provide levels of secure habitat adequate to support breeding, feeding, and sheltering activities for grizzly bears, including females (USFWS 2011b, p. A-65). Adverse effects of road densities would be avoided.
- Through 2019, a low amount of adverse effects and impairment of breeding, feeding and sheltering would occur in those BMUs in the CYE and SE not yet meeting research benchmarks. Once research benchmarks are met in a BMU, we anticipate no adverse

effects to grizzly bears as a result of motorized access. The plan would increase core area to 58.5 percent of the CYE recovery zone by 2019 (USFWS 2011, p. A-60). Thus the Revised Plan direction for motorized access supports recovery in the CYE and SE.

- For the one remaining BMU in the CYE that does not meet OMRD and/or TMRD benchmarks, we anticipate a low level of adverse effects associated with high road densities. This is because this BMU meets the core benchmarks. The maintenance of good quality core areas within this BMUs may lessen the overall displacement impacts to grizzly bears related to the high OMRD and TMRD outside the core by providing ample amounts of relatively secure habitat within home ranges (USFWS 2011b, p.A-67). Therefore, we expect the affected BMU to continue to support grizzly bears albeit at lower densities than in fully functional BMUs. Under the Access Amendment, just one BMU in the CYE action area (Grouse) and one BMU in the SE action area (Lakeshore) would not meet the research benchmark for core area. Given the Revised Plan direction for the CYE and SE recovery zones overall, the adverse effects related to road densities (access management) in these two subunits would likely be insignificant to the grizzly bear population.
- In BORZ, we anticipate that linear miles of road are likely causing adverse effects on grizzly bears. The IPNF had not specifically managed for grizzly bear habitat relative to road standards outside of the recovery zones until implementation of the Access Amendment. The Access Amendment limits linear miles of open and total permanent roads to the baseline condition in BORZ. The Access Amendment does allow temporary increases in linear miles of total roads, but these roads must be closed to public access and total roads returned to baseline after the project is complete. Overall, these provisions limit the adverse effects of roads on grizzly bears in these areas. The Revised Plan would retain the motorized access conditions in BORZ; conditions that currently allow some use by grizzly bears.
- Additional adverse effects may occur where snowmobile activities occur in the late season in proximity to denning habitat including 14,250 acres in the CYE and 7,440 acres in the SE. The likelihood of an adverse effect is low for all the reasons described in the Analysis of Effects. Because females with cubs/young are most likely to stay in the vicinity of the den sites until later in spring, this segment of the population may be most exposed to late season snowmobiling, while males and lone females probably move to lower, snow-free elevations. Once winter travel plans are in place, the Revised Plan could decrease the acres of overlap between grizzly bear denning habitat and snowmobile activities.
- The Proposed Action direction would not increase the existing level of adverse effects on grizzly bears in the CYE and SE resulting from use of snowmobiles. Individual grizzly bears may be adversely affected where late season snowmobile activities occur in denning habitat, including 14,250 acres (19 percent of total denning habitat in the action

area) in the CYE (9 percent of the total denning habitat on both Forests in the CYE recovery zone) and 7,440 acres in the SE subunits (6 percent of denning habitat in the action area in the SE). The likelihood of adverse effects to individual grizzly bears is very low for all the reasons described in the Analysis of Effects, including Revised Plan elements (FW-DC-WL-01; FW-DC-WL-04; FW-GDL-WL-01; and FW-STD-WL-04). We anticipate adverse effects would be so infrequent and affect so few females that effects of snowmobile use would not be likely to have substantial impacts on the grizzly bear population in CYE or SE.

Factors Related to Attractants and Food Storage

It is the Service's opinion that the mandatory Food Storage and Sanitation Special Order implemented in 2011 on the IPNF contributes to the survival and recovery of the CYE and SE grizzly bear populations. There have been no grizzly bear mortalities on the IPNF related to livestock grazing allotments or food storage/attractants. The IPNF has taken numerous actions to minimize the risk of habituation/food conditioning to grizzly bears. We expect that continuation of these programs as well as elements of the Revised Plan that address attractants and food storage would ensure that the risk of conflicts on the IPNF remains low.

- The Revised Plan implements the IGBC Guidelines to minimize grizzly bear-human conflicts in accordance with the grizzly bear Management Situation designations on the IPNF. The IPNF will follow the IGBC Guidelines for nuisance bear management. The Guidelines are embedded in the Revised Plan (FW-GDL-WL-18).
- The IPNF's existing livestock grazing program has avoided adverse effects on grizzly bears. There are no allotments on IPNF lands in the CYE; just two on the SE; and portions of two additional cattle grazing allotments (approximately 3,930 acres) situated in the Priest River BORZ. No changes in existing allotments are expected and current use levels are expected to be maintained for the next 10 to 15 years (USFS 2011b, pp.388-389). Thus, we do not consider this type of land use, at its current or anticipated levels, to result in adverse effects on grizzly bears in the recovery zone or BORZ.
- There is a food storage order on the IPNF (USFS 2013a, Appendix F). Information on the Order is provided to forest users through information pamphlets at visitor centers, trailheads and kiosks and the IPNF website.
- The Revised Plan requires permits and operating plans (e.g., special use, grazing, mining) to specify attractant storage measures to reduce human/wildlife conflicts and grizzly bear mortality by making wildlife attractants (ex: garbage, food, livestock carcasses) inaccessible through proper storage or disposal (FW-STD-WL-03).

Other Factors Affected by the Revised Plan

The Revised Plan desired conditions and standards and guidelines (in addition to and/or other than those related to motorized access management) applied at the project level would avoid, reduce, or minimize adverse effects on grizzly bears. Adverse effects that could result in impairment of breeding, feeding or sheltering would be infrequent and affect few bears. We conclude that this direction in the Revised Plan adequately conserves effective grizzly bear habitat and substantially reduces the risks of conflict between people and bears, and so promotes the recovery and survival of the CYE or SE grizzly bear populations.

