



Swan View Coalition

"People Helping People Help the Earth"

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August 24, 2006

Proposed Flathead Forest Plan
Bitterroot National Forest
1801 North First Street
Hamilton, MT 59840

Dear Revision Team and others;

Please accept these comments on the Draft Revised Flathead Forest Plan (USFS 2006), hereafter DRP, into the public record. We incorporate by reference all of our earlier conversations, letters, emails, and their enclosures in this regard. They include but are not necessarily limited to our communications by 4/21/04 letter, 5/27/04 letter, 6/8/04 email, 6/11/04 letter, 3/8/05 email, 8/17/05 letter, 9/6/05 letter and email, and 2/28/06 email, as well as their enclosures. We also incorporate by reference the comments of Friends of the Wild Swan in this regard and their enclosures.

Exhibits to this letter are provided on a CD to conserve paper and provide ease of duplication and sharing. The exhibits include, among other things, many photos to illustrate the points made in our comments. The CD exhibits are identified by the letter/number combination appearing at the beginning of the file name and, for those dated, the date appears in yymmdd format just prior to the file type suffix.

We ask that this letter be read concurrently with viewing of the CD contents. This letter is also included on the CD as Word file 1A-SVC_Comments.doc.

Due to the lack of information provided to substantiate the DRP, as described below, we include in this letter a list of questions designated by the letter "Q" followed by a hyphen and the question number. We ask for a written response to each of these questions.

Lack of Adequate Documentation and Scientific Integrity

The DRP contains no bibliography, nor does it provide adequate citations to scientific literature. Nor do the various Reference Guides and other documents referenced in the DRP provide adequate citations to scientific literature.

The DRP does not provide citations to the Analysis of the Management Situation (USFS 2004a) as a basis for its proposals. Nor does it provide any other explanation of the basis for its proposals.

As a result, the reader is left wondering why the DRP would propose to log a certain amount or acreage of timber or decommission a certain mileage of roads - as compared to any other amount one could pull out of a hat. We are unable to answer these questions by searching the various Reference Guides and other information on the Forest Service web sites. This renders the public comment process essentially meaningless because the public is not able to determine why the Forest Service has proposed what it has proposed in the DRP, nor able to determine the proposal's environmental impacts or whether it is based on the best available science.

The DRP and its supporting documents fail to describe a rational connection between the facts found and the conclusions made, in violation of the Administrative Procedures Act (APA). The DRP fails to evaluate and disclose how the best available science was taken into account, substantial uncertainties in that science, risks associated with plan components based on that science, and whether that science was appropriately interpreted and applied. This violates 36 CFR 219.11, the National Forest Management Act (NFMA), the National Environmental Policy Act (NEPA), and the Endangered Species Act (ESA).

Information Lacking or Late in the Process

We have not been able to obtain requested Revision information in a timely manner. For example, we first asked for a copy of Recreation Opportunity Spectrum (ROS) maps on 6/28/05 following a Forest Service open house in Kalispell that displayed these maps. In spite of repeated requests over the intervening months, we still have received no such maps. Meanwhile, the DRP at 81 states ROS will continue to be used.

Similarly, we first requested a copy of the wilderness recommendation criteria on 9/6/05, following a Forest Service field tour. In spite of repeated requests, we did not receive the criteria until 6/28/06, well over half way through the public comment period for the DRP.

Lack of Non-Discretionary Management Standards

The DRP contains no non-discretionary "will" or "must" management standards, only a lot of "should" and "consider." Hence, the Forest Service is not bound to accomplish anything in the DRP nor bound to ensure future projects comply with DRP standards - since there are none. Moreover, the DRP guidelines can be adjusted to suit particular projects without even amending the Plan (DRP at 4 and 125).

The NFMA, at 16 USC 1604(i), requires that all projects "shall be consistent with the land management plans." Management standards are the essential conduit and measure for determining whether projects are or are not consistent with the Plan. Without management standards, the DRP is an amorphous and meaningless document with which anything and everything can be argued to be consistent. This was not the intent of Congress and violates the NFMA.

The Flathead has the option of incorporating into its DRP already existing management standards (DRP at 7). It fails to either do this or develop new standards. Indeed, the DRP lists no management standards, nor have they been incorporated into the Environmental Management System (EMS) required by the new NFMA planning regulations.

Marc Fink, attorney for Forest Service Employees for Environmental Ethics, provides in his July 11, 2006 comments on the DRP convincing legal arguments for why the Revised Plan should contain mandatory management standards, why an EIS must be prepared for the DRP, and why the Forest Service and Fish and Wildlife Service must formally consult on the effects of the Revised Plan on listed species. We incorporate by reference (and include as CD Exhibits A1-A2) the July 11, 2006 FSEEE letter and its Exhibit A.

Suitability for Motorized Vehicles

The DRP, its maps and its supporting documents reveal that determinations regarding the suitability of areas and trails to motorized vehicles is arbitrary and capricious. The Forest Service is simply designating areas and trails for motorized use according to its own whims and wishes, not basing those designations on the suitability of the land to withstand such use and its ability to simultaneously provide adequate wildlife security, water quality, fisheries, and quality quiet recreation.

The DRP, at 104, correctly acknowledges that "backcountry areas [MA 2.2] are not suitable for motorized travel except in emergency situations." Then it promptly launches down the slippery slope of providing a laundry list of backcountry areas and trails where snowmobiles and ATVs will be allowed, shifts from "not suitable" to "generally not suitable," and broadly asserts that backcountry areas "are suitable for helicopter access."

The current Forest Plan, including Amendment 19, finds unsuitable many areas found suitable in the DRP. In the northern Swan Range, for instance, the West Side Reservoir Post-Fire Project FEIS (USFS 2004b) shows that compliance with Amendment 19 per its Alternative C would close to motorized use Alpine #7 and most of its feeder trails.

Indeed, Alternative C is the only West Side Alternative that would receive rankings of "good" and "adequate" connectivity between grizzly bear security core areas, while the chosen alternative ranks "no good" and "not very good." (USFS 2004b, at 3-304 to 3-312). Consequently, the Record of Decision for the West Side Project identified Alternative C as the "environmentally preferred alternative" because it provides a higher level of habitat security for grizzly bears and would have the most long-term benefits to water quality and fisheries because "fewer culverts would remain on the landscape" due to more road reclamation than other alternatives. (USFS 2005, at 32).

The trails and roads left open to motorized use in the DRP and the West Side Project are primarily responsible for fragmenting core security areas/core connectivity. They are left open only by relaxing Amendment 19 grizzly bear security standards and ignoring the Forest Plan requirement that decisions in Management Situation (MS) 1 grizzly bear

habitat must favor the bear. (See our 8/17/05 letter for a more complete discussion of this situation).

After relaxing these standards via project-specific Forest Plan amendments to allow excessive levels of wheel-driven motor vehicles, the pending Amendment 24 (USFS 2003) will further reduce grizzly bear security by allowing snowmobiles to operate in the northern Swan Crest through May 31. This even though Amendment 19 requires that such use cease March 15, when grizzly bears and their cubs emerge from their dens and cannot yet flee such disturbance.

The DRP would allow this late-season snowmobiling even though Fish and Wildlife Service has found it constitutes a "taking" of grizzly bear. FWS found that the portion of the Lost Johnny Bear Management Subunit providing Security Core Habitat would be only 23% - far below the 68% minimum required by Amendment 19 (USFWS 2006, at 35 and 43). Beating FWS into submission during years-long consultations hardly constitutes an objective assessment of motorized suitability on the part of either the Forest Service or FWS.

Nor does allegedly avoiding jeopardy to the NCDE grizzly bear population fulfill the ESA's requirement that the species be recovered. Nowhere does the Forest Service present a plan or explanation of how it intends to recover the NCDE population while, among other things, the northern Swan Mountains population declines at over 2% per year, a rate that will halve the population in 30 years (Mace and Waller 1997, at page 112 errata).

The draft Evaluation of Potential Wilderness Areas criteria provided by the Flathead lies to suggest the northern Swan is suitable for such late-season snowmobiling. It states the "2002 [Snowmobile] Settlement Agreement and subsequent Winter Recreation Amendment 24 retained winter motorized use throughout most of this IRA including a late season snowmobile area from Wounded Buck Creek north to the Beta area." On the contrary, FWS's 3/3/06 Biological Opinion on Amendment 24 states, at 42:

"In terms of post den-emergence effects, this population has been exposed to extended snowmobile seasons (after grizzly bear den emergence in mid-March through April) despite the reported requirements . . . of the Forest Plan and the Settlement Agreement for an end date to snowmobiling of March 15 for areas on the Forest within the NCDE recovery zone."

Q-1: The Amendment 24 FEIS and the DRP claim the settlement agreed to the extended snowmobile season, while FWS claims the settlement agreed to a March 15 closure date. Which, if either, is the case?

Regardless, the Settlement Agreement does not provide the assessment of suitability required by law and regulation. Moreover, Amendment 19 does not allow helicopter use of Security Core grizzly bear habitat by any motorized vehicles, including helicopters, during the non-denning season. (USFWS 2005, at 85).

Q-2: What is the basis for the DRP's blanket claim that backcountry areas "are suitable for helicopter access?"

No one can argue with a straight face that the levels of motorized use retained and proposed in the West Side Project, Amendment 24 and DRP is suitable or sustainable in terms of its impacts to grizzly bear and other wildlife. Indeed, the Forest Service fails on DRP page 47 to even list the northern Swan Crest as "key grizzly bear habitat," as it does do for other areas currently designated MS-1. Make no mistake the Flathead is attempting to renege on its prior agreement to re-designate the northern Swan from MS-2 to MS-1 in order to at that time obtain a favorable Biological Opinion from FWS on its initial Forest Plan. Twenty years later, the DRP sets out to instead favor motorized vehicles over the needs of grizzly bears in an area where Mace and Waller (1997) found a population of grizzly bears already dying at a rate that would halve the population in 30 years.

The DRP fails to recognize and address the role that motorized access plays in causing the deaths of grizzly bears due to malicious killing and mistaken killing during the spring black bear hunt. In 2005 a near-record 25 grizzly bears died as a result of encounters with humans, with nearly half of them killed by poachers and vandals. Of note concerning the Swan Range: a grizzly bear was found shot to death "near a Forest Service road in the Clayton Creek drainage" on May 17, 2005, apparently in the same area a grizzly bear was mistakenly shot for a black bear during the spring black bear hunt in 2004. (Lee 2006 and USFS 2004b, at 3-300).

Q-3: Why is the northern Swan Range not described as "key grizzly bear habitat?"

Q-4: Why does the DRP make no mention of Management Situation 1 and other MS designations?

Q-5: What does the Forest Service and DRP intend to require in terms of restricting motorized vehicles in order to provide adequate wildlife security, including adequate grizzly bear security from black bear hunters?

Inappropriate Motorized Use in Unsuitable Areas

Wheeler/Quintonkin/Peterson

We've attached as CD Exhibits B1-B11 photos of motorcycle damage to historic Alpine Trail #7 and Echo Broken Leg Trail #544 in the Wheeler Creek drainage of the northern Swan Crest. This damage to high alpine trails traversing both wet meadows and dry slopes is chronic and evident every time we visit the area, even though Alpine #7 and Echo Broken Leg Trail #544 in this area are closed to motorized use. Alpine Trail #7 and Echo Broken Leg Trail #544 clearly are not suitable for motor vehicle use. Once on Alpine Trail #7, motorcycles are continuing illegally up and along the ridge of Broken Leg Mountain on Echo Broken Leg Trail #544 (tracks witnessed by Keith Hammer on August 5 and 12, 2006 and other dates).

Indeed, damage is not limited to trails in alpine wet meadows. Even on relatively firm and dry trail, motorcycles tend to wear the trail into a narrow trough that is difficult if not impossible to walk. Subsequent erosion by channeled water compounds the

problem. This forces hikers, horses and even other motorcycles to travel parallel to the main trail and cause unsightly braiding of the trail. Herein lies a basic incompatibility between motorcycles and foot travel that is permanent and not resolved by even the best of manners and user relations: it is often difficult if not impossible to hike on/in a trail used by motorcycles. (See for example CD Exhibits B1-B11, with B3 including a human foot for scale and comparison).

Not only is motorized use of Peterson Creek Trail #293 and Quintonkin Trail #72 facilitating illegal motorcycle use of Alpine #7 in the Quintonkin/Wheeler area, it is damaging the "legal" trails themselves. We've attached as CD Exhibits C1-C4 photos of motorcycle damage to Peterson Creek Trail #293 where they are detouring around water bars and tree roots and scouring/trenching switchbacks. While we do not have photos available, similar damage and motorcycle ruts short-cutting switchbacks is also evident on the higher ridge-top reaches of Echo Broken Leg Trail #544.

Doris/Lost Johnny/Wounded Buck/Peters Ridge

We do have photos of motorcycle damage to trails and meadows along the Swan Crest north of Jewel Basin. A sampling of these are attached as CD Exhibits D1-D5.

We have more photos of the damage done to this area by motorcycles running off-trail and snowmobiles running on inadequate snow pack, conditions that can be expected to occur during the late-season snowmobile season proposed by Amendment 24 (USFS 2003). These photos are included as "slides" in our PowerPoint presentation "Flathead National Forest Off-Road Vehicle Pop Quiz," which is attached as CD Exhibit E1.

Jewel Basin Access/Switchback Trail

We also have photos of motorcycle damage to Switchback Trail #725, which leads to Alpine Trail #7 and Jewel Basin from the Jewel Basin Road. A sampling of these are attached as CD Exhibits F1-F5. These photos include damage as 4-wheelers start a second, parallel track (F1), short-cutting of switchbacks (F2), short-cutting from one switchback to the next (F3), rutting of switchbacks (F4), and straying from the trail immediately following switchbacks (F5).

Columbia Mountain

We also have photos of such damage to Columbia Mountain Trail #51 and have attached a sampling of them as CD Exhibits G1-G3. Peterson Creek Trail #293 and Columbia Mountain Trail #51 were both recently reconstructed, apparently in part to accommodate motorcycle use. The photos of motorcycle damage to these trails indicate the terrain and soils these trails traverse is not suitable for motorized use. Otherwise, such significant damage would not occur on a regular basis.

Sixmile/Thunderbolt/Bruce Ridge

We've attached as CD Exhibit H1 a photo of the rugged topography of Bruce Ridge taken from Alpine Trail #7 on Thunderbolt Mountain, near its junction with the Bruce Ridge Trail. CD Exhibit H2 is a photo of the rugged area traversed by Alpine Trail #7

from Sixmile Trail #10 to Hall Lake Trail #61. The DRP proposes a motorized shortcut from Swan Lake to Spotted Bear by keeping open to motorcycles the Sixmile, Alpine #7, Bruce Ridge, and Bruce Creek trails - all wholly unsuited to motorcycle use and in rugged country unsuited to motorized use, as illustrated by CD Exhibits H1 and H2.