- The desired condition under the Revised Plan is to provide large, remote areas with low levels of disturbance for grizzly bears and to ensure access management promotes recovery of grizzly bears (FW-DC-WL-02 through 05 and MA1a,b,c,e-DC-WL-01, MA3-DC-WL-01, MA5-DC-WL-01, GA-DC-WL-CDA-03, GA-DC-WL-LK-01 and 02, GA-DC-WL-PO-01, GA-DC-WL-PR-01 and 03, and GA-DC-WL-SJ-02). The Revised Plan reduces the area where roads or trails may be designated for wheeled motorized use in the recovery zones by 64,440 acres. These conditions complement the Access Amendment and could result in additional non-motorized areas beyond those required by the Access Amendment (S. Dekome 08/13/2013 pers.comm.). These same elements of the Revised Plan maintain habitat connectivity and linkage areas for movement of bears between U.S. and Canada and between U.S. recovery zones. The IPNF took into consideration connectivity issues when setting the individual BMU access management parameters (BA 2010a, p.50; Kaiser 2003 *In* USFWS 2011a, p. A-76).
- Timber harvest would be allowed on just 47 percent and 54 percent of the SE and CYE recovery zones in the action area, respectively. Additionally, the Access Amendment also indirectly limits the amount of grizzly bear habitat in BMUs (and subunits) affected by vegetation management activities that generate noise and other disturbance (e.g. timber harvest and recreation) by limiting the road access needed for these activities during the active bear year.
- The Revised Plan's desired condition for patches which includes a range of larger opening sizes may result in adverse effects if lack of cover leads to under use of foraging habitat or increased risk of human-grizzly bear conflicts causing mortality of a grizzly bear. Openings created by timber harvest, depending on site conditions, may retain features that interrupt the line of sight and provide cover for bears (J. Anderson 03/12/2013 pers. comm.). These measures could improve security and so promote foraging by bears in areas away from open motorized routes. Based on our history of consultation and proposed plan direction - specifically, road closures and restrictions directed by the Access Amendment - as well as public information and education programs that reduce the risk of human/bear conflicts, we anticipate that in most instances, the size of harvest units would not result in adverse effects on grizzly bears. Over the life of the Revised Plan, we anticipate that a few individual bears would be

adversely affected by opening size, but we expect these instances would be rare; that significant impairment of breeding feeding and sheltering infrequent; and that any such instances would undergo project-specific consultation. Thus, we conclude that opening size would have no substantial impacts on the grizzly bear populations in the CYE or SE.

- In BORZ, grizzly bears would have fewer options providing undisturbed areas to select from if disturbed by timber harvest and prescribed fire activities. However, we do not anticipate significant impairment of grizzly bears' ability to feed, breed, or shelter. This is attributed to the occupation of these areas by grizzly bears despite the sub-optimal conditions (including existing, ongoing levels of timber harvest), the elements of the Access Amendment that limit open, total, and temporary roads, and the Access Amendment requirement in BORZ to schedule timber harvest activities that will occur within multiple watersheds in a manner to minimize disturbance of grizzly bears resulting from road use during project level consultation (prescribed fire is often implemented as a post-harvest activity).
- Helicopter use associated with timber harvest would be designed using the *Guide to Effects Analysis of Helicopter Use in Grizzly Bear Habitat* (USFWS and USFS 2009) and is subject to project-specific consultation. Use of this guidance in planning activities would help avoid or reduce adverse effects on grizzly bears from helicopter use, including timber harvest. Based on our history of consultation on Forest management activities, we anticipate that helicopter use that may adversely affect grizzly bears would be relatively infrequent. Most projects would be designed to avoid or minimize adverse effects since the recovery zone is under MS1 designation where the needs of grizzly bears are favored when grizzly habitat and other land use values compete. Adverse effects on grizzly bears would likely occur only infrequently and many would be of short duration, and impairment of breeding, feeding and sheltering even more infrequent, and so these effects would not have substantial negative effects on the grizzly bear population.
- If future mines are proposed, the potential for adverse effects would be reduced or minimized through Revised Plan desired conditions FW-DC-WL-01 through 05; linkage guidelines FW-GDL-WL-15 through 17; food storage and attractant requirements (FW-STD-WL-03; Food Storage Order); and standards for access management (FW-STD-WL-02) as well as the development of appropriate mitigation plans where needed, as in the case of large scale operations such as the Troy Mine and Rock Creek Mine on the KNF.
- Under the Revised Plan, BORZ will continue to support grizzly bear movement and linkage on the whole, while causing some adverse effects on individual bears related to baseline conditions. However, we do not anticipate substantial negative effects on the population. This is because the allowable uses under the Revised Plan are already occurring in the BORZ and yet bears are meeting resources needs, albeit at lower densities than in the recovery zones. Additionally, the Revised Plan implements the

Access Amendment in BORZ which limits linear miles of open and total permanent roads to no more than the existing baseline conditions, which supports some use by grizzly bears, including females with cubs. Notably, the IPNF took into consideration connectivity issues when developing the BORZ polygons (USFS 2010a: Appendix F *In* USFWS 2011a, p. A-76). Lastly, the food storage order in BORZ will further facilitate connectivity between the SE and CYE by limiting risk of conflicts between grizzly bears and humans.

- The desired condition under the Revised Plans is that forest management contributes to wildlife movement within and between national forest parcels; movement between those parcels separated by other ownerships is facilitated by management of the NFS portions of linkage areas identified through interagency coordination; and federal ownership is consolidated at these approach areas to highway and road crossings to facilitate wildlife movement (FW-DC-WL-18). This would be achieved at the project or site-specific level through guidelines FW- GDL-WL-15 through 17.

Factors Related to the Grizzly Bear Populations

The current estimate for the CYE grizzly bear population is approximately 42 bears. The population trend for CYE grizzly bears is declining slightly (by less than one percent annually), but has improved since 2006. Since 2006, grizzly bear numbers in the CYE have been slowly, steadily increasing (Kasworm et al. 2012, p. 38, Figure 9). The rate of change in the population (λ) has also improved and moved closer to stability (Kasworm 2013 unpublished data). These are indications that the CYE grizzly bears population status is improving.

The estimated population size in the SE is 83 grizzly bears Proctor et al. (2012, p.31), with 25-30 in the U.S. (W. Wakkinen 07/02/2013 pers. comm.). As previously discussed, it was estimated in 2004 that the population of grizzly bears in the SE was slowly increasing at a rate of 1.9 percent annually (Wakkinen and Kasworm 2004, p.72). There is no evidence to suggest that the growth rate has undergone major changes from the 2004 estimate (W. Wakkinen 07/02/2013 pers. comm.).

- In the CYE, one of the four 1993 demographic recovery criteria was met in 2012. The six-year running average for females with cub was 2.8, compared to the criteria of 6. The distribution criterion has not been met with only 13 of 22 BMUs occupied by females with young. Total human-caused mortality limits were not met in 2012, but had been met each year for the past four years (2008-2011) (Kasworm et. al 2012, p.18). The running 6-year average (2007-2012) of total human-caused mortality was 1.7 animals per year, compared to the sustainable limit of no more than 1.6 (ibid). Female mortality (0.5) meets the recovery goal of no more than 30% (0.5) of total mortality criteria. Due to the current small population size (estimated at 42), the mortality *goal* remains zero. Nonetheless, given the importance of female grizzly bears to the population, the current

6-year average level of human-caused female mortality is a positive sign for the status of this population.

- The population level estimate in the Cabinet Mountains was 21 bears in 2011. The estimate for 1998 was 15 bears or fewer. The augmentation effort appears to be the primary reason that grizzly bears are increasing in the Cabinet. The MFWP intends to continue the augmentation effort into the future with plans to relocate two grizzly bears for the coming season (depending on suitability of captured bears) (J. Williams 06/12/2013 pers. comm.).
- None of the 1993 demographic recovery criteria have been met in the SE (USFWS 2011a, p. A-115). Wakkinen (2009 pers. comm. as cited *In* USFWS 2011a) noted: “that the ability to monitor the population has declined due to funding limitations and the reduction in trapping and radio collaring activities” in the recovery area. As described above, the USFWS has recently renewed efforts to monitor the SE population and data is forthcoming.
- BORZ associated with the CYE and SE on the IPNF have recurring use by grizzly bears, including females (USFWS 2011a, p. A-72). With implementation of the Access Amendment, which maintains baseline linear miles of open and total roads in BORZ, we expect these areas to continue to support grizzly.

Factors Related to the Conservation Needs of the SE and CYE Grizzly Bear Populations

Six conservation needs were identified for the SE and CYE grizzly bear population (Proctor et al. 2004, pp.155-157; Servheen 10/01/2006 pers. comm. as cited *In* USFWS 2011a, p. A-46):

1. Augment the Cabinet Mountains and Canadian Selkirks populations – Augmentation continues on the KNF portion of the CYE recovery zone;
2. Limit human-caused mortality - The IPNF implements extensive programs to limit the risk of human-caused grizzly bear mortality (Access Amendment; Food Storage and Sanitation Order; Ongoing Information and Education Programs; IGBC Guidelines - FW-GDL-WL-18; and food storage/sanitation requirements for special use permits - FW-STD-WL-03). There have been no grizzly bear mortalities attributed to improper attractant storage on the NFS lands in the CYE or SE. To date, there have been no grizzly bear deaths associated with food or attractants on NFS lands in the CYE or SE recovery zones nor has there been a grizzly bear/livestock conflict.
3. Enhance population linkage across Highways 2, 3, 200, 135, and 95 - The Revised Plan supports opportunities to install wildlife crossing structures and to maintain important habitat at crossing locations through desired condition FW-DC-WL-18 and guidelines FW-GDL-WL-15 through 17.
4. Address the needs of bears outside the recovery zone line - Through the Access Amendment, the IPNF and Service established BORZ areas. Within the boundaries of BORZ, the Access

Amendment limits linear miles of open and total permanent roads to the existing baseline condition; additionally, within BORZ, the Food Storage and Sanitation Order is applied; the Access Amendment requires the USFS to schedule timber harvest activities that will occur within multiple watersheds in a manner to minimize disturbance of grizzly bears resulting from road use during project level consultation; and the IPNF took into consideration connectivity issues when developing the BORZ polygons (USFS 2010a: Appendix F *In* USFWS 2011b, p. A-76).

5. Inside the recovery zone, a) complete access management in most important areas - The IPNF currently implements the Access Amendment (USFS 2011c) and b) improve sanitation standards on public lands – the IPNF implemented a Food Storage and Sanitation Order in 2011; the Revised Plan implements sanitation measures in permits and plans of operation (FW-STD-WL-03).

6. Increase outreach and public involvement - Existing public outreach and education programs will continue through IPNF's role in the Selkirk/Cabinet-Yaak Subcommittee of the IGBC.