Fortunately, motorcycle use appears to be light along this stretch of the Swan Crest, the entirety of which was hiked by Swan View Coalition members during the public comment period for the DRP. Indeed, impacts to Alpine Trail #7 in some areas like Thunderbolt Mountain are light enough that glacier lilies and other vegetation grows in the trail tread (see CD Exhibit H3).

The DRP should nip motorcycle use of the Swan Crest in the bud, rather than promote it by leaving and mapping trails as open to motorized use. The DRP foolishly proposes the same fate and damage for trails in the Sixmile/Bruce/Inspiration stretch of the Swan Crest that has already been realized along the Crest north of Jewel Basin (compare CD Exhibit H3 to CD Exhibits B1-B11 and G1-G3, for example).

The trans-Swan Crest motorcycle trails in the DRP are a slap in the face to the quiet and sensitive high alpine meadows and forests of the Swan Crest and to those seeking quiet hiking and backpacking opportunities there. The Forest Service had the wisdom to protect the high alpine country of Jewel Basin from the ravages of motorized vehicles and should now have the wisdom to extend that protection to the entire Swan Crest. The Forest Service should not bend to the whims of elite motorcyclists wanting to brag that they motored from Swan Lake to Spotted Bear for dinner at one of the guest ranches there, nor should those hikers making the effort to visit this backcountry under their own power be subjected to such out of character uses of the Swan Crest. Nor should they be forced to hike in trails consisting of motorcycle troughs too narrow for the human feet God and nature gifted us (see for example CD Exhibit B3).

Trail Suitability Summary

Had the Flathead faithfully implemented its Forest Plan management standards in the northern Swan Crest, especially Amendment 19 standards, motorized use would largely be banned from the area in order to provide adequate grizzly bear security in essential MS-1 habitat. Instead, the Flathead abandoned its promises, its initial Forest Plan, common sense, and the law to now claim these areas are suitable for motorized use - and it proposes to perpetuate this myth in the DRP. This is akin to firstly printing counterfeit money, then promoting its continued circulation when the counterfeit is discovered.

We once again ask that all trails on the Flathead be closed to motorized use, that motor vehicles be allowed only on roads open to motor vehicles, and that helicopters be allowed in backcountry areas only in cases of emergency. We also ask that the Alpine #7 "gap" be bridged by trail between Sixmile Mountain and Broken Leg Mountain by closing to motorized use the Posey Creek Road and upper portion of the Quintonkin Creek Road, then reclaiming them by re-contouring and re-vegetating the road prism to retain only a foot and pack trail. Given the world class popularity of historic Alpine #7, this is a reclamation project for which funds could be raised in the private sector to

supplement federal appropriations. It is also a reclamation project that would showcase the positive benefits of road reclamation in a popular area.

Wilderness Recommendations

The draft Evaluation of Potential Wilderness Areas criteria is inadequate and applied in an inconsistent, arbitrary and capricious manner. For example, the Evaluation claims that Jewel Basin receives too much recreation use to be managed as wilderness, then turns around and also denies wilderness recommendation to the Swan Crest south of Jewel Basin, where trail use is of low enough impact to allow glacier lilies to grow in the trail tread (see CD Exhibit H3).

Many wilderness areas have high levels of recreation use and the impacts of such use can be limited by such methods as the Limits of Acceptable Change. Moreover, some trails in Jewel Basin receive low enough use to retain vegetation in the trail tread, such as Alpine Trail #7 in the Jewel Basin portion of the Wheeler Creek drainage, where motorcycles have been banned long enough for the trails to recover.

The Forest Service should be looking at how to reduce the impacts of recreation, such as by prohibiting motor vehicles and pulling high-elevation trailheads further down the road and mountain. It should not be encouraging greater impacts by refusing to manage areas as proposed wilderness and by encouraging motorcycle and snowmobile uses.

Twenty-five years ago, the Forest Service opposed designation of the Rattlesnake Wilderness on the outskirts of Missoula. Today, Missoula District Ranger Maggie Pittman claims "Having the Rattlesnake National Recreation and Wilderness right in our backyard makes Missoula a very special place." (Backus 2005). The Forest Service is making a big mistake by not recognizing the need for a backyard wilderness in the rapidly growing Flathead - and not recognizing it has preempted any mountain bike controversy in Jewel Basin by having had the foresight to close the Jewel to bikes years ago. The Forest Service has preserved the wilderness values of Jewel Basin and recommended it for wilderness in its initial Forest Plan. We urge the Forest Service to have similar foresight and recommend wilderness for all roadless lands in the Swan Range and the rest of the Flathead National Forest, as proposed in our previously submitted Citizen reVision and the Rockies Prosperity Act, which currently has 188 cosponsors in Congress.

Road Management, Closure, and Reclamation

The DRP is vague and inadequate in describing its road management, closure and reclamation program. On page 89, the DRP simply states the Flathead may decommission "100 to 500 miles of road within ten years."

Q-6: Why this mileage and not some other? Does this mileage include the 385 miles of road decommissioning already having NEPA decisions as of 3/29/06 but not yet implemented? Does it include previous decisions, like Paint Emery, that do not have a

specific implementation schedule like Spotted Beetle, Moose, Robert-Wedge, and West Side Reservoir? Does it include previous decisions that do have a specific implementation schedule like Spotted Beetle, Robert-Wedge, and West Side Reservoir?

The Assessment of the Management Situation, at 4-2, finds the Flathead needs over \$6 million annually for its road maintenance and backlog, but receives less than \$1 million. Indeed, the DRP, at 89, finds the Flathead needs more money to maintain even 400 - 800 miles of its 3,500 miles of system roads - and more money to "treat any of the stream crossings that have a high risk of failure." Nowhere, however, does the DRP set forth a realistic road management program, disclose the likelihood of various funding levels, nor disclose the risks associated with funding shortages or the proposed program.

Culvert blowouts and road slumps in the northern Swan Range this early summer provide an example of the Flathead's failure to adequately integrate road decommissioning into its road management program in order to reduce the total miles of road to a level that can indeed be adequately maintained. The Flathead is hence in the process of repairing the Lost Johnny and Beta roads, even though compliance with Amendment 19 in the West Side Reservoir Post-Fire Project would require they be closed year-long. Rather than comply with Amendment 19, the Flathead instead chose in the West Side ROD to leave both these roads open year-long even though they compromise promised grizzly bear security.

Summer rains blew out the Otila Creek culvert on Lost Johnny Road and caused a half dozen slumps to slide onto the Beta Road where attempts have been made in the past to stabilize it. Swan View photographed both of these sites in 2005 because they exhibited such a potential for failure - and again in 2006 after they indeed failed. Attached as CD Exhibit I1 is a Word document with photos and captions showing the blowout of the Lost Johnny Creek culvert on the West Side Road and the Otila Creek culvert on Lost Johnny road - in comparison to no damage to a reclaimed crossing of Lost Johnny Creek on a properly reclaimed road located between the two culvert failures.

The Flathead's current agenda, by default, appears to retain as many roads as possible even though it receives less than one-sixth of the budget needed to maintain them, leaving stream crossings and roads to fail in order to then secure emergency funding to repair them. This is both fiscally irresponsible and environmentally unacceptable. The DRP does nothing to alter this course.

Indeed, the DRP attempts to downplay the problem by stating on page 16 that "Not all roads or road segments are considered threats to bull trout or westslope cutthroat trout habitat." Nowhere does the DRP address the fact that its own Revision data shows that 58% of the Flathead's 79 bull trout sub-watersheds (6th-Code HUCs) are functioning at risk or unacceptable risk to bull trout due to densities and locations of roads (see our Watersheds at Risk report previously submitted and at www.swanrange.org). Instead, the DRP on page 85 arbitrarily and lamely sets non-binding objectives to "Restore five to seven watersheds . . . Improve hydrologic conditions on at least 10 to 20 miles of roads [and] . . . Remove 20 to 40 native fish passage barriers . . . within ten years of Plan implementation."

These objectives appear all the more lame in light of the DRP admission on page 17 that "80 percent of inventoried road culverts are partial barriers to native fish migration." As of the year 2000, the Flathead had 5,555 inventoried culverts and an estimated 74,445 non-inventoried culverts (see our Counting Culverts report previously submitted and at www.swanrange.org). The DRP's non-binding objective to remedy 20 to 40 fish passage barriers out of some 4,444 known barriers (and an untold number of unknown barriers) is laughable.

Moreover, the DRP on page 39 makes the pie in the sky assertion that culverts left in "roads in long-term storage pose minimal risk to water quality and aquatic ecosystems [and] have a minimal risk of failure." On the contrary, Fish and Wildlife Service has determined "Whatever the design life, any crossing structure would have a 100% chance of failure over its installation life if it is not removed after the road is abandoned." (USFWS 2002). And, where these culverts are left in bull trout watersheds "leaving these culverts in on decom[missioned] and bermed roads will negatively impact bull trout and will result in take sometime in the future." (Kubin 2002, also attached as CD Exhibit J1). This is precisely why Amendment 19 requires that all stream-bearing culverts be removed from decommissioned roads, yet the DRP provides no such requirement and instead suggests everything will be just fine with unspecified numbers of culverts left in place.

Q-7: We find neither the requirements of Amendment 19 in the DRP nor any standards to replace them. How precisely will the Revised Plan manage roads and motorized vehicle use and how will that management insure survival and recovery of threatened and endangered species as well as the protection of water quality and all species of plants, fish, and wildlife?

Q-8: What criteria and standards are used to determine which watersheds will be restored first and to determine at what pace restoration must occur in order to recover all damaged watersheds in a timely fashion?

Vegetation Management

Table 3 on page 22 of the DRP indicates the acreage of seedling, sampling and small trees will be increased nearly 40%, while the acreage of medium and large trees will be decreased by a similar amount. This appears to run contrary to recent trends, allegedly based in fire ecology, to retain the more fire-resistant larger trees while reducing the amount of smaller trees, fine fuels, and ladder fuels. Ditto for recent trends in fuels reduction work in the urban/wildland interface. It appears to instead return to the old business of logging old growth and mature forests.

Q-9: How, specifically, are these projections of managed changes in vegetation to be consistent with the principles of fire ecology, fuels reduction work near structures, and the retention of old growth and old growth associated wildlife?

We included with our April 21, 2004 letter a copy of our Ponderosa Post Child report, also available at www.swanview.org. We included our report to provide a scientific and

photographic basis for our contention that low-severity, high frequency fire models were being misapplied to justify the thinning of ponderosa/Douglas fir forests in mixed-severity fire regimes, including opening of their canopy. We have attached as CD Exhibit K1 a paper by Baker et al (2006) which details the scientific foundation for not applying the low-severity model too broadly and to consider application of the mixed-severity model. Baker concludes, in part:

Local tree-density estimates must be used, but thinning today's forests, whether young or old, to dramatically lower tree densities, is not likely to be warranted at the stand level in most Rocky Mountain ponderosa pine-Douglas-fir forests where the variable-severity model applies. . . The most effective restoration strategy for undisturbed mature and old-growth forests is likely a passive approach, in which fire is restored, but natural processes (from fire and other sources of mortality) accomplish gradual restoration of tree density and fuels.

Without, a specific answer to our Question #9, above, and citations to relevant scientific literature, we are unable to determine what exactly the DRP is proposing and whether it is based in science.

While our experience with implementation of the existing Forest Plan indicates a reduction in the 54 MMBF/year timber sale level is likely warranted, the DRP provides no basis on which to conclude the proposed 30 MMBF/year level (DRP at 87) is sustainable. This uncertainty is compounded by the fact the DRP (at 93-96) decreases the acreage "suitable for timber production" from 671,000 acres in the current Forest Plan to 328,000 in the DRP, while simultaneously allowing logging at the whim of the Forest Service on an additional 660,159 acres!

Q-10: What standards and criteria will be used to determine where logging will and won't be allowed?

Q-11: Where are the management area designations that limit or prohibit logging in sensitive areas, like riparian areas?

Habitat Connectivity

The DRP at 65 states the Swan Valley is an important connectivity zone for grizzly bear.

Q-12: What areas of the Forest are important for habitat connectivity for all fish and wildlife species, what criteria are used to make this determination, and what standards will be applied to insure that adequate habitat connectivity is maintained for these species?

Overall Summary

Unfortunately, the DRP follows a fatal strategy consisting of at least two primary components:

1. Carry on with current management direction and/or on-the-ground circumstances, even though it is counterfeit and not consistent with both current Forest Plan standards and past promises to faithfully implement its management standards. (For example, the DRP continues to allow excessive motorized use of the northern Swan Range, even though this use was supposed to be brought into compliance with Amendment 19 standards.)

2. Promise improvements in both management strategy and on-the-ground circumstances, without providing so much as a single management standard or other requirement that would insure these improvements are indeed realized.

The result is a bunch of pie in the sky promises with no basis in common sense or science. Besides the fact this violates both law and regulation, the Forest Service most certainly does not have the credibility to ask the public to simply make the required leap in faith needed to support the DRP.

Thank you for this opportunity to comment on the DRP. We ask, however, that the public be provided an opportunity to comment on a DRP that is accompanied by the required NEPA documents and adequate references to the science upon which it is based.

Sincerely,

/s/ Keith J. Hammer

Keith J. Hammer
Chair

Cc: Flathead Forest Supervisor Cathy Barbouletos
Swan Lake District Ranger Steve Brady
Hungry Horse-Glacier View District Ranger Jimmy DeHerrera
Spotted Bear District Ranger Deb Mucklow
Tally Lake District Ranger Lisa Krueger

List of Exhibits on CD

(1A-SVC_Comments.doc)
A1-FSEEE_Comments.pdf
A2-FSEEE_Ex._A.pdf
B1-Alpine_7_Wheeler_060701.JPG
B2-Alpine_7_Wheeler_060701.JPG
B3-Alpine_7_Wheeler_060805.JPG
B4-Alpine_7_Wheeler_060805.JPG
B5-Alpine_7_Wheeler_060805.JPG
B6-Alpine_7_Wheeler_060805.JPG
B7-Alpine_7_Wheeler_060805.JPG
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B9-Alpine_7_Wheeler_060805.JPG
B10-Broken_Wheeler_060805.JPG
B11-Broken_Wheeler_060805.JPG
C1-Peterson_Switch_060805.JPG
C2-Peterson_Switch_050823.JPG
C3-Peterson_Avoid_050823.JPG
C4-Peterson_Avoid_050823.JPG
D1-Peters_Ridge_050721.JPG
D2-Wounded_Buck.JPG
D3-Lamoose_Cycle_Himark.JPG
D4-Hash_Mtn_990916.JPG
D5-Hash_Mtn_990916.JPG
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F1-Switchback_050809.JPG
F2-Switchback_060624.JPG
F3-Switchback_060624.JPG
F4-Switchback_060624.JPG
F5-Switchback_060624.JPG
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G2-Columbia_Mtn_2005.JPG
G3-Columbia_Mtn_2005.JPG
H1-Bruce_Ridge_060715.JPG
H2-Sixmile_7_Hall_060803.JPG
H3-Thunderbolt_7_060714.JPG
I1-Lost_Johnny_Comparison.doc
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July 11, 2006

Proposed Land Management Plan
Flathead National Forest
1935 Third Avenue East
Kalispell, MT 59901

RE: Proposed Forest Plan for the Flathead National Forest

Dear Revision Team,

Please accept FSEEE's comments on the Proposed Land and Resource Management Plan ("Forest Plan") for the Flathead National Forest. FSEEE's comments are supported by Exhibit A, *attached hereto*, which sets forth the mandatory standards and guidelines under both the existing and proposed Forest Plans for the Flathead National Forest. The proposed Forest Plan eliminates virtually all mandatory standards and protection for wildlife, fish, water quality, and other forest resources.