In summary, the proposed action conserves and increases the amount of grizzly bear habitat in conditions that support female grizzly bears and reproduction on IPNF lands in recovery zone. Forest Plan access management and the food storage order would support continued use of habitat by bears in BORZ. Forest-wide, access management and the food storage order reduce the potential for conflicts between grizzly bears as a result of excessive road access and food and attractant storage, which in turn reduces human-caused mortality risk to grizzly bears. Finally the Revised Plan adequately minimizes the impacts of adverse effects of Forest management on grizzly bears. We conclude that the Revised Forest Plan would not appreciably diminish, but would increase the likelihood of recovery of both the CYE and SE grizzly bear populations. Therefore, the proposed action is not likely to jeopardize grizzly bears.

G. INCIDENTAL TAKE STATEMENT

Section 9 of the Act, and Federal regulations pursuant to section 4(d) of the Act, prohibit the take of endangered and threatened species, respectively without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission that creates the likelihood of injury to listed wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with this Incidental Take Statement.

The measures in an incidental take statement are non-discretionary and must be undertaken by the action agency so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The action agency has a continuing duty to regulate the activity that is covered by this incidental take statement. If the action agency (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the action agency must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

1. Amount or Extent of Take Anticipated in the Action Area

This biological opinion considered the effects to grizzly bears from implementation of the Revised Plan direction as guided by the Revised Plan elements (goals, objectives, desired condition, standards, and guidelines). It includes specific elements for the conservation of grizzly bears and grizzly bear habitat, but does not authorize specific actions.

This biological opinion does not provide an analysis for effects of specific actions. Rather, our analysis is a broad-scale examination of the types of projects and activities conducted under the Revised Plan that could potentially occur in grizzly bear habitat and result in effects on grizzly bears. The Revised Plan contained sufficient specificity through its suite of elements to permit an adequate analysis of the effects of types of projects and activities on grizzly bears and to make a determination that the extent of adverse effects on grizzly bear as a result of the Revised Plan does not rise to levels that are likely to jeopardize grizzly bears.

In this biological opinion, we documented how the Proposed Action reduces the potential for adverse effects and incidental take to occur as a result of Forest management. However, the potential remains for specific projects and activities to result in adverse effects and incidental take of grizzly bears. The mere potential for future take from these actions is not a legitimate basis for providing an exemption for take. The IPNF is responsible for section 7 consultation on all future projects (conducted under the Revised Plan) that may affect the grizzly bear or its habitat, even if those projects are consistent with Revised Plan. Subsequent consultation, as appropriate, on the specific actions developed pursuant to the Revised Plan will serve as the basis for enumerating the incidental take and determining if an exemption from the section 9 take prohibitions is warranted. If so, the Service will provide Reasonable and Prudent Measures and Terms and Conditions, as appropriate, to minimize the impacts of the taking on the grizzly bear in accordance with 50 CFR 402.14(i).

Two exceptions to this approach are related to the effects of motorized access route densities and over-snow motorized use on grizzly bears. For motorized route densities, the science is clear that above certain average road densities, bears may suffer adverse effects that can lead to significant impairment of the ability to feed, breed, or shelter. Further the Forest carefully examined, monitored and reported motorized access route densities in each BMU, set access standards for each BMU and provided a timeframe for achieving BMU access standards. In the BORZ, the Forest examined, monitored and reported linear motorized road miles and adopted a

prohibition on increasing the existing road miles. Hence, we are able to ascertain the level of adverse effects and provide surrogate measures of incidental take of grizzly bears related to road densities and that analysis, previously conducted in our consultation on the 2011 Access Amendment, was brought forward in this document.

For over-snow motorized use (i.e. snowmobile use) the Forest examined, monitored and reported the amount of denning habitat that was impacted by late season snowmobile use. The best available science and information suggests that recently emerged females with cubs would be vulnerable to adverse disturbance effects of snowmobile use near densities during late spring. The Forest provided both acres of denning habitat and an estimate of late season snowmobile use in denning habitat. Thus, we are able to ascertain the level of adverse effects and provide surrogate measures of incidental take of grizzly bears related to late-season snowmobile use. These two types of incidental take are examined below.

Finally, although it is not Revised Plan direction, a food storage order is in effect for the IPNF (USFS 2013a, Appendix F). Additionally, contracts and permits in the action area include food storage requirements under the Revised Plan. Lastly, there has been a concerted effort to address sanitation on NFS lands throughout the action area and CYE and SE as a whole, with many campgrounds and developed recreation sites now having bear-resistant garbage and/or food storage container. Additionally, dispersed recreationists are informed of the food storage order through trail-head signs and pamphlets at visitor centers and developed recreation sites. For reasons detailed in the biological opinion, we anticipate no incidental take as a result of habituation and food conditioning of grizzly bears related to improper food or attractant storage on the IPNF over the life of the Revised Plan and so no take is exempted. Further, for reasons detailed in this biological opinion, we do not anticipate incidental take of grizzly bears as a result of habituation and food conditioning as a result of grazing under the Revised Plan, and so no take is exempted.

Access Management –The Service analyzed the amount or extent of incidental take of grizzly bears anticipated as a result of the Access Amendment on the IPNF in our 2011 biological opinion and incidental take statement (USFWS 2011a). As detailed in the IPNF’s Draft EIS for the Revised Plan (USFS 2011b), the associated BA (USFS 2013a) and this biological opinion, the Revised Plan incorporates the Access Amendment in its entirety and would result in no additional adverse effects on grizzly bears related to motorized access management.

The proposed Revised Plan will establish grizzly bear habitat management standards for all 22 BMUs in the CYE. Within the action area, the proposed standards for 20 of 22 BMUs in the CYE will meet or exceed (be better than) the benchmarks for core area; 15 of 22 in the CYE will meet or be better than the benchmark for OMRD; and 16 of 22 in the CYE will meet or be better than the benchmark for TMRD that research suggests provide conditions necessary to support the home range use and habitat needs of an average adult female grizzly bear (Table A8, page A-68 *In* USFWS 2011b). The grizzly bear access management benchmarks identified through research specific to these ecosystems are as follows: home ranges were comprised of 1) an average 55 percent core area; 2) an average of 26 percent TMRD greater than 2 miles per square mile; and 3) and average of 33 percent OMRD greater than 1 mile per square mile.