The Forest Service has violated the National Environmental Policy Act ("NEPA") and the Endangered Species Act ("ESA") in developing the revised LRMP for the Flathead National Forest. Forest Plan revisions are major federal actions with significant environmental impacts, requiring preparation of an environmental impact statement ("EIS") under NEPA. At the very least, the Forest Service was required to prepare an environmental assessment ("EA") in order to properly determine whether an EIS was required. The revised Flathead Forest Plan would also result in adverse impacts to threatened and endangered species, and their critical habitat, requiring formal consultation with the expert agencies under Section 7 of the ESA. FSEEE requests that the Forest Service prepare an EIS and consult with the expert agencies under the ESA prior to finalizing the revised Forest Plan for the Flathead National Forest.

I. The Forest Service Must Prepare an EIS, or at least an EA, on the Revised Forest Plan for the Flathead National Forest

Under NEPA, federal agencies must prepare an EIS for any "major Federal action" that "may" have a significant impact on the environment. 42 U.S.C. § 4332(2)(C). Therefore, unless the federal action will have "no significant impact," an EIS must be prepared. 40 C.F.R. § 1501.4(e). The revision of a Forest Plan is a major federal action with the potential for significant environmental impacts, and the Forest Service must prepare an EIS on the proposed Flathead Forest Plan.

A. Background on NEPA

NEPA “is our basic national charter for protection of the environment.” 40 C.F.R. § 1500.1(a). The Council on Environmental Quality (CEQ) promulgates regulations binding federal agencies implementing NEPA. *Sierra Club v. U.S. Forest Serv.*, 843 F.2d 1190, 1193 (9th Cir. 1988). “The procedures prescribed both in NEPA and the implementing regulations are to be strictly interpreted ‘to the fullest extent possible’ in accord with the policies embodied in the Act.” *Id.* (citing *California v. Block*, 690 F.2d 753, 769 (9th Cir. 1982)).

NEPA imposes procedural requirements “designed to force agencies to take a ‘hard look’ at environmental consequences” of their proposed actions. *Earth Island Inst. v. U.S. Forest Serv.*, 351 F.3d 1291, 1300 (9th Cir. 2003). Through NEPA, Congress mandated that federal agencies must “carefully weigh environmental considerations and consider potential alternatives to [proposed actions] before . . . [launching] any major federal action.” *Lands Council v. Powell*, 395 F.3d 1019, 1026 (9th Cir. 2005). NEPA’s purpose is to ensure “that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts . . . [and] that the relevant information will be made available to the larger [public] audience that may also play a role in both the decisionmaking process and implementation of that decision.” *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

NEPA requires federal agencies “to assess the environmental consequences of their actions before those actions are undertaken.” *Klamath-Siskiyou Wildlands Center v. Bureau of Land Management*, 387 F.3d 989, 993 (9th Cir. 2004). Therefore, the procedural requirements of NEPA must be fulfilled “before decisions are made and before actions are taken.” 40 C.F.R. §§ 1500.1(b), 1502.5; *Save the Yaak Committee v. Block*, 840 F.2d 714, 718 (9th Cir. 1988).

Under NEPA, federal agencies must prepare an EIS for any “major Federal action” that may “significantly affect” the quality of the human environment. 42 U.S.C. § 4332(C). “An EIS *must* be prepared if ‘substantial questions are raised as to whether a project . . . *may* cause significant degradation of some human environmental factor.’” *Idaho Sporting Congress v. Thomas*, 137 F.3d 1146, 1149 (9th Cir. 1998), *quoting Greenpeace Action v. Franklin*, 14 F.3d 1324, 1332 (9th Cir. 1992) (emphasis in original). “To trigger this requirement a ‘plaintiff need not show that significant effects *will in fact occur*,’ raising ‘substantial questions whether a project may have a significant effect’ is sufficient.” *Id.*

Federal agencies often prepare an EA to determine whether preparation of an EIS is required. 40 C.F.R. §§ 1501.4(b), 1508.9. If the agencies determines on the basis of an EA not to prepare an EIS, it must prepare a “finding of no significant impact,” to present its reasons why the action will not have a significant impact on the environment. 40 C.F.R. §§ 1501.4(e), 1508.13.

Each federal agency is authorized to establish categories of actions that normally do not have significant environmental impacts. 40 C.F.R. § 1508.4. These actions may be “categorically excluded” from the requirement of preparing an EIS. *Id.* However, “any procedures under this section shall provide for extraordinary circumstances in which a normally excluded action may have a significant environmental effect.” *Id.* Such “extraordinary circumstances” for the Forest Service's use of categorical exclusions include: steep slopes or highly erosive soils; threatened and endangered species or their habitat; floodplains, wetlands, or municipal watersheds; National Recreation Areas; inventoried roadless areas; Research Natural Areas; Native American religious or cultural sites; and archaeological sites. FSH 1909.15 §§ 30.3(2)(a)-(g).

If an agency does not prepare an EIS, it must “supply a 'convincing statement of reasons' to explain why a project's impacts are insignificant.” *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998). This statement is “crucial to determining whether the agency took a 'hard look' at the potential environmental impact of a project.” *Id.* Courts defer only to “well informed and well considered” agency decisions to not prepare an EIS. *Save the Yaak Comm. v. Block*, 840 F.2d 714, 717 (9th Cir. 1988).

B. The Revised Forest Plan is a Major Federal Action under NEPA

“Major federal action” is defined by CEQ to include “actions with effects that may be major and which are potentially subject to Federal control and responsibility.” 40 C.F.R. § 1508.18. “Action” under NEPA is further defined to include revised agency plans. 40 C.F.R. § 1508.18(a). “Federal actions” explicitly include the “adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of Federal resources, upon which future agency actions will be based.” 40 C.F.R. § 1508.18(b)(2).

The stated purpose of the revised Flathead Forest Plan is to “provide overall strategic guidance for the sustainable management of the Flathead National Forest by guiding relevant resource management programs, practices, uses, and projects.” Proposed Forest Plan, Introduction, p. 1. The Forest Plan “sets the overall context for informed decision making by evaluating and addressing social, economic, and ecological considerations relevant to management of the forest.” *Id.* Clearly, the effects of the revised Forest Plan may be major as the Plan sets the overall context of decision making across the Flathead National Forest, *id.*, and falls within the identified category of major federal actions. 40 C.F.R. § 1508.18(b)(2). The revised Forest Plan is a “major Federal action” subject to the mandatory procedural requirements of NEPA.

In *Environmental Protection Information Ctr. (“EPIC”) v. United States Forest Service*, the Forest Service argued that a Fire Management Plan did not constitute a “major Federal action.” 2003 U.S. Dist. LEXIS 18241 (D. Cal., 2003). The court rejected this argument despite the Forest Service's assertion that the Fire Management Plan did not commit the Forest Service to take any action, consisted only of discretionary guidelines, and did not satisfy the “point-of-commitment” test at which an EIS would be

required. As with a Forest Plan, the Fire Management Plan set forth a number of policies and objectives to guide actions taken at the site-specific level. The court held that the Plan therefore constituted a “major Federal action” subject to the requirements of NEPA. *Id.* at 38.

The revised Forest Plan for the Flathead National Forest similarly commits the Forest Service to follow a set of policies and objectives and makes a number of management decisions. For example, the revised Plan describes the “desired condition” for wildlife in the Flathead, including such conditions as the continuance of hunting, fishing, and wildlife viewing opportunities, and that “[c]onnectivity areas would allow and encourage movement of desired animals and plants across the Forest and adjacent lands.” Revised Forest Plan, p. 25-26. In addition to broad objectives, the revised Forest Plan describes specific direction for site-specific action. For instance, the Plan directs managers that projects “should not occur within one mile of known active dens or rendezvous sites of wolves between April 15 and June 30.” Revised Forest Plan, p. 126. Another specific direction is that in “occupied grizzly bear habitat where traffic safety is not an issue, a vegetative screen should be maintained when brushing roads.” *Id.* at 128.

Like the Fire Management Plan at issue in *EPIC*, the revised Flathead Forest Plan sets a number of policies and objectives for future management decisions and, despite the Forest Service's argument that the policies and objectives are non-committal and only discretionary guidance, constitutes a major federal action requiring preparation of an EIS or at least an EA under NEPA.

C. The Revised Forest Plan May Result in Significant Impacts on the Environment

Under NEPA, an EIS must be prepared if the federal action may significantly affect the environment. 42 U.S.C. § 4332(C). The Ninth Circuit has established a “relatively low” threshold for considering a potential impact as “significant.” *NRDC v. Duvall*, 777 F. Supp. 1533, 1537 (E.D. Cal. 1991). To determine whether potential environmental impacts may be “significant,” the agency should consider both context and intensity. 40 C.F.R. § 1508.27.

The revised Flathead Forest Plan clearly has the potential to result in significant environmental impacts. It will apply in an extensive set of circumstances—indeed, it will guide all actions taken at the site-specific level—and its impacts will likely be intense given the weakening and elimination of substantive environmental protections. Additionally, the revised Forest Plan contains controversial decisions, may adversely affect threatened and endangered species, will establish a precedent for future actions with significant effects, represents a decision in principle about a future consideration, and threatens to violate a federal law imposed for the protection of the environment (i.e. the ESA). Each of these factors supports the need for an EIS. 40 C.F.R. § 1508.27(b). Indeed, any one of these factors alone may be sufficient to require preparation an EIS. *Ocean Advocates v. U.S. Army Corps of Engineers*, 361 F.3d 1108 (9th Cir. 2004).

When evaluating potential environmental impacts under NEPA, the agency must consider all significant impacts, both direct and indirect, of the proposed action. *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975); 40 C.F.R. § 1502.16; 40 C.F.R. § 1508.8. “Indirect effects” are those that “are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.” 40 C.F.R. § 1508.8(b). The weakening and elimination of substantive environmental standards and guidelines at higher levels of planning is “reasonably foreseeable” to at least indirectly result in environmental harm at the site-specific level. *See Turtle Island Restoration Network v. Dep’t of Commerce*, 438 F.3d 937, 941 (9th Cir. 2006).

In *Citizens for Better Forestry v. U.S. Department of Agriculture*, the Ninth Circuit recognized that the revised 2000 NFMA regulations decreased substantive environmental requirements as compared to the 1982 NFMA regulations. 341 F.3d 961, 972 (9th Cir. 2003). Because the regulations controlled the development of forest plans and site-specific projects, the court held that the regulations posed “an actual, physical effect on the environment in national forests and grasslands.” *Citizens*, 341 F.3d at 973. The Ninth Circuit rejected the Forest Service’s argument that the lowering of environmental safeguards at the national programmatic level may not necessarily result in lower environmental safeguards at the site-specific level. *Id.* at 975. Likewise, the replacement of numerous mandatory standards from the 1985 Forest Plan with discretionary guidelines in the 2006 Forest Plan will, with “reasonable foreseeability,” result in fewer environmental safeguards at the site-specific level, and thereby result in significant on-the-ground impacts on the environment. *See Exhibit A, attached hereto.*

Even if these environmental impacts are uncertain, the Ninth Circuit has held that if substantial questions exist as to whether the proposed action may have a significant environmental impact, then the agency must prepare an EIS. *Greenpeace Action v. Franklin*, 14 F.3d at 1332; *Idaho Sporting Congress v. Thomas*, 137 F.3d at 1149. The elimination of mandatory standards that provided substantive environmental protections at least raises “substantial questions” regarding the environmental effects of the revised Forest Plan, and therefore the Forest Service must prepare an EIS for the revised Plan.

D. The Categorical Exclusion of the Revised Forest Plan from the Preparation of an Environmental Impact Statement or an Environmental Analysis Violates NEPA and is Arbitrary

While certain federal actions may be categorically excluded from NEPA analysis, the revision of a Forest Plan is not one of them. Only federal actions which “do not individually or cumulatively have a significant effect on the human environment” may be excluded. 40 C.F.R. § 1508.4. As discussed above, the revised Flathead Forest Plan will at least indirectly result in significant on-the-ground impacts on the environment, and the Forest Service must prepare an EIS to evaluate and consider these impacts.

Also, if the proposed action may have a significant impact on “extraordinary circumstances” such as federally listed threatened or endangered species, wilderness areas, inventoried roadless areas, etc., reliance on a categorical exclusion is improper.

FSH 1909.15 § 30.3(2). The revised Forest Plan has the potential to significantly affect many of these “extraordinary circumstances” and, therefore, reliance on a categorical exclusion is misplaced and in violation of NEPA.

Furthermore, an agency's decision not to prepare an EIS will be considered unreasonable if the agency fails to supply a “convincing statement of reasons” why potential effects are insignificant. *Save the Yaak Committee v. Block*, 840 F.2d 714, 717 (9th Cir. 1988); *Blue Mts.*, 161 F.3d at 1212. The statement of reasons is “crucial” to determining whether the agency took the requisite “hard look” at the potential environmental impacts of the proposed action. *Save the Yaak Committee v. Block*, 840 F.2d 714, 717 (9th Cir. 1988); *Blue Mts.*, 161 F.3d at 1212. The revised Flathead Forest Plan does not contain such a “convincing statement of reasons.” Rather, the proposed Plan simply asserts that a “plan, plan amendment, or plan revision may be categorically excluded (CE) from documentation in an EIS or EA” under the 2005 Planning Rule. Proposed Forest Plan, Introduction, p. 7.

The revised Forest Plan for the Flathead National Forest constitutes a major federal action that may have significant environmental impacts, and the use of a categorical exclusion is improper, arbitrary, and capricious.

II. The Forest Service Must Consult with the Expert Agencies on the Revised Forest Plan for the Flathead National Forest, Pursuant to the ESA

The Forest Service must consult under the ESA with the expert agencies (the United States Fish and Wildlife Service and/or National Marine Fisheries Service, depending on the species at issue) whenever a proposed action may affect a threatened or endangered species or its critical habitat. *See* 16 U.S.C. § 1536. The Flathead National Forest contains numerous threatened and endangered species, such as grizzly bear, Canada lynx and bald eagle. Because the revised Forest Plan may affect listed species and their habitat, the Forest Service is required to formally consult with the expert agencies on these potential impacts.