As described in the accompanying biological opinion, the effect of roads upon grizzly bear behavior and habitat use has been well documented in the scientific literature. We anticipate that incidental take of grizzly bears is likely to occur in the form of harassment of adult female grizzly bears in highly roaded areas (through displacement caused by road-related disturbance in areas of high open road densities). We also anticipate harm of adult female bears (through significant habitat modification or degradation caused by high open or total road densities). Both harassment and harm cause actual injury to female grizzly bears by significantly disrupting normal behavioral patterns, including breeding, feeding, or sheltering.

The take we anticipate would be caused by displacement (i.e. significant underuse) of female grizzly bears from key habitat areas in highly roaded areas, which may result in decreased fitness that impairs a female's inherent reproductive potential. In other words, some adult female grizzly bears wary of humans and human-generated disturbance may fail to breed at their potential frequency or they would fail to complete gestation due to decreased fitness. We do not expect all adult female grizzly bears affected by displacement or by alteration of habitat caused by the proposed action to suffer impairment of breeding, feeding and/or sheltering. We do not anticipate incidental take of male and subadult grizzly bears, which are independent and thus more mobile and do not have the physiological or nutritional requirements of pregnant or lactating females.

Currently, the Service is unaware of scientific or commercial information that could be used to quantify the exact level of incidental take of female grizzly bears as a result of such impacts to or degradation of their habitat, disturbance, or displacement. Reduced reproductive success of females as a result of displacement effects could include grizzly bear cub injury or mortality, but it is more likely to occur through failure to breed or complete gestation. The amount of take is difficult to quantify for the following reasons:

1. The amount of take would depend on the number of adult female grizzly bears impacted by high road densities. We lack specific information on the precise number of adult female grizzly bears that use the action area, but due to the amount of habitat meeting acceptable habitat parameters, we reasonably assume very few adult females would be affected.
2. Individual grizzly bears would react differently to the disturbance. Not all adult female bears that are exposed to disturbances from roaded areas would be adversely impacted to the point of take.
3. Individual female grizzly bears that initially may be sensitive to disturbances may over time become accustomed to the routine disturbances generated by routine forest road use. Therefore, determining the precise amount of take, as defined by impaired reproductive potential, is difficult.

Therefore, as detailed in this biological opinion, the Service anticipates some low level of incidental take of female grizzly bears would occur in the form harm or harassment from the displacement effects of road densities.

The amount of take would be also difficult to detect for the following reasons:

1. Grizzly bears are not easily detected or observed in the wild.
2. Reproductive rates of individual female grizzly bears vary naturally due to environmental and physiological causes.
3. A reduction in “normal” reproductive success of an individual female is not easily discernible in the wild.
4. The reasons a grizzly bear fails to breed and/or failure to complete gestation are not discernible in the wild.

In instances where incidental take is difficult to quantify or detect, the Service uses surrogate measures of take. Here, we use the research benchmark levels of OMRD, TMRD, and security core as our surrogate measure of incidental take. These benchmarks were discussed in detail in this biological opinion. Where individual BMU road densities are higher than benchmark levels of OMRD or TMRD, or where core is less, we conservatively anticipate some level of impaired habitat use, resulting in impaired breeding or feeding for some adult female grizzly bears.

Based on the best available research and information, we anticipate that some level of incidental take of female grizzly bears will occur within individual BMUs as long as: 1) OMRD exceeds one mile per square mile in more than 33 percent of a BMU; 2) TMRD exceeds two miles per square mile in more than 26 percent of a BMU, and/or 3) core area makes up less than 55 percent of a BMU. Within those BMUs achieving the research benchmarks, incidental take of grizzly bears is unlikely to occur. Through 2019, IPNF actions will reduce motorized route densities to achieve Revised Plan standards in each BMU. Four of 6 in the CYE and 7 of 8 in the SE of the proposed BMU standards meet research benchmarks. Until these benchmarks are met, we anticipate some level of incidental take of female grizzly bears in these BMUs, and that the likelihood and level of take will diminish over the following years as BMUs attain the benchmark levels for access management.

In 3 of the 14 BMUs on the IPNF in both the CYE and SE, one or more of the Revised Plan’s standards do not meet all three of the research benchmarks. In these BMUs, we anticipate incidental take of female grizzly bears is likely to occur, and that the level and likelihood of take will diminish as open and/or total road densities are lowered, and/or core area increases nearer to benchmark levels. However, the likelihood of incidental take would not be entirely eliminated in these BMUs. We anticipate a low level of take for 1 of the 3 BMUs on the IPNF that have standards near the research benchmark for OMRD and TMRD (Table A8, p.A-68 *In* USFWS 2011a), because this BMU will eventually provide 55 percent core area or more (Table A8, p.A-68 *In* USFWS 2011a), and because of the three reasons listed above related to quantification of take.

Two BMUs on the IPNF (Grouse in the CYE and Lakeshore in the SE) may never be capable of providing the conditions that research has indicated needed to support an average female home range. Therefore, for these BMUs, the proposed action establishes grizzly bear habitat management standards at levels that may not be capable of providing the full suite of home range

needs of the average adult female grizzly bear. Thus, female grizzly bears with home range use in this area may significantly avoid key habitat in these BMUs, and so incidental take in the form of harm may be a persistent long-term condition.

Using this surrogate measure of incidental take, by the end of 2019, all BMUs shall meet the Revised Plan (Access Amendment) standards (shown in blue in [Table II-10](#) above), or the amount of take we anticipated and analyzed here would be exceeded, and reinitiation of consultation would be required.

In the BORZ (areas outside the recovery zones within the action area), we anticipate some level of incidental take of female grizzly bears. We base our opinion on the facts that: 1) linear miles of road are relatively high in these areas; and 2) the IPNF has not specifically managed for grizzly bear habitat relative to road standards outside of the recovery zones. Thus, given these facts, in conjunction with the cited research pertaining to the effects of roads on grizzly bear behavior and habitat use, we anticipate that linear miles of road are likely causing incidental take of grizzly bears and this will continue. This is a conservative conclusion. Since grizzly bears moving into these areas did so under prevailing conditions, it is also possible that incidental take is not occurring for every female. Grizzly bears are known to tolerate a range of conditions; some apparently adjust to high levels of human activity without apparent consequence. Further, because few grizzly bears occupy this area, intraspecific competition is probably not significant. Those grizzly bears using the BORZ likely have options related to home range selection and use. Similar to the incidental take likely occurring within BMUs, we anticipate a low level of incidental take of female grizzly bears in the BORZ in the form of harassment, and /or harm through significant habitat modification or degradation as a result of high road densities and associated disturbance, which causes actual injury to grizzly bears by significantly disrupting normal behavioral patterns, to the extent that a female's normal reproductive potential is impaired.

In the BORZ, we use the surrogate measure of the linear miles of road in each BORZ polygon as of 2010. In the BORZ, permanent increases in linear miles of open road and/or permanent increases in linear miles of total road beyond the standards shown in [Table II-11](#) of this biological opinion will result in levels of take that exceed the amount of incidental take we anticipate here, and reinitiation of consultation would be required.

Through 2019, the IPNF may conduct a one-time entry (i.e., one season of construction activity) of core within a BMU, for the sole purpose of completing needed road decommissioning and stabilization activities on existing closed or barriered roads in core area (i.e., legacy roads that were closed to create core before this issue was identified), that shall occur during one bear season. Such management is in the interest of creating long term secure habitat for bears and in protecting aquatic habitats for bull trout and other species. Roads that are closed in the future will be hydrologically stabilized so as not to need such maintenance. Motorized use of such previously closed roads in core may in some cases result in incidental take of female grizzly bears in the form of harassment (displacement) or harm (significant habitat modification or degradation), which causes actual injury to grizzly bears by significantly disrupting normal behavioral patterns to levels that impair reproduction. Adult female grizzly bears that have

established habitat use patterns within a core area may experience significant displacement from an area if a road(s) were entered for decommissioning. We anticipate a low level of take, as we do not expect take would occur if entries were limited in duration and actions taken were of relatively low impact. Further, not all females impacted by such entries and actions in core would suffer significant displacement.

For reasons stated above, this take is difficult to quantify. Here, we use the following surrogate measures to quantify and measure incidental take of female grizzly bears related to such entries into core: If more than one entry of core occurs prior to the end of 2019 within any block of core, or occurs for more than one bear season, or occurs for reasons other than completing road decommissioning/stabilization activities on existing closed or barriered roads in core area habitat (see Part I.B.2.a *In* USFWS 2011a, p. A-13), the level of incidental take anticipated here would be exceeded and reinitiation of consultation would be required.

Similarly, after all BMUs have reached standards (i.e. 2019), adverse effects on grizzly bears may occur over the short-term through any permanent loss of core area from existing conditions within any individual BMU currently exceeding (being better than) the research benchmarks. Adult female grizzly bears that have established habitat use patterns within a core area may experience significant displacement from an area if a road(s) were built or upgraded, and used. The Revised Plan (with incorporation of the Access Amendment), in and of itself, does not permit permanent reductions in core area; but rather establishes some BMU core standards at levels less than the existing condition. The IPNF commits to no permanent reductions in core area in such BMUs until all the BMUs within their jurisdiction in the respective recovery zones are up to standard. Once all BMUs achieve standards, grizzly bear habitat across multiple BMUs, as well as within, will be more conducive to supporting female home ranges across the landscape. Adult females impacted by new roads in core would likely have options within their home range to find alternate suitable habitat over time, and adjust habitat use patterns accordingly. These projects would occur in the future, where the environmental baseline, status of the species, and cumulative effects may be substantially different than now. Further, each project would have specific design elements related to scale and timing. Thus, we lack information needed to enumerate the amount of take associated with these actions. As explained earlier, these projects would undergo independent section 7 consultation (as appropriate) and will be analyzed given the prevailing conditions and information at the time, including grizzly bear population and habitat indices. *Thus, any incidental take that may result from future permanent reductions of core area to standards is not exempted here.*

Over-snow Motorized Use – In the CYE and SE, incidental take in the form of harm may occur where late season snowmobiling overlaps with grizzly bear post-denning habitat. The incidental take is expected to be in the form of harassment to individual female grizzly bears and/or cubs caused by premature den emergence or premature displacement from the den site area, resulting in reduced fitness of females and cubs. We expect the amount and extent of take would be very low. Late season snowmobile use would affect very few individual females with cubs over the life of the plan, as adult females with cubs occur at very low numbers compared to the amount of denning habitat available. As spring season ends, the amount of snowmobile use decreases. Finally, an individual female would not likely be affected for more than one denning season.

Grizzly bears typically do not reuse den sites. Thus, if a female grizzly bear suffers significant disturbance at or near her den site, it is probable that she would locate a new site to den in the future and would have options for denning elsewhere.

In the CYE, female grizzly bears with cubs emerge around the third week of April. By May 31, we conservatively anticipate conditions would no longer be conducive to snowmobile use. Therefore, in the CYE, we conservatively anticipate some level of incidental take on 14,250 acres between April 15 and May 31 where snowmobile use currently occurs in denning habitat.