A. Background on the ESA

The ESA consultation requirement “imposes a rigorous duty” on the Forest Service to protect listed species through conservation plans and by ensuring its actions will not adversely affect listed species. *Sierra Club v. Marsh*, 816 F.2d 1376, 1385 (9th Cir. 1987). Section 7(a)(1) of the ESA requires the Forest Service to consult with the expert agencies to carry out “programs for the conservation of endangered species and threatened species.” 16 U.S.C. § 1536(a)(1). A Forest Plan is one place where these mandatory programs must be found, due to its programmatic nature and its important role in guiding and restricting subsequent site-specific activities.

The Forest Service must also insure that any proposed action “is not likely to jeopardize the continued existence” of a threatened and endangered species or result in the destruction or adverse modification of its “critical habitat.” 16 U.S.C. § 1536(a)(2).

The Forest Service must engage in formal consultation with the expert agencies if a proposed action may adversely affect a listed species. *Bennett v. Spear*, 520 U.S. 154, 158 (1997); *see* 50 C.F.R. § 402.14. The expert agency then provides the Forest Service with a biological opinion, “explaining how the proposed action will affect the species or its habitat.” *Bennett*, 520 U.S. at 158; *see* 16 U.S.C. § 1536(b). The formal consultation procedure gives the expert agency an opportunity to determine the likely effect of the Forest Service’s proposed action and to “identify reasonable and prudent alternatives that will avoid the action’s unfavorable impacts.” *Turtle Island Restoration Network v. National Marine Fisheries Serv.*, 340 F.3d 969, 974 (9th Cir. 2003).

B. The Revised Forest Plan is an Agency “Action” Pursuant to the ESA.

Agency “action” under the ESA is to be construed broadly. *See Tennessee Valley Authority v. Hill*, 437 U.S. 153 (1978) (holding that Section 7 “admits of no exception”). Accordingly, regulations define “action” as “all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies” 50 C.F.R. § 402.02, and include “actions that will directly or indirectly impact the environment” as agency actions. *Id.* The revised Forest Plan for the Flathead National Forest will at least indirectly impact the environment, and is an action under the ESA.

C. The Revised Forest Plan “May Affect” Threatened and Endangered Species

The Forest Service must consult with the expert agencies if the revised Forest Plan “may affect” a listed species. 50 C.F.R. § 402.14; *Turtle Island*, 340 F.3d at 974 n.9. The “may affect” threshold is extremely low. “Any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement.” *National Wildlife Federation v. FEMA*, 345 F. Supp. 2D 1151, 1174 (W.D. Wash. 2004), (quoting 51 Fed. Reg. 19,926, 19,949 (June 3, 1986) (codified in 50 C.F.R. pt. 402)).

The revised Forest Plan meets the “may effect” standard. By eliminating the mandatory standards and guidelines from the 1985 Flathead Forest Plan, the revised Forest Plan will indirectly affect listed species and critical habitat. Indirect effects that must be considered under the ESA are those effects that are “caused by the proposed action and are later in time, but are still reasonably certain to occur.” 50 C.F.R. § 402.02.

As noted above, the Ninth Circuit recognized in *Citizens for Better Forestry* that the weakening of national-level safeguards would likely lead to fewer protections at the site-specific level. 341 F.3d at 975. Likewise, removing mandatory standards from the Forest Plan will, with reasonable certainty, result in less protection for listed species in site-specific plans and on-the-ground actions taken by the Forest Service. Because of the reasonable certainty that the elimination of protective, mandatory, substantive standards at the Forest Plan level will result in actual, physical environmental impacts, the Forest Service must consult with the expert agencies on the revised Forest Plan pursuant to Section 7 of the ESA.

Furthermore, the Ninth Circuit has already determined that a Forest Plan, as an action with the potential to affect listed species, requires consultation under the ESA. *See Pacific Rivers Council v. Thomas*, 30 F.3d 1050, 1055 (9th Cir. 1994); *Lane County Audubon Society v. Jamison*, 958 F.2d 290, 294 (9th Cir. 1992). In *Pacific Rivers*, the Ninth Circuit rejected the Forest Service's attempt to evade consultation by labeling a Forest Plan as a merely “programmatic” document. 30 F.3d 1050, 1055 (9th Cir. 1994). The court held that the Forest Plan constituted an action under Section 7 of the ESA given the importance of the Forest Plan in establishing resource and land use policies for the Forest that affect threatened and endangered species and their habitat *Id.*

Likewise, the Flathead National Forest's revised Forest Plan establishes resource and land use policies that may affect threatened and endangered species and their habitat. Because of the many resource and land use policies established by the revised Forest Plan, the Forest Service must consult with expert agencies regarding the potential effects of the revised plan on threatened and endangered species.

III. CONCLUSION

To comply with NEPA and the ESA, the Forest Service needs to prepare an EIS, or at the very least an EA, and consult with the expert agencies on the revised Flathead Forest Plan. Congress imposed these procedural requirements in order to lead to better federal agency decisionmaking, and FSEEE requests that these mandatory procedures be followed in order to ensure the protection of threatened and endangered species, their habitat, and the overall environment of the Flathead National Forest.

Sincerely,

/s/ Marc D. Fink

Marc D. Fink, Attorney
Forest Service Employees for
Environmental Ethics

Exhibit A2

Exhibit A: Forest Plan Standards for the Flathead NF – the 1985 Forest Plan and 2006 Proposed Forest Plan Revision

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Maintain and, where feasible, improve fish habitat capacities to achieve cooperative goals with the State Department of Fish, Wildlife, and Parks and to comply with State water quality standards.	Forest-wide	
Control sedimentation from land management activities so that unacceptable fish losses do not occur.	Forest-wide	
Coordinate fish habitat and riparian management activities to provide suitable riparian vegetation to aquatic habitats.	Forest-wide	
Pursue an annual program of direct habitat improvement work.	Forest-wide	
Use sediment model techniques whenever possible in the important bull trout streams to predict changes in stream-bed composition due to proposed development. In the Swan Lake Ranger District, these streams include: Cold Creek, Elk Creek, Goat Creek, Jim Creek, Lion Creek, Lost Creek, North Fork Lost Creek, Piper Creek, and South Fork Lost Creek. In Glacier View Ranger District, these streams include: Big Creek, Coal Creek, Hallowat Creek, Mathias Creek, Red Meadow Creek, Shorty Creek, South Fork Coal Creek, Trail Creek, and Whale Creek. In Hungry Horse Ranger District, these streams include: Bear Creek, Granite Creek, and Morrison Creek.	Forest-wide	
Hold estimated increases in sediment at a level at which spawning and/or rearing habitat remains at 85 to 95 percent of its potential at specific sites.	Forest-wide	
Control livestock grazing in riparian areas to maintain water quality and fisheries habitat.	Forest-wide	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Coordinate management of riparian areas with the management of adjacent areas to ensure the protection of T & E species.	MA-12	
Maintain adequate tree and shrub vegetation to provide bank and instream thermal cover unless project analysis indicates a need to reduce cover to meet fish or wildlife habitat objectives.	MA-12	
Maintain sufficient trees within 30 feet of the streams to provide snag recruitment to create pools and enhance spawning gravels for fish habitat.	MA-12	
Maintain down woody material within the riparian area (not in the stream) to the level indicated in the Forest-wide standards (10-15 tons/acre and in material greater than 6-10 inches diameter).	MA-12	
Maintain minimum streamflow needed to sustain the biological community.	MA-12	
Complete a riparian area analysis before any major project is implement on the ground, either separately or as part of the project planning. This will be done on each riparian ecosystem' to define its physical limits and current conditions and to specify the desired future conditions necessary to support any proposed management actions in this Management Area.	MA-17	
Maintain adequate old growth trees within 30 feet of streams to provide recruitment to the fisheries streams to create pools for fish habitat.	MA-17	
Maintain adequate tree and shrub vegetation to contribute tree cover to banks and in-stream areas to provide favorable water temperatures.	MA-17	
Maintain desirable levels of instream large woody debris to provide fish habitat.	MA-17	
Maintain the minimum streamflow necessary to sustain the biological community in the Management Area as well as the downstream	MA-17	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
biological communities.		
Prohibit timber cutting, including firewood cutting, except: (1) Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting only where present and future woody debris needs are met, where cutting would not retard or prevent attainment of other Riparian Management Objectives, and where adverse effects can be avoided to inland native fish. For priority watersheds, complete watershed analysis prior to salvage cutting. (2) Apply silvicultural practices to acquire desired vegetation characteristics where needed to attain Riparian Management Objectives. Apply silvicultural practices in a manner that does not retard attainment of Riparian Management Objectives and that avoids adverse effects on inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Cooperate with Federal, Tribal, State, and county agencies, and cost-share partners to achieve consistency in road design, operation, and maintenance necessary to attain Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
For each existing or planned road, meet the Riparian Management Objectives and avoid adverse effects to inland native fish by: (a) completing watershed analysis prior to construction of new roads or landings within priority watersheds. (b) minimizing road and landing locations	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
(c) initiating development and implementation of a Road Management Plan or a Transportation Management Plan. At a minimum, address the following in the plan: (1) road design criteria, elements, and standards that govern construction and reconstruction (2) road management objectives for each road (3) criteria that govern road operation, maintenance, and management (4) requirements for pre-, during-, and post-storm inspections and maintenance (5) regulation of traffic during wet periods to minimize erosion and sediment delivery and accomplish other objectives (6) implementation and effectiveness monitoring plans for road stability, drainage, and erosion control (7) mitigation plans for road failures (d) avoiding sediment delivery to roads: (1) outsloping of the ordinary road surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where outsloping is infeasible or unsafe (2) route road drainage away from potentially unstable stream channels, fills, and hillslopes (e) avoiding disruption of natural hydrologic flow paths (f) avoiding sidecasting of soils or snow. Sidecasting of road material is prohibited on road segments on or abutting priority watersheds.		
Determine the influence of each road on the Riparian Management	Riparian Habitat	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Objectives. Meet Riparian Management Objectives and avoid adverse effects on inland native fish by: (a) reconstructing road and drainage features that do not meet design criteria or operation and maintenance standards, or that have been shown to be less effective than designing for controlling sediment delivery, or that retard attainment of Riparian Management Objectives or do not protect priority watersheds from increased sedimentation. (b) prioritize reconstruction based on the current and potential damage to inland native fish and their priority watersheds, the ecological value of the riparian resources affected, and the feasibility of options such as helicopter logging and road relocation outside of RCHAs. (c) closing and stabilizing or obliterating, and stabilizing roads not needed for future management activities. Prioritize these actions based on the current and potential damage to inland native fish priority watersheds, and the ecological value of the riparian resources affected.	Conservation Areas and other areas affecting the RCHAs	
Construct new, and improve existing, culverts, bridges, and other stream crossings to accommodate a 100-year flood, including associated bedload and debris, where those improvements would/do pose a substantial risk to riparian conditions. Substantial risk improvements include those that do not meet design and operation maintenance criteria, or that have been shown to be less effective than designed for controlling erosion, or that retard attainment of Riparian Management Objectives, or that do not protect priority watersheds from increased sedimentation. Base priority for upgrading on risks in priority watersheds and the ecological value of riparian resources affected. Construct and maintain crossings to prevent	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
diversion of streamflow out of the channel and down the road in the event of crossing failure.		
Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Modify grazing practices (e.g., accessibility of riparian areas to livestock, length of grazing season, stocking levels, time of grazing, etc.) that retard or prevent attainment of Riparian Management Objectives or are likely to adversely affect inland native fish. Suspend grazing if adjusting practices is not effective in meeting Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Locate new livestock handling and/or management facilities elsewhere.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Assure that existing livestock handling facilities do not prevent attainment of Riparian Management Objectives and relocate or close facilities when these objectives cannot be met.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Limit livestock trailing, bedding, watering, salting, loading, and other handling efforts to those areas and times that would not retard or prevent attainment of Riparian Management Objectives or adversely affect inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Adjust wild horse and burro management to avoid impacts that prevent attainment of Riparian Management Objectives or adversely affect inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
	RCHAs	
Design, construct, and operate recreation facilities, including trails and dispersed sites, in a manner that does not retard or prevent attainment of Riparian Management Objectives or avoids adverse effects on inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Complete watershed analysis prior to construction of new recreational facilities within priority watersheds.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Assure that existing recreational facilities, or use of existing facilities, would not prevent attainment of Riparian Management Objectives or adversely affect inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Relocate or close existing recreation facilities where Riparian Management Objectives cannot be met or adverse effects on inland native fish cannot be avoided.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Adjust dispersed and developed recreation practices that retard or prevent attainment of Riparian Management Objectives or adversely affect inland native fish. Where adjustment measures such as education, use limitations, traffic control devices, increased maintenance, relocation of facilities, and/or specific site closures are not effective in meeting Riparian Management Objectives and avoiding adverse effects on inland native fish, eliminate the practice or occupancy.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Address attainment of Riparian Management Objectives and potential effect on inland native fish Wild and Scenic Rivers, Wilderness, and	Riparian Habitat Conservation Areas and	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
other Recreation Management plans.	other areas affecting the RCHAs	
Minimize adverse effects to inland native fish species from mineral operations. If a Notice of Intent indicates that a mineral operation would be located in a RHCA, consider the effects of the activity on inland native fish in the determination of significant surface disturbance pursuant to 36 C.F.R. 228.4. For operations in a RHCA, ensure all operators take all practicable measures to maintain, protect, and rehabilitate fish and wildlife habitat which may be affected by the operations. When bonding is required, consider (in the estimation of the bond amount) the cost of stabilizing, rehabilitating, and reclaiming the area of operations.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Locate structures, support facilities, and roads elsewhere. If no alternative exists, locate and construct the facilities in ways that avoid impacts to RHCAs, streams, and adverse effects on inland native fish. Where no alternative road construction exists, keep the roads to the minimum necessary for the approved mineral activity. Close, obliterate, and revegetate roads no longer required for mineral or land management activities.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Prohibit solid and sanitary waste facilities. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities exists, and releases can be prevented and stability be ensured, then: (a) analyze the waste material using the best conventional sampling methods and analytic techniques to determine its chemical and physical stability characteristics.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
(b) locate and design the waste facilities using the best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, prohibit such facilities. (c) monitor waste and waste facilities to confirm predictions of chemical and physical stability, and make adjustments to operations as needed to avoid adverse effects to inland native fish and to attain Riparian Management Objectives. (d) reclaim and monitor waste facilities to assure chemical and physical stability, and make adjustments to operations as needed to avoid adverse effects to inland native fish and to attain Riparian Management Objectives. (e) require reclamation bonds adequate to ensure long-term chemical and physical stability and successful revegetation of mine waste facilities.		
For leasable minerals, prohibit surface occupancy for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist, unless no other location options exist and Riparian Management Objectives can be attained and adverse effects to inland native fish can be avoided. Adjust the operating plans of existing contracts to (1) eliminate impacts that prevent attainment of Riparian Management Objectives and (2) avoid adverse impacts to inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Permit sand and gravel mining and extraction only if no alternatives exist, if the action(s) would not retard or prevent attainment of Riparian	Riparian Habitat Conservation Areas and	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Management Objectives, and adverse effects to inland native fish can be avoided.	other areas affecting the RCHAs	
Develop inspection, monitoring, and reporting requirements for mineral activities. Evaluate and apply the results of inspection and monitoring to modify mineral plans, leases, or permits as needed to eliminate impacts that prevent attainment of Riparian Management Objectives and avoid adverse effects to inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Design fuel treatment and fire suppression strategies, practices, and actions so as not to prevent attainment of Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could perpetuate or be damaging to long-term ecosystem function or inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Locate incident bases, camps, helibases, staging areas, helispots, and other centers for incident activities elsewhere. If no other suitable location exists, an exemption may be granted following a review and recommendation by a resource advisor. The advisor would prescribe the location, use conditions, and rehabilitation requirements, with avoidance of adverse effects on inland native fish as a primary goal. Use an interdisciplinary team, including a fishery biologist, to predetermine incident base and helibase locations during presuppression planning.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Avoid delivery of chemical retardant, foam, or additives to surface waters. An exception may be warranted in situations where overriding immediate safety imperatives exist or, following a review and recommendation by a resource advisor and a fishery biologist, when the action agency determines an escape fire would cause more long-term	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
damage to fish habitats than chemical delivery to surface waters.		
Design prescribed burn projects and prescriptions to continue the attainment of the Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Immediately establish an emergency team to develop a rehabilitation treatment plan to attain Riparian Management Objectives and avoid adverse effects on inland native fish whenever RHCAs are significantly damaged by a wildfire or a prescribed fire burning out of prescription.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Require instream flows and habitat conditions for hydroelectric and other surface water development proposals that maintain or restore riparian resources, favorable channel conditions, and fish passage, reproduction, and growth. Coordinate this process with the appropriate State agencies.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
During relicensing of hydroelectric projects, provide written and timely license conditions to the Federal Energy Regulatory Commission (FERC) that require fish passage and flows and habitat conditions that maintain/restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate State agencies.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Locate new hydroelectric ancillary facilities elsewhere.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
For existing hydroelectric ancillary facilities that are essential to proper management, provide recommendations to FERC to assure that the facilities would not prevent attainment of the Riparian Management Objectives and that adverse effects on inland native fish are avoided.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Where these objectives cannot be met, provide recommendations to FERC that such ancillary facilities should be relocated.		
Locate, operate, and maintain hydroelectric facilities that must be located RHCAs to avoid effects that would retard or prevent attainment of Riparian Management Objectives and avoid adverse effects on inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Issue leases, permits, rights of way, and easements to avoid effects that would retard or prevent attainment of Riparian Management Objectives and avoid adverse effects on inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Where the authority to do so was retained, adjust existing leases, permits, rights of way, and easements to eliminate effects that would retard or prevent attainment of Riparian Management Objectives and avoid adverse effects on inland native fish. Where adjustments are not effective, eliminate the activity.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Where the authority to adjust was not retained, negotiate to make changes in existing leases, permits, rights of way, and easements to avoid effects that would prevent attainment of Riparian Management Objectives or adversely affect inland native fish. Priority for modifying existing leases, permits, rights or way, and easements would be based on current and potential adverse effects on inland native fish and the ecological value of the riparian resources affected.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Use land acquisition, exchange, and conservation easements to meet Riparian Management Objectives and facilitate restoration of fish stocks and other species at risk of extinction.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Identify and cooperate with Federal, Tribal, State, and local governments to secure instream flows needed to maintain riparian resources, channel conditions, and aquatic habitat.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Trees may be felled when they pose a safety risk. Keep felled trees on site when needed to meet woody debris objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Apply herbicides, pesticides, and other toxicants, and other chemicals in a manner that does not retard or prevent attainment of Riparian Management Objectives and avoids adverse effects on inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Prohibit storage of fuels and other toxicants. Prohibit refueling unless no other alternative locations exist. Refueling sites must be approved by the Forest Service or Bureau of Land Management and have an approved spill containment plan.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Locate water drafting sites to avoid adverse effects to inland native fish and instream flows, and in a manner that does not retard or prevent attainment of Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Design and implement watershed restoration projects in such a manner that promotes the long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and contributes to attainment of Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Cooperate with Federal, Tribal, State, and local agencies, and private landowners to develop watershed-based Coordinated Resource	Riparian Habitat Conservation Areas and	