In the SE we expect female grizzly bears with cubs to also emerge around the third week of April. By May 31, we conservatively anticipate conditions would no longer be conducive to snowmobile use. In the SE, we conservatively anticipate some level of incidental take on 7,440 acres of denning habitat between April 15 and May 31 where snowmobile use currently occurs in denning habitat.

Thus in this case, we use the acres of denning habitat that overlap with areas currently receiving snowmobile use as our surrogate measure of incidental take. The surrogate measure of take is the amount of potential denning habitat currently used by snowmobiling. In the CYE recovery zone: 14,250 acres; in the SE: 7,440 acres. If the IPNF detects chronic late season use on more than this amount of denning habitat in either recovery zone, then the amount of take we anticipated in this biological opinion would be exceeded.

2. Effects of Take

Effects of Take in the CYE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the grizzly bear. The best information indicates the overall status of the Cabinet-Yaak grizzly bear population is probably decreasing, by about -0.8 percent per year. However population trend has improved; since 2006 the numbers of bears have increased and population is now nearing stability. The rate of increase in the population has also improved. As detailed in this biological opinion, the proposed action may cause localized and short- or long-term adverse effects, but would result in overall ecosystem-wide improvements.

Notably, the Forest Plan incorporates the 2011 Access Amendment, which would reduce the amount of incidental take related to high motorized route densities. Motorized access densities in BMUs would be reduced, and core area would increase, to standards in the plan, reducing the amount of take related to motorized access management. Most BMU standards require access levels that research indicates would support an average female home range and reproduction. Core area across the recovery zone would increase to 58.5 percent. The Revised Plan would preclude permanent increases in either open or total linear miles of permanent road in the BORZ areas outside of the recovery zones, which would not increase the existing amount of take related to motorized access in these areas. Grizzly bear use of BORZ has been documented.

As also detailed in this biological opinion, the Revised Plan includes a suite of Desired Conditions (FW-DC-WL-02 through 05 and MA1a,b,c,e-DC-WL-01, MA3-DC-WL-01, MA5-

DC-WL-01, GA-DC-WL-LK-02, and GA-DC-WL-PO-01,) that describe a forest trend toward large, remote areas with low levels of human disturbance and thereby complement the requirements of the Access Amendment.

Revised Plan direction reduces the incidental take of grizzly bears related to motorized access to a low amount in the recovery zone, and limits the amount in the BORZ. Thus, this amount of incidental take is unlikely to result in substantial negative impacts on the CYE population. The net effect of the access management direction supports survival and recovery of the population by supporting the numbers, distribution and reproduction of grizzly bears, including females, across the ecosystem.

The biological opinion determined that some low amount (low number, and short-term impact) of incidental take is anticipated where late season snowmobiling currently overlaps with denning habitat. We determined that the anticipated amount of incidental take is limited to the disturbance of a low number of females with cubs, during a short period of snowmobile use in a small portion of available denning habitat. This level of take is unlikely to result in substantial negative impacts on the CYE population. The net effect of Plan direction would not increase the level of this take, and may decrease it in the future. Thus, the take would not substantially negatively impact the survival and recovery of the population reducing the numbers, distribution and reproduction of grizzly bears across the ecosystem.

Finally, the opinion determined that a low amount of incidental take associated with helicopter harvest, large opening sizes, mining proposals, or special use authorizations could occur. This take would be infrequent and affect few individuals. Forest Plan direction would be unlikely to increase the level of this take, and elements of the Plan would avoid, reduce, or minimize the impact of any take. Thus, the take would not substantially negatively impact the survival and recovery of the population reducing the numbers, distribution and reproduction of grizzly bears, including females, across the ecosystem.

Effects of Take in the SE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the grizzly bear. The best information indicates the Selkirk grizzly bear population estimate 83 grizzly bears, with 25-30 in the U.S. (W. Wakkinen 07/02/2013 pers. comm.), which is based on expert opinion. As previously discussed, it was estimated in 2004 that the population of grizzly bears in the SE was slowly increasing at a rate of 1.9 percent annually (Wakkinen and Kasworm 2004, p.72). Recently, Wakkinen indicated that there is no evidence that would suggest any major changes from the 2004 population growth rate; however, this will be updated in upcoming years (W. Wakkinen 07/02/2013 pers. comm.).

Notably, the Forest Plan incorporates the 2011 Access Amendment, which would reduce the amount of incidental take related to high motorized route densities. Motorized access densities in BMUs would be reduced, and core area would increase, to standards in the plan, reducing the amount of take related to motorized access management. Most BMU standards require access levels that research indicates would support an average female home range and reproduction. Core area across the IPNF portion of the recovery zone would increase to 61.4 percent. The

Revised Plan would preclude permanent increases in either open or total linear miles of permanent road in the BORZ areas outside of the recovery zones, which would not increase the existing amount of take related to motorized access in these areas. Grizzly bear use of BORZ has been documented.

As also detailed in this biological opinion, the Revised Plan includes a suite of Desired Conditions (FW-DC-WL-02 through 05 and MA1a,b,c,e-DC-WL-01, MA3-DC-WL-01, MA5-DC-WL-01, GA-DC-WL-LK-01 and 02, GA-DC-WL-PR-01 and 03,) that describe a forest trend toward large, remote areas with low levels of human disturbance and thereby complement the requirements of the Access Amendment.

Revised Plan direction reduces the incidental take of grizzly bears related to motorized access to a low amount in the recovery zone, and limits the amount in the BORZ. Thus, this amount of incidental take is unlikely to result in substantial negative impacts on the SE population. The net effect of the access management direction supports survival and recovery of the population by supporting the numbers, distribution and reproduction of grizzly bears, including females, across the ecosystem.