<i>Standards Protecting Fish and Wildlife in Riparian Areas</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Management Plans (CRMPs) or other cooperative agreements to meet Riparian Management Objectives.	other areas affecting the RCHAs	
Design and implement fish and wildlife habitat restoration and enhancement actions in a manner that contributes to the attainment of Riparian Management Objectives.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Design, construct, and operate fish and wildlife interpretive and other user-enhancement facilities that does not retard or prevent attainment of Riparian Management Objectives or adversely affect inland native fish. Where Riparian Management Objectives cannot be met or adverse effects on inland native fish avoided, relocate or close such facilities.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
For existing fish and wildlife interpretive and other user-enhancement facilities, assure that Riparian Management Objectives are met and adverse effects on inland native fish are avoided. Where Riparian Management Objectives cannot be met or adverse effects on inland native fish avoided, relocate or close such facilities.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Cooperate with Federal, Tribal, and State wildlife management agencies to identify and eliminate ungulate impacts that prevent attainment of the Riparian Management Objectives or adversely affect inland native fish.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	
Cooperate with Federal, Tribal, and State fish management agencies to identify and eliminate adverse effects on native fish associated with habitat manipulation, fish stocking, fish harvest, and poaching.	Riparian Habitat Conservation Areas and other areas affecting the RCHAs	

<i>Standards Protecting Big Game</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Manage "Moist Sites," composed of specific habitat types, topographic situations, and elevations some of which have been tentatively mapped in the Flathead National Forest planning data base as summer habitat, according to the habitat type – moist site recommendations.	Forest-wide	
During the elk use period, limit open road densities of "Moist Sites" to an average of 1 mile or less per square mile.	Forest-wide	
Manage "Security Areas", composed of the areas associated with the moist sites that provide security and other necessary components of elk summer habitat, according to the security area recommendations from the Coordinating Elk and Timber Management, Final Report of the Montana Cooperative Elk-Logging Study, 1970-1985, January 1985	Forest-wide	
Reduce slash in managed stands of both "Moist Sites" and "Security Areas" to levels that do not impede elk movement.	Forest-wide	
Complete a Long-Range Whitetailed Deer Winter Range Activity Schedule for each winter range unit. Utilize this schedule to guide project planning.	MA-9	
Consider those portions of this Management Area separated by one-half mile or more as separate winter ranges.	MA-9, MA-13, MA-13a	
Manage to achieve at least 50 percent of the area in winter thermal cover.	MA-9	
Each managed habitat unit (cover or forage area) will generally be less than 10 acres and shaped to ensure optimum use of the forage produced. Regeneration of each managed habitat unit will include diverse tree species but will feature Douglas fir (40 percent of trees, by number) if the site is capable of growing Douglas fir.	MA-9	
Complete a Long-Range Mule Deer and Elk Winter Range Activity	MA-13, MA-13a	

<i>Standards Protecting Big Game</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Schedule for each winter range unit. Utilize this schedule to guide project planning.		
To be acceptable habitat, each separate winter range area must have 30 percent of the area in winter thermal cover (i.e., a stand of evergreen coniferous trees with a minimum average height of 60 feet and a minimum crown canopy of 70 percent).	MA-13, MA-13a	
Maintain whitetailed deer summer range habitat units (cover/forage areas) at 20 acres or less.	MA-15c	
Manage to provide vegetation manipulation that maintains or enhances whitetailed deer summer habitat condition while emphasizing timber management.	MA-15c	
Analyze project proposals to determine the specific elk habitat component possessed by the unit, and timber harvest plans will recognize these values in sale design.	MA-16c	

<i>Standards Protecting Bald Eagle and Peregrine Falcon</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Prohibit disturbance-causing activities such as road construction, logging, and seismic exploration using explosives within one-half mile of active bald eagle or peregrine falcon nests during the nesting period: February 1 through August 1.	Forest-wide	

<i>Standards Protecting Bald Eagle and Peregrine Falcon</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Complete a biological evaluation and initiate formal consultation with the U.S. Fish and Wildlife Service prior to implementing National Forest management activities that would result in changes in vegetation (such as logging and road construction) within one-fourth of a miles of known active bald eagle or peregrine falcon nests.	Forest-wide	
Complete a biological investigation prior to the use of pesticides within 15 miles of an active bald eagle or peregrine falcon nest.	Forest-wide	
Prohibit cutting of snags for firewood within 300 feet of any river, lake, or reservoir.	Forest-wide	

<i>Standards Protecting Threatened and Endangered Species</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Do not deviate from standards established for threatened and endangered species conservation and protection unless a biological evaluation concludes that such deviation would have no effect on the recovery of the species, or until there has been consultation with the Fish and Wildlife Service.	Forest-wide	
Give high priority to the conservation of threatened and endangered species and their habitats in management of the wilderness resource.	MA-21	

<i>Standards Protecting Grizzly Bear</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Timber sale project plans will include grizzly bear habitat improvement if there is a determined need to improve grizzly bear habitat in the project area or develop habitat improvement techniques, provided the timber sale and/or wildlife funds are available to accomplish the improvements.	S1, S2	
Coordinate timber sale activities in time and space so that activities occur at a time when the area has the least biological importance to the bear.	S1, S2	
When harvest units are located adjacent to natural or manmade openings, maintain hiding cover on approximately 75 percent of the opening's perimeter.	S1, S2	
Maintain a minimum of 40 percent cover of each project analysis area with 20 percent in summer hiding cover and 20 percent in summer thermal cover distributed throughout the area.	S1, S2	
Use prescribed fire (at natural fire frequency levels) on non-timber production areas to improve grizzly bear habitat.	Forest-wide (S1, S2, S3)	
On all project fires, the resource coordinator will evaluate ongoing and potential impacts on the grizzly.	Forest-wide (S1, S2, S3)	
Evaluate all livestock use on allotments, including recreation horse allotments, through the biological evaluation process for its effect on grizzlies and/or their habitat. Evaluation will follow the direction established for preparation and revision of allotment management.	S1, S2	
Modify grazing activities with potential for affecting the grizzly bear, as determined in the biological review, so as not to adversely affect the grizzly bear and its habitat.	S1, S2	
Allotment management direction will specify, when applicable, measures to protect in time and space food production areas vitally important to	S1, S2	

<i>Standards Protecting Grizzly Bear</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
grizzlies (i.e. wet alpine and subalpine meadows, stream bottoms, aspen groves, and other riparian areas) from conflicting and competing use by livestock.		
Outfitter/guide permits will specify measures to be taken in terms of food storage, refuse disposal, and wild meat storage. Work with Montana Department of Fish, Wildlife, and Parks on enforcement of the permit regulations.	Forest-wide (S1, S2, S3)	
Make available to the public an information brochure summarizing human conduct in grizzly country. Make a supply of the brochure available to local offices of the Montana Department of Fish, Wildlife, and Parks.	Forest-wide (S1, S2, S3)	
Reduce grizzly mortality illegally occurring during big-game hunting seasons by (a) assisting Montana Department of Fish, Wildlife, and Parks in making information available to all hunters to assist them in distinguishing between black and grizzly bear; (b) assisting Montana Department of Fish, Wildlife, and Parks in issuing special warnings to hunters using areas frequented by grizzly bear; and (c) closing roads in key grizzly bear habitat.	Forest-wide (S1, S2, S3)	
Require grizzly bear habitat component mapping and analysis and coordination and consultation with State and Federal wildlife management agencies for all projects.	MA-11, MA-11a, MA-11c	
Manage adjacent grizzly bear foraging areas (openings) only when previously cut unit sustains adequate hiding cover (i.e., the amount of cover required to conceal at least 90 percent of an adult grizzly bear at 200 feet)	MA-11, MA-11a, MA-11c	
Develop a Long-Range Grizzly Bear Habitat Activity Schedule, with all	MA-11, MA-11a	

<i>Standards Protecting Grizzly Bear</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
habitat components mapped and analyzed, prior to allowing any vegetative manipulation of grizzly bear habitat. Utilize this schedule to guide project planning.		
Manage riparian areas to optimize grizzly travel security and forage production.	MA-11, MA-11a	
Provide for security from human conflict through year-round closures of all newly constructed roads and closures of existing roads and trails as necessary to maintain the security of the area. Monitor and manage all human activity in the area.	MA-11, MA-11a	
Provide and maintain hiding cover over at least 70 percent of the area.	MA-11c	
While grizzly bear management and research is the primary management emphasis for this area, recognize the needs of the existing gray wolf population and the potential existence of an occasional band of mountain caribou.	MA-11, MA-11b	
Keep the public will be kept informed of known grizzly problem areas, but generally do not restrict use in these areas. Emphasize education of bear avoidance techniques. Forest Supervisors will direct the development of more detailed standards necessary to protect both the bear and wilderness visitors. Standards will be consistent with Forest-wide standards for grizzly bear management in occupied grizzly bear habitat, and will be incorporated into the Forest Plan through amendment.	MA-21	
Establish and maintain annual contact with Border Grizzly Project personnel to assure continued and up-to-date knowledge of grizzly bear population dynamics.	MA-22	

<i>Standards Protecting Gray Wolves</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Have wolf habitat maintenance and improvement and wolf-human conflict minimization as a primary management objective. Management needs will favor the needs of the wolf when wolf habitat and other land uses compete.	Zone 1	
Management will be provided to at least maintain the habitat conditions that resulted in the area being classified as Zone 2. Wolf activities and needs will be accommodated if possible, but not to the extent of excluding other high priority land uses.	Zone 2	
The Forest Service shall monitor gray wolf population status.	MA-11, MA-11b	
Establish and maintain annual contact with members of the Wolf Ecology Project to assure continued and up-to-date knowledge of wolf population dynamics.	MA-22	

(lots of guidelines and management direction—standards or not? Many use “will” so i’m not sure—the above where designated “guidelines.” Nothing was specifically labeled as a “standard” although the whole section was “wolf standards”)

<i>Standards Protecting Caribou</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Cooperate with the State of Montana and the U.S. Fish and Wildlife Service in further identification of the status of woodland caribou. If caribou populations are ascertained, tconsider a Plan amendment to assist in recovery.	Forest-wide	

<i>Standards Protecting Caribou</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
The Forest Service shall monitor mountain caribou population status.	MA-11, MA-11b	

<i>Standards Protecting Rare Plants</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Work with the State and private organizations in the inventory of threatened, endangered, or sensitive plants. Develop conservation management direction for all such plants and plant communities. Plant species of possible concern include: Peculiar moonwort (<i>Botrychium paradoxeum</i>), Mountain moonwort (<i>Botrychium montanum</i>), Howellia (<i>Howellia aquatilis</i>), and Howell's gumweed (<i>Grindelia howellia</i>)	Forest-wide	

<i>Standards Protecting Wildlife and Habitat Generally</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
Use prescribed fire to improve habitat for wildlife.	MA-2, MA-2a, Ma-2b, MA-2c, MA-3	
Maintain the number and distribution of snags to achieve 100 percent of the maximum potential population of snag cavity dependent species. Manage for a minimum of 225 snags per 100 acres, composed of: 14	MA-2, MA-2a, Ma-2b, MA-2c, MA-3, MA-12, MA-17, MA-20	

<i>Standards Protecting Wildlife and Habitat Generally</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
snags greater than 20 inches d.b.h, 136 snags greater than 12 inches and up to 20 inches d.b.h., 75 snags greater than 10 inches and up to 12 inches d.b.h. Consideration will be given to location and availability of snags in adjacent management areas.		
Prohibit overnight camping on Clayton Island (Hungry Horse Ranger District) until August 1 each year to protect wildlife habitat.	MA-2b	
Implement habitat improvement projects for small mammals, birds, and other species adapted to developed sites, if cost-effective and compatible with developed site management.	MA-4	
Maintain the number and distribution of snags for at least 50 percent of the maximum potential population of snag cavity dependent species. Manage for a minimum of 112 snags per 100 acres, composed of: 7 snags greater than 20 inches d.b.h., 68 snags greater than 12 inches and up to 20 inches d.b.h., 37 snags greater than 10 inches and up to 12 inches d.b.h. Consideration will be given to location and availability of snags in adjacent management areas.	MA-5, MA-7, MA-7a, MA-8	
Implement the full range of wildlife habitat improvements.	MA-9, MA-13, MA-13a	
Maintain the number and distribution of snags for at least 80 percent of the maximum potential population of snag cavity dependent species. Manage for a minimum of 180 snags per 100 acres, composed of: 11 snags greater than 20 inches d.b.h., 109 snags greater than 12 inches and up to 20 inches d.b.h., 60 snags greater than 10 inches and up to 12 inches d.b.h. Consideration will be given to location and availability of snags in adjacent management areas.	MA-9, MA-11, MA-11a, MA-11c, MA-13, MA-13a	
Provide the full range of habitat improvement practices, including prescribed fire, shrub planting, and timber harvest to maintain or enhance	MA-11, MA-11a	

<i>Standards Protecting Wildlife and Habitat Generally</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
the number and availability of habitat components (listed in the “Goals” section for these management areas). Consider the needs of the gray wolf and other endangered species in authorizing habitat improvement projects.		
Ensure proper distribution and quantity of old growth habitat for each watershed.	MA-12	
Thermal and hiding cover will be provided by old growth. The continued maintenance of these cover types will facilitate use of the riparian areas as travel corridors.	MA-12	
Generally retain 10 to 15 tons per acre of down woody material as habitat for small mammals and ground nesting birds unless otherwise specified in management area direction.	Forest-wide	
Maintain old-growth habitat and snags at elevations below 5,000 feet at the number and distribution that will achieve the desired potential populations of old growth and snag cavity dependent species. Desired snag requirements are specified for each management area.	Forest-wide	
The species designated for old growth and snag management in descending order of preference are: western larch, aspen, paper birch, black cottonwood, ponderosa pine, Douglas-fir, Engelmann spruce, subalpine fir, and other species.	Forest-wide	
Implement those wildlife habitat improvements that are consistent with the visual quality objective.	MA-13c, MA-13d	
Research activities will consider improving wildlife and fish habitat to meet research objectives.	MA-14	

<i>Standards Protecting Wildlife and Habitat Generally</i>	<i>1985 Flathead NF Plan (and amendments) with Applicable Management Areas</i>	<i>2006 Flathead NF Proposed Plan with Applicable Management Areas</i>
When consistent with this Management Area's goals, and where appropriate, the number and distribution of snags for at least 40 percent of the maximum potential population of snag cavity dependent species will be maintained. Manage for a minimum 90 snags/100 acres composed of: 5 snags greater than 20 inches d.b.b., 55 snags greater than 12 inches and up to 20 inches d.b.h., and 30 snags greater than 10 inches and up to 12 inches d.b.h. Consideration will be given to location and availability of snags in adjacent Management Areas.	MA-15, MA-15a, MA-15b, MA-15c, MA-15d, MA-15e, MA-16, MA-16a, MA-16b, MA-16c	
Maintain average unrestricted road densities of less than 1.8 miles per section.	MA-15c	
Manage to provide vegetation that maintains the variety of habitat requirements compatible with adjacent MA-13.	MA-15e	
Protect goat habitat.	MA-19	
Managers will consult annually with personnel from the Montana Department of Fish, Wildlife, and Parks regarding levels of appropriate harvest for maintaining native hunted and trapped species as part of the wilderness resource.	MA-21	
Natural processes such as fire, wind, and insect and disease activity will be the only agents permitted to influence vegetation and its associated wildlife in the wilderness.	MA-21, MA-22	

Exhibit B1



Exhibit B2



Exhibit B3



Exhibit B4



Exhibit B5







Exhibit B8



Exhibit B9



Exhibit B10



Exhibit B11



Exhibit C1



Exhibit C2



Exhibit C3



Exhibit C4



Exhibit D1

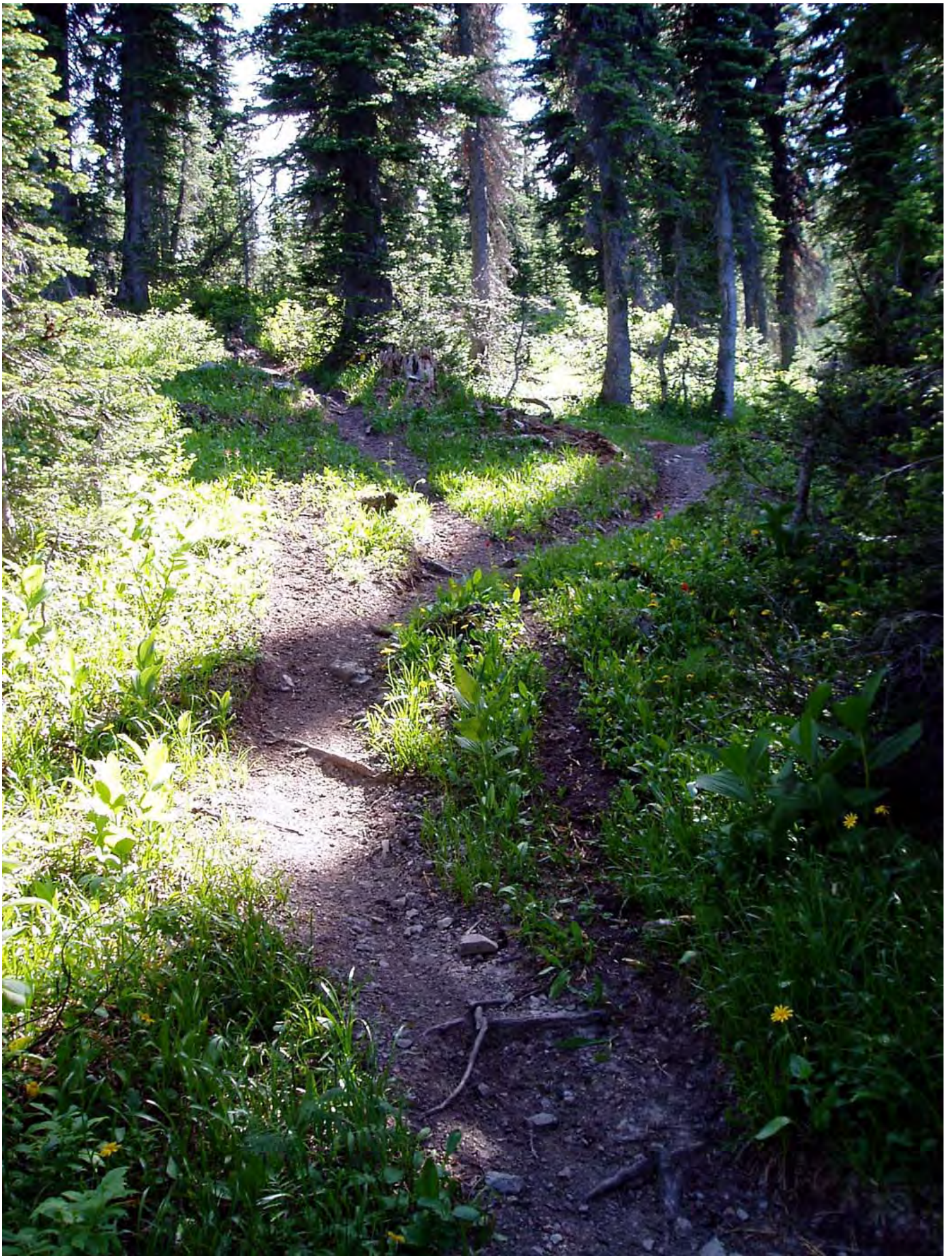


Exhibit D2



Exhibit D3



Exhibit D4



Exhibit D5



Flathead National Forest Off-Road Vehicle Pop Quiz

By
Swan View Coalition
www.swanview.org

Were the tracks in the following
photos made by snowmobiles or
wheel-driven ORVs?

Test yourself in 6 minutes!

*This slide-show quiz accelerates
automatically. Hang on tight!*

Snowmobile or wheel-driven ORV?



Hint: Tracks made in June.

Snowmobiling near Strawberry Lake,
northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Snowmobiles high-mark here.

Motorcycle high-marking near LaMoose
Lake, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Named “Mud Hill” by snowmobilers.

Illegally cleared trail and snowmobile tracks
in Krause Basin, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: “Mud Hill” in summer.

Where snowmobiles tread, motorcycles and
ATVs follow.

Snowmobile or wheel-driven ORV?



Hint: More horsepower than a Subaru.

June snowmobiling in Lost Johnny Basin,
northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Can chew through anything in its path.

June snowmobiling in Lost Johnny Basin,
northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Only 2 miles to snow.

Memorial Day snowmobiling on Doris Creek Road, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: “Map says ‘road closed.’ Sure glad the Ranger left an old bridge we can use!”

Memorial Day snowmobiling on closed Doris Creek Road, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Wet and wild, 1 mile left to snow.

Memorial Day snowmobiling on closed Doris Creek Road, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: “Sure glad we cut this brush out of the way last summer! . . .”

Memorial Day snowmobiling on closed Doris Creek Road, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: “. . . And these trees too!”

Memorial Day snowmobiling on closed Doris Creek Road, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: “Aren’ t old clear-cuts great!”

Memorial Day snowmobiling in
Doris Creek, northern Swan Range.

Snowmobile or wheel-driven ORV?



Hint: Mission accomplished!

Illegal Memorial Day snowmobiling in Jewel Basin Hiking Area, accessed via two miles of bare and closed Doris Creek Road, northern Swan Range.

Late season snowmobile trespass does more than just harm soils, water, vegetation, and quiet recreation.



It harms wildlife trying to get back on their feet after a long, hard winter . . .

Especially grizzly bears just emerging from their winter dens in March or April . . . 15

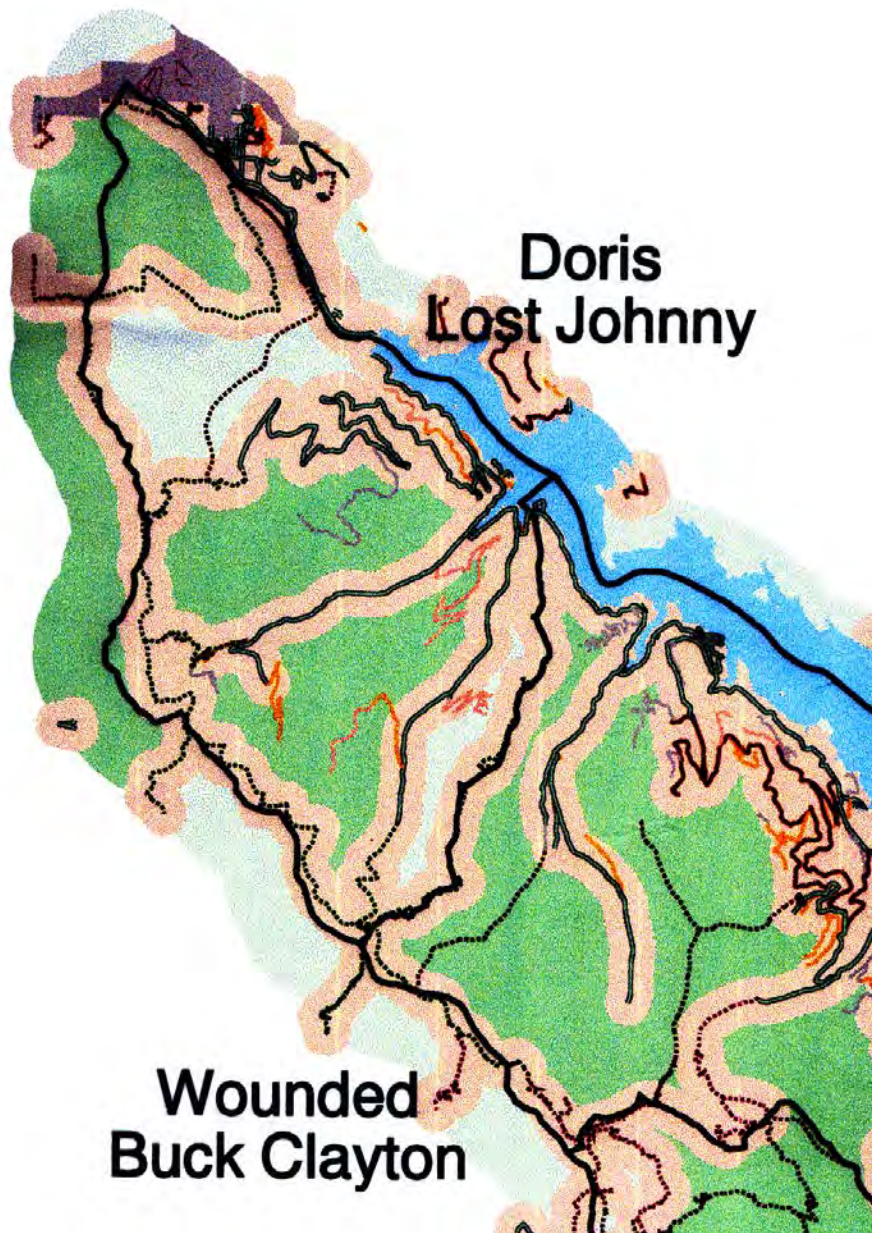
It especially harms female bears with cubs that can't travel far and must remain near their dens as late as June.



These bears are supposed to have springtime “core security areas” free from motorized use starting March 15.