The biological opinion determined that some low amount (low number, and short-term impact) of incidental take is anticipated where late season snowmobiling currently overlaps with denning habitat. We determined that the anticipated amount of incidental take is limited to the disturbance of a low number of females with cubs, during a short period of snowmobile use in a small portion of available denning habitat. This level of take is unlikely to result in substantial negative impacts on the SE population. The net effect of Plan direction would not increase the level of this take, and may decrease it in the future. Thus, the take would not substantially negatively impact the survival and recovery of the population reducing the numbers, distribution and reproduction of grizzly bears across the ecosystem.

Finally, the opinion determined that a low amount of incidental take associated with helicopter harvest, large opening sizes, mining proposals, or special use authorizations could occur. This take would be infrequent and affect few individuals. Forest Plan direction would be unlikely to increase the level of this take, and elements of the Plan would avoid, reduce, or minimize the impact of any take. Thus, the take would not substantially negatively impact the survival and recovery of the population reducing the numbers, distribution and reproduction of grizzly bears, including females, across the ecosystem.

3. Reasonable and Prudent Measures

Biological opinions typically provide reasonable and prudent measures that are expected to reduce the amount of incidental take. Reasonable and prudent measures are those measures necessary and appropriate to minimize incidental take resulting from a proposed action. Reasonable and prudent measures are nondiscretionary and must be implemented by the agency in order for the exemption in section 7(o)(2) to apply.

The Service concludes that the Forest has incorporated all practical measures possible into the proposed action to minimize the impacts of take on grizzly bears. For that reason, the Service has not identified any Reasonable and Prudent Measures necessary to further minimize the

impacts of such take on the grizzly bears. However, the Service has identified mandatory reporting and monitoring requirements below as Terms and Conditions that must be complied with in order for the take exemption in this Incidental Take Statement to be valid.

It is critical to understand that the conclusion of this opinion is based on those features being implemented as part of the proposed action; if they are not implemented, our analysis may not remain valid and this opinion may be subject to reinitiation (50 CFR 402.16(3)).

4. Terms and Conditions and Reporting Requirements

The Forest shall conduct monitoring and reporting of incidental take as follows:

- 1) By April 15 each year, the IPNF shall submit an annual report to the Service that details the progress made toward achieving and maintaining the standards for percent Core Area, OMRD, and TMRD within the Recovery Zones.
- 2) The annual report shall provide an ongoing list detailing the locations, dates, duration, and circumstances for invoking the Access Amendment allowance for entering core area for the purposes of road decommissioning or stabilizations.
- 3) The IPNFs shall coordinate with State and Federal agency biologists to collect credible grizzly bear observations that occur outside of the Recovery Zone boundaries and add this information to the 6th-order HUC database for inclusion into the annual report.
- 4) During the first year of implementation of the Revised Forest Plan, the Forest and the Service shall cooperatively develop a plan to monitor the scope and magnitude of late-season snowmobiling (post April 15) as it relates to effects on post-den emergent grizzly bears (see Incidental Take Statement). Within five years of implementation of the Revised Forest Plan, the Forests shall complete a winter travel plan, which will include considerations for grizzly bear and other federally listed species.
- 5) The Forest shall notify the Service's North Idaho Field Office or Grizzly Bear Recovery Coordinator within 24 hours of any bear-human conflicts that occur on the Forest, regardless of cause or season.

H. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service provides the following conservation recommendations for the grizzly bear:

1. Continue to install grizzly bear information signs at major access points advising the public of grizzly bear presence, proper sanitation/food storage techniques, and providing information on distinguishing characteristics between grizzly bears and black bears.
2. The Forest develops, in coordination with the Service and the IGBC, a strategy addressing point source disturbances (e.g., helicopter logging, mining, etc.).

3. The Forest works cooperatively with the Service to identify linkage areas that may be important in providing landscape connectivity within and between geographic areas, across all land ownerships for grizzly bears and Canada lynx.
4. Within linkage areas, the Forest provides for landscape connectivity by participating in the development and implementation of a management plan to protect and restore habitat connectivity within these areas on federal lands.
5. The Forest plans recreational development, and manages recreational and operational uses to provide for grizzly bear, Canada lynx, and mountain caribou movement, and to maintain effectiveness of grizzly bear, Canada lynx, and mountain caribou habitat.
6. The Forest identifies and prioritizes roads for reclamation or seasonal restrictions within watersheds with relatively high road densities so as to improve habitat quality and/or security for grizzly bears, Canada lynx, mountain caribou, and bull trout, as well as other listed and non-listed fish and wildlife species.

I. REINITIATION NOTICE

This concludes formal consultation on the KNF Revised Plan and its effects on grizzly bears and grizzly bear habitat. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been maintained (or is authorized by law) if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species in a manner or to an extent not considered in this opinion; (3) the proposed action is subsequently modified in a manner that causes an effect to the listed species that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

Thus, reinitiation is required if, at any time during the course of the action, the level of take occurring exceeds that anticipated in this incidental take statement:

- The BMUs on the IPNF in the SE recovery zone exceed the standards contained in Table II-10 of this biological opinion.
- The BMUs on the IPNF in the CYE recovery zone exceeds the standards contained in Table II-10 of this biological opinion.
- The BORZ exceed the permanent linear miles of open road and/or permanent linear miles of total road depicted in Table II-11 of this biological opinion.
- 14,250 acres of potential denning habitat that overlap with areas currently receiving snowmobile use on IPNF lands in the CYE recovery zone.
- 7,440 acres of potential denning habitat that overlap with areas currently receiving snowmobile use in the SE recovery zone.

Such incidental take requires reinitiation of consultation and review of the incidental take statement. In instances where the amount or extent of incidental take is exceeded any operations causing such must cease pending reinitiation.

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