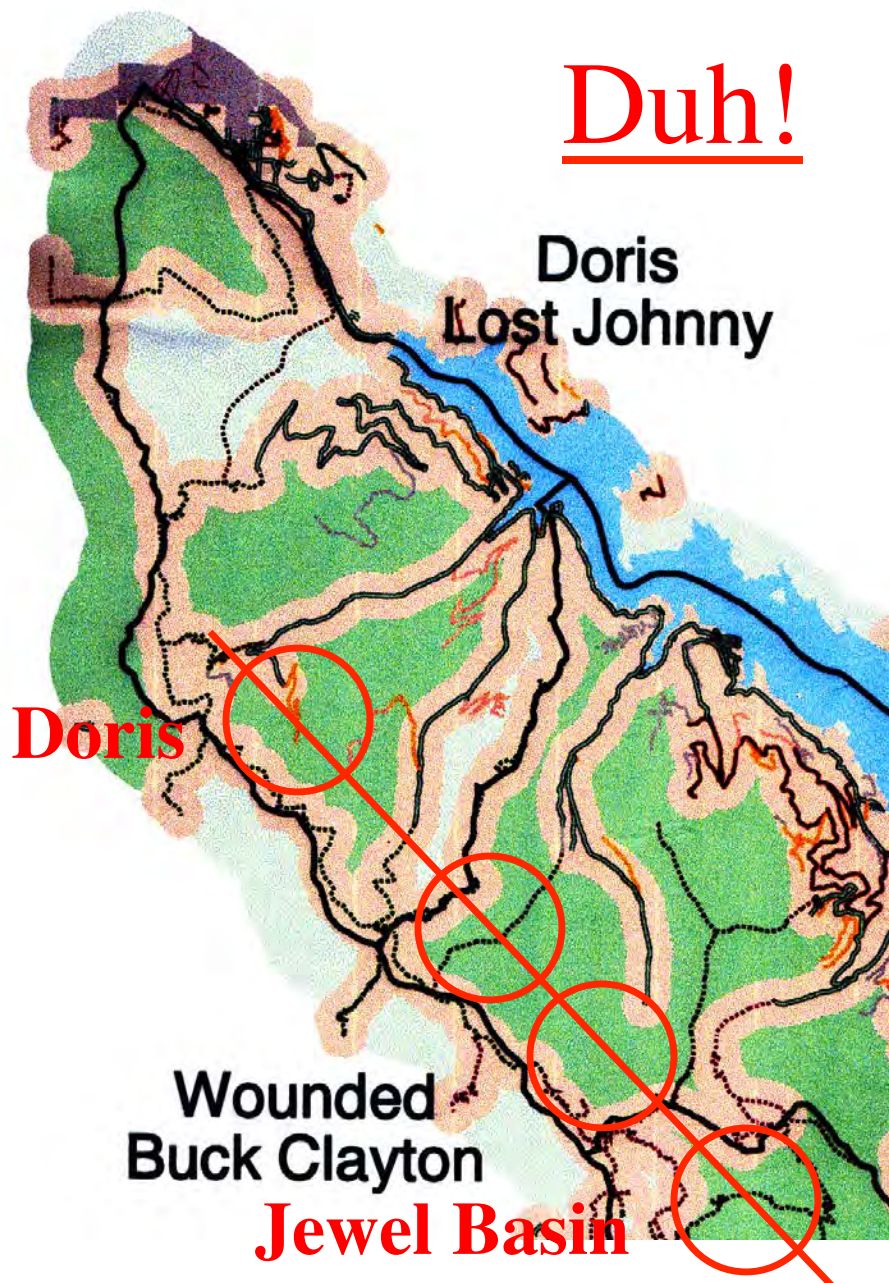
Which color do you think shows the “core security areas” on this Forest Service map?

The green remote areas or the brown kilometer-wide strip along each open motorized road or trail?



Do you think snowmobiles using the closed Doris Creek Road after March 15 would disqualify this habitat as “secure?”

And what about the Lost Johnny, Wounded Buck and other basins being violated?



How did you do with the quiz?
Dizzy yet?

Does reality suck, or what?

Don' t worry, it' s not your head that
is screwed up.

It' s the Forest Service' s policy for
managing ORV' s that is screwed up!

Rather than get a grip on the nonsense
you saw in these photos, the Flathead
National Forest instead wants to
legalize most of it!

What can you do about it?

Write a letter to the folks revising the
Flathead Forest Plan.

Tell them you want all motor vehicles
treated the same and restricted to
open roads only.

Tell them you want all roadless areas
managed as Wilderness, including the
northern Swan Range.

Write the Revision Team at:
wmpz@fs.fed.us -or-
USFS, Fort Missoula, Bldg. 24
Missoula, MT 59804

Thank you for taking the pop quiz.

*You have just a minute to write that
address down, then the quiz repeats!* ²⁰

Exhibit F1



Exhibit F2



Exhibit F3



Exhibit F4



Exhibit F5



Exhibit G1



Exhibit G2



Exhibit G3



Exhibit H1



Exhibit H2



Exhibit H3



Lost Johnny Flood Damage Comparison

June 21, 2006

Keith Hammer
Swan View Coalition

I provide here three photos I took on June 21, 2006. They show damage caused days earlier by two culvert failures in the Lost Johnny watershed, in contrast to no damage done to a reclaimed road crossing between the two washouts, where high water also flowed during heavy rains but bridges, culverts and road fill had been removed years ago.

Below: Sixty foot wide washout of West Side Road 895 at Lost Johnny Creek due to debris plugging the large culvert.



Below: Washout of Lost Johnny Road 895B by Otila Creek due to rocks and debris plugging the modest size culvert, resulting in the creek shifty course and washing out the road.



Below: No damage was done to the decommissioned/reclaimed crossing of Lost Johnny Creek by Road 11024 because the road fill had been removed from near the stream along with the stream-narrowing crossing structure. Note the high water "tide" mark at right, behind the boulders blocking the road, where the stream was allowed to widen and dissipate its erosive force.



Leslie Kubin

09/06/02 10:25 AM

To: Tim Bodurtha/R6/FWS/DOI@FWS, Anne
 Vandehey/R6/FWS/DOI@FWS, Jay Frederick/R6/FWS/DOI@FWS,
 Katrina Dixon/R6/FWS/DOI@FWS, Paul Hanna/R6/FWS/DOI@FWS,
 Dan Brewer/R6/FWS/DOI@FWS

cc:

Subject: last notes on Moose before I leave

Here are the concerns I still have at this time on the project. The primary concern is culverts left on decommissioned roads and bermed roads. Many of these culverts are being left in place for snowmobile access. Some of these culverts are being upsized at this time to meet INFISH standards under the BMP project. Specifically, the culvert on Kinnimiki creek and culverts on the Werner Peak road. The Forest has indicated that these roads will be level one maintenance and according to Earl Applecamp they will be maintained as needed. Or they may be decommissioned at a later date. An excavator will be needed to maintain these after a couple of years and even getting people into inspect these is very problematic according to Earl. He has been attempting to put together what he calls a hotshot crew to inspect these roads but the crew has not been formed as of yet. The Forest Plan states that maintenance on a level one road as "This level is basic custodial care as required to protect the road investment and to keep damage to adjacent land and resources to a minimum." That provides no direction or commitment to maintain a road hydrologically. The information provided to me from fisheries biologists and roads folks is that monitoring does not occur but every 3-10 years. Dean Suireck stated yesterday that it occurs every two years. I was later informed that this is not true, it just happened this year and two years ago. I was informed that this had more to do with the fire than anything. I was also informed that regardless of what we put in the BO monitoring will not occur more frequently because they do not have money or people. (The example was the Spotted Beetle BO, they will not monitor more than every three years) The concern is that monitoring will not occur. They have also told me that after a road grows in that they do not monitor because it is too hard to access the site. I have witnessed plugged culverts on many of the roads we are talking about in this project. Plugged culverts are fairly frequent on some of the roads in this project. From a fisheries perspective this is a huge concern because these will continue to plug and eventually fail causing all the road fill to flush into the stream and potentially take bull trout. There is literature to support that this is a problem. Influences of Forest and Rangeland Management by Meehan is one reference. Paul also has a BA from the Kooteni that supports removal of culverts due to risk of failure and impacts to fisheries. Ask Paul for this. Also paper by Keith Hammer. So there are other Forests out there that are not leaving culverts in place. I would just like to emphasize that this needs to be discussed in the BO in detail. From a fisheries perspective the best thing is no culverts be left on decom. or bermed roads, especially since monitoring is not a sure thing as stated above. If they are left in the potential impacts to bull trout needs to be assessed.

Earl did provide a new idea for culverts to be left in that is much better than what is out there now in that the fill would be removed so if the culvert plugs and blows fines will not be deposited downstream. But, as Dean stated it is not a free picnic because all of the fill gets pushed up and a bench is formed that at times is very large. This bench causes increased erosion and sediment delivery to the stream. This needs to be looked into more.

The BA presently does not contain enough information on bermed roads and culverts that will be left in place. If the new design Earl mentioned will be used we need to know where it will be used. I would recommend determining the number of culverts on bermed roads that are to be left; location in regards to bull trout spawning; associated fill with these culverts (shallow, moderate or deep as described in the BMP BA/BO); get a clear answer in writing from the Forest as to monitoring and maintenance of these structures; get the Forest to state specifically which roads will be bermed versus decommissioned (provided). The last item will be difficult as they have not selected an alternative. They just selected alternative 3 to do the BA on. At least determine under that alternative which roads will be bermed. Due to potential changes to this alternative there should be a term and condition that requires the Forest to provide an updated list of work on roads or change in status of roads at the beginning of the year. This should also include an assessment of and any change there may be to T&E species as a result of this change. If the change is considered substantial by FWS consultation should be reinitiated.

I would just like to make it clear that I think leaving these culverts in on decom. and bermed roads will negatively impact bull trout and will result in take sometime in the future. So are we providing the Forest with an incidental take statement for that future take (I would assume no)? I would also like to have considered a term and condition or conservation recommendation that requires the Forest to pull these culverts at some later date, prior to the risk of failure. I will think on this one some more and see if I can come up with more specific details before I leave at the end of the day.

The latest thing I heard from Betty Kuropat was that the Forest (Terry Schute) is not planning on addressing the culvert issues in the snowmobile access issue this winter. He is planning on continuing to do it project by project, site specific. Betty was concerned about this as are the fish biologists. From a fisheries perspective this is a huge nightmare and I am concerned about the precedence this Forest and this project will be setting for the Flathead and other Forests on the issue of culverts.

Other non-culvert issues or recommendations for terms and conditions. Have one Mcneil core sample site in Hallowat creek and possibly one in Big Creek above the present site the state has. Three of these could be monitored each year to assess changes in sediment deposition associated with roads, culvert work and decommissioning work. Data should be provided each year to FWS prior to work that year. If at any time the levels reach above 35% for fines <6.4mm (indicating that spawning is threatened) the Forest should contact FWS to reassess impacts from actions scheduled that year. It may require delaying of decommissioning work and culvert work until fine sediment levels drop. This will help to take the guess work out of what Mother Nature is doing and the effects of rain events or lack of rain in combination with sediment delivery associated with the road work.

One last thing not directly part of the Moose Fire project but part of the Big MT project. The culvert that was replaced in Kinimiki Creek (\$20,000 or more) we consulted on in the BMP project as road maintenance so the project went forward. What we (I) did not know was that was part of the Big MT project and the road will be decom. in 2005. The culvert was put in for snowmobiles, which has yet to be consulted on, not because the road will stay open.

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Title: Fire, Fuels, and Restoration of Ponderosa Pine-Douglas-Fir Forests in the Rocky Mountains, USA

Running Title: Restoration of Rocky Mountain Ponderosa Pine Forests

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1 **ABSTRACT**

2 **Aim** Forest restoration in ponderosa pine and mixed ponderosa pine-Douglas-fir forests in the U.S.
3 Rocky Mountains has been highly influenced by a historical model of frequent, low-severity surface fires
4 developed for the ponderosa pine forests of the Southwestern USA. A restoration model, based on this
5 low-severity fire model, focuses on thinning and prescribed burning to restore historical forest structure.
6 However, in the U.S. Rocky Mountains, research on fire history and forest structure, and early historical
7 reports, suggest the low-severity model may only apply in limited geographical areas. The aim of this
8 article is to elaborate a new variable-severity fire model and evaluate the applicability of this model,
9 along with the low-severity model, for the ponderosa pine-Douglas-fir forests of the Rocky Mountains.

10 **Location** Rocky Mountains, USA.

11 **Methods** The geographical applicability of the two fire models is evaluated using historical records, fire-
12 histories, and forest age-structure analyses.

13 **Results** Historical sources and tree-ring reconstructions document that, near or before A.D. 1900, the
14 low-severity model may apply in dry, low-elevation settings, but fires naturally varied in severity in most
15 of these forests. Low-severity fires were common, but high-severity fires also burned thousands of
16 hectares. Tree regeneration increased after these high-severity fires, and often attained densities much
17 greater than those reconstructed for Southwestern ponderosa pine forests.

18 **Main conclusions** Exclusion of fire has not clearly and uniformly increased fuels or shifted the fire type
19 from low- to high-severity fires. However, logging and livestock grazing have increased tree densities
20 and risk of high-severity fires in some areas. Restoration is likely to be most effective which seeks to (1)
21 restore variability of fire, (2) reverse changes brought about by livestock grazing and logging, and (3)
22 modify these land uses so that degradation is not repeated.

23
24 **Keywords** Douglas-fir, ecosystem restoration, fire ecology, historical accounts, *Pinus ponderosa*,
25 ponderosa pine, *Pseudotsuga menziesii*, Rocky Mountains

INTRODUCTION

In the Southwestern United States, the structure and composition of ponderosa pine (*Pinus ponderosa* P. and C. Lawson) forests are thought to have been altered by fire exclusion, leading to increases in tree density and a host of associated ecological changes (Covington and Moore, 1994). A formalized restoration model (Friederici, 2003), suggests that restoration of pre-fire-exclusion forest conditions and a low-severity fire regime is also consistent with a reduction in the risk of crown fires in ponderosa pine ecosystems. Thus, this low-severity model has contributed to the widespread assumption that ecological restoration and fire hazard mitigation can be simultaneously achieved in most low-elevation, dry forest ecosystems of the western United States (e.g. Covington, 2000), which is a major driver of U.S. national fire policy (USDA, 2002; White House, 2002). Ecologists have devised detailed proposals for restoring Southwestern ponderosa pine forests and reintroducing fire (Allen et al., 2002, Friederici, 2003). But, do these proposals apply to related forests of the Rocky Mountains? Ecologists have cautioned that evidence about the applicability of the low-severity model should be examined before restoration (Gutsell et al., 2001; Veblen, 2003a; Brown et al., 2004; Odion et al., 2004; Schoennagel et al., 2004).

In this article, we draw upon some previously unused historical sources and other evidence to assess the applicability of the low-severity model, and an alternative variable-severity model, throughout ponderosa pine-Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) forests of the U.S. Rocky Mountains. The primary focus of this paper is on forests dominated by ponderosa pine, either solely or in mixtures with Douglas-fir within the Rocky Mountains (Figure 1). However, because succession can result in the replacement of ponderosa pine by Douglas-fir, we also include some information from forests where ponderosa pine occurs, but Douglas-fir is dominant. In this gradient from ponderosa pine-dominated to Douglas-fir-dominated forests, other conifers (e.g., *Larix*, *Abies*) or aspen (*Populus tremuloides* (Michx.)) may also be found but are not dominants. Questions addressed about Rocky Mountain ponderosa pine-Douglas-fir forests, in assessing these models, include: (1) was the pre-20th

century fire regime (i.e., prior to fire exclusion) dominated by low-severity surface fire or by variable-severity fire (i.e., with a significant role played by severe fires), (2) was tree density generally low and comparable to density expected under the low-severity model, or variable as under the variable-severity model, (3) under the variable-severity model, how did fires of different severity affect spatial and temporal variation in tree density, (4) under the variable-severity model, how did variable fire affect fuels, and (5) under the variable-severity model, what have been the effects of fire exclusion, logging, and livestock grazing on tree density and fuels?

The low-severity and variable-severity restoration models

Many forest restoration proposals are based on models (or restoration frameworks) derived from an assessment of historical variability. The idea in using historical variability as a model is not to exactly re-create the past, but to restore enough forest structure, and the processes that maintain it, to put the forest back on a track congruent with its history (Landres et al., 1999). These models are derived using historical ecology--analysis of accounts and photographs by early explorers and settlers, as well as tree-ring-based reconstructions of tree density and fire history before EuroAmerican settlement (White and Walker, 1997; Egan and Howell, 2001).

The central image in the low-severity model (Table 1) is a pre-20th century forest with widely spaced, mature trees (often old growth) over a grassy or herbaceous forest floor (Figure 2a). Low-severity fires are thought to have burned frequently through these fine surface fuels, leaving most larger trees alive, but killing small trees and maintaining low tree density, while preventing fuel buildup. Excluding fires, under this model, leads to increased survival of small trees and a buildup of fuels, which may then cause uncharacteristic high-severity fires. This summary of the low-severity model is necessarily simplified, emphasizing the central features. Variation from this central concept has been elaborated and detailed in a recent collection (Friederici, 2003).

Recent research has concluded that the low-severity model is inappropriate for most ponderosa pine

forests in the Colorado Front Range (Veblen et al., 2000; Huckaby et al., 2001; Ehle and Baker, 2003; Sherriff, 2004). Based on the ideas and evidence in this research, we make an initial formulation of a variable-severity model as a coherent alternative to the low-severity model. The new model (Table 1) is based around a variable-severity fire model, often also called mixed severity (Agee, 1993). In this model, natural fires vary in severity and frequency, sometimes burning at low severity in surface fuels and sometimes burning as high-severity fires in the crowns of trees, or with a mixture of surface and crown fire. In the variable-severity model, most of the landscape historically experienced or is capable of supporting high-severity fire and most stands (i.e., 1-100 ha areas of forest) have evidence of mixed- or high-severity fire over the last few centuries. Patches of high-severity fire probably exceeded 100 ha but continuous mapping of past fire severity has not been conducted at broader spatial scales. The central landscape image from this model is of patches of forest varying in tree age and density, including some young, dense patches (Figure 2b) and some older, lower-density patches (Figure 2a). Variability in tree age and density comes in part from variation in environment (dry, south-facing slopes versus moister, north-facing slopes) but also from variation in fire severity within each environment. As fires vary in severity, the number of surviving trees and density of post-fire regeneration also vary, as do snags and dead wood. Not all regenerating young trees are killed by fires. Tree regeneration is also favored after fires, especially high-severity fires. Thus, the exclusion of fire may have different effects than under the low-severity model, leading in some cases to decreased tree regeneration and other processes that produce fuels thought to lead to subsequent high-severity fire. These two models can and should be revised or replaced with other models as new knowledge of local conditions accumulates, but at the present time these two models are the only models with a substantive body of evidence.

SOURCES OF EVIDENCE

Evidence about the relevance of these two models in the Rocky Mountains is in part from early reports on forest reserves, which later became National Forests, but also from the available scientific

1 literature. The forest-reserve reports were conducted by government scientists in the late-1800s. If these
2 scientists had an agenda that affected their observations, it was that they were instructed to document the
3 extent of human-set fires and unregulated logging and grazing thought to be affecting resources in the
4 reserves (Pinchot, 1898). However, these were not early explorers in the usual sense, as they were trained
5 scientists who made systematic observations and estimates of area burned and the severity of fires, tree
6 density, tree regeneration, and effects of logging and livestock grazing. We focused on evidence from
7 unlogged portions of the reserves. We extracted all quotes and data relevant to the questions posed in the
8 introduction and placed this evidence in tables (See Tables S1-S4 in Supplementary Material) or have
9 reviewed it in the text.

10 Researchers have generally considered A.D. 1900 to be sufficiently early in the Rocky Mountain
11 region to provide suitable reference conditions from which to gage natural fire regimes and forest
12 structure (Arno et al., 1995, 1997; Kaufmann et al., 2001), although climatic conditions and fire regimes
13 may have shifted during the 20th century. Forest-reserve reports have been used for this purpose in the
14 past (e.g., Shinneman and Baker, 1997). These reports provide direct estimates of the density of small
15 trees near or before A.D. 1900 in some areas. Precise determination of the proportion of the landscape
16 with a particular tree density usually is not feasible. Nevertheless, the tree density estimates in the 16
17 forest-reserve reports and related documents from the Rocky Mountains used here (Figure 1) are
18 adequate for evaluating some of the questions posed in the introduction.

19 Another source of reliable information on historical fire regimes and forest structure in Rocky
20 Mountain forests consists of tree-ring reconstructions of past fire regimes and forest conditions (Arno et
21 al., 1995, 1997; Kaufmann et al., 2000; Veblen et al., 2000; Ehle and Baker, 2003; Sherriff, 2004).
22 Relevant aspects of fire history methods are discussed in further detail later, but the critical parameter for
23 the current discussion is the severity of past fires. This requires dating the year of a fire using fire scars,
24 combined with age data from nearby trees (Bekker and Taylor, 2001; Ehle and Baker, 2003; Sherriff,
25 2004). High-severity fire is identified by evidence that a contiguous area of trees died about the time of a

fire and/or regenerated in a pulse after a fire. A precise date for the fire usually comes from a surviving tree inside the high-severity fire or on its margin. Low-severity fires, in contrast, are identified by fire scars from more than one location along with intervening trees that mostly pre-date and thus survived the fire. A single fire event is identified as mixed severity if it has substantial fractions of burn area with evidence of both high- and low-severity fire. We use all available tree-ring studies with both fire scars and age structure (Figure 3a). Note that we specifically omit fire-history studies that rely only upon dating fire scars (Figure 3a), as these studies lack data on age structure and thus do not provide evidence about fire severity. Tree-ring reconstructions of tree density near or before A.D. 1900 also are used (some of the points in Figure 3b), although these estimates often are only approximations, due to mortality of some of the trees present at that time.

THE APPLICABILITY OF THE TWO MODELS

Was the historical fire regime dominated by low-severity surface fires?

In Rocky Mountain ponderosa pine-Douglas-fir forests, data from the few places with the necessary tree age and fire-history evidence suggest that the pre-20th century fire regime varied in severity, and displayed more mixed- and high-severity fires than expected under the low-severity model. In Colorado, ponderosa pine-Douglas-fir forests at Cheesman Lake, southwest of Denver (Brown et al., 1999; Huckaby et al., 2001), pure ponderosa pine forests in Rocky Mountain National Park (Ehle and Baker, 2003), and ponderosa pine-Douglas-fir forests in many other locations in northern Colorado's Front Range (Sherriff, 2004) had variable-severity fire, based on tree-ring evidence, as summarized in a recent review (Romme et al., 2003). In Montana, tree-ring studies show that some ponderosa pine-Douglas-fir forests had infrequent high-severity fires as well as more frequent low-severity fires (Barrett, 1988; Arno et al., 1995, 1997). The area of these forests from eastern Montana to northeastern Wyoming, including the Black Hills, appears to have had variable fire severity, based on historical and tree-ring evidence (Shinneman and Baker, 1997; Arno and Allison-Bunnell, 2002). Forest-reserve reports also indicate that

1 mixed- and high-severity fire (Figure 4) occurred in pure ponderosa pine forests from Idaho to Colorado
 2 (See Table S1 Items 1, 6, 8, 14, 17, 18, 28, 32-38, 40, 42 in Supplementary Material) and in mixed
 3 ponderosa pine-Douglas-fir forests (See Table S1 Items 1, 12, 15, 26, 43 in Supplementary Material).
 4 Where Douglas-fir was more common or dominated, the reports suggest that high-severity fire was also
 5 more common (See Table S1 Items 2, 10, 11, 13, 15, 24, 25 in Supplementary Material). Indeed, in
 6 Douglas-fir forests in ponderosa pine landscapes, surface fires are seldom mentioned—the predominant
 7 fire type was reported to be high severity. High-severity fires were reported during early forest exams in
 8 Douglas-fir and ponderosa pine-Douglas-fir forests on several national forests in Idaho in A.D. 1900-
 9 1915 (Ogle and DuMond, 1997). Reported high-severity fires in ponderosa pine-Douglas-fir forests often
 10 covered thousands of hectares (See Table S1 Items 15,, 37 in Supplementary Material), and exceptional
 11 fires of 24,000 to 52,000 ha (60,000 to 128,000 acres) are also reported (See Table S1 Items 38, 42, 43 in
 12 Supplementary Material). Only the smallest of these large fires was in a logged area (See Table S1 Item
 13 42 in Supplementary Material).

14 Low-severity surface fires are mentioned in forest-reserve reports for Idaho (See Table S1 Items 3, 7,
 15 9, 42 in Supplementary Material), Montana (See Table S1 Items 16, 19, 20, 21, 42 in Supplementary
 16 Material), Wyoming and South Dakota (See Table S1 Items 28-30, 42 in Supplementary Material), and
 17 Colorado (See Table S1 Items 30, 41, 42 in Supplementary Material). The reports recognize that low-
 18 severity surface fires are promoted by low-density forest with a grassy understorey and by the ability of
 19 mature ponderosa pine to resist damage by fire (See Table S1 Items 3, 6, 10, 19, 23, 42 in
 20 Supplementary Material). However, low-severity surface fires alone do not imply that mixed- or high-
 21 severity fire was lacking, since low-severity fire was also part of the variable-severity model.

22 Although variable fire-severity appears to have characterized most of the range of ponderosa pine-
 23 Douglas-fir forests in the Rocky Mountains, in limited areas high-severity fire was absent over the last
 24 few centuries. Some stands in Montana (Barrett, 1988; Arno et al., 1995, 1997), southwestern Colorado
 25 (Wu, 1999) and the Colorado Front Range (Huckaby et al., 2001; Ehle and Baker, 2003; Sherriff, 2004)

1 were uneven-aged, based on tree-ring reconstructions, suggesting an absence of high-severity fire and
2 dominance by low-severity fire. These stands were more common on lower-elevation or drier sites
3 (Barrett, 1988; Wu, 1999; Veblen et al., 2000; Arno and Allison-Bunnell, 2002; Ehle and Baker, 2003;
4 Sherriff, 2004). In the only studies to date spanning the elevational range of ponderosa pine, about 20%
5 of the ponderosa pine zone on public and private land in northern Colorado was found to have been
6 dominated by low-severity fires (Platt 2004; Sherriff, 2004; Platt et al., in press), suggesting a more low-
7 severity than variable-severity model.

8 We stress that fire history data and forest age structures document substantial variation in the fire
9 regime along elevation and moisture gradients within the broad vegetation zone characterized by
10 ponderosa pine-Douglas fir forests, reflecting local variations in moisture availability and other factors
11 that determine fuels productivity and other vegetation attributes (Peet, 1981). For example, in the
12 northern Colorado Front Range, in a c. 61,000 ha area of ponderosa pine-Douglas-fir forests extending
13 from 1800 to 3000 m elevation, the area of more abundant low-severity fire was successfully predicted
14 from elevation and topographic variables (Sherriff, 2004). Although the zone of more low-severity fire is
15 broadly associated with lower elevations, at a finer scale abiotic factors also account for smaller areas of
16 predominantly low-severity fire at mid- to upper elevations in the ponderosa pine zone (Sherriff, 2004).

17 Why is the natural fire regime in most Rocky Mountain ponderosa pine-Douglas-fir forests variable
18 in severity? Extended droughts and high winds can lead to exceptional fire spread across a broad
19 spectrum of fuel loads and forest structures. For example, almost 25,000 ha of ponderosa pine-Douglas-
20 fir forest burned on a single day, June 9, 2002, driven by strong winds (Finney et al., 2003). Yet, brief
21 episodes when the winds declined and fuel moisture rose, led to low-severity fire in the same landscape
22 (Finney et al., 2003), suggesting that extreme weather, not fuels, was the chief cause of high-severity fire
23 under those conditions. Even during summer, ponderosa pine-Douglas-fir landscapes in the Rocky
24 Mountains are subject to rapid increases in wind speed and changes in direction from jet streams or cold
25 fronts (Baker, 2003). During spring and fall, more frequent cold fronts, along with strong down-sloping

winds (foehn or chinook winds), can lead to rapidly spreading, high-severity fires if ignitions occur. Furthermore, variation in topography and time-since-fire lead to considerable variation in tree density and fuel loads over short distances, as reviewed later. A major fire, burning for days or weeks, may incur substantial variation in wind speed and direction, fuel loads, and fuel moisture. During the Hayman fire in Colorado in 2002, strong southwesterly prefrontal winds drove a major fire run through both young and old forests. After the front, winds blew the fire back south, followed by southeasterly winds, before another major fire run, driven again by southwesterly winds (Finney et al., 2003). A map shows a patchy mosaic of varying severity, reflecting this variation in fuels, wind, and topography (Figure 5).

Was tree density generally low and comparable to tree density under the low-severity model?

Both tree-ring reconstructions and forest-reserve reports document that tree density was highly variable in Rocky Mountain ponderosa pine-Douglas-fir forests near or before A.D. 1900, suggesting that the low-severity model is inappropriate in most cases. Pre-fire-exclusion tree densities in ponderosa pine forests under the low-severity model were estimated to fall between about 7 and 60 trees ha⁻¹ (Covington and Moore, 1994), ranging up to 140 trees ha⁻¹ in some areas (Fulé et al., 2002). In contrast, two studies in the northern Colorado Front Range report that current densities of trees that were alive in A.D. 1900 (an underestimate of A.D. 1900 tree density) vary from 68 to 3,052 trees ha⁻¹ (Ehle and Baker, 2003) and 39 to 3,410 trees ha⁻¹ (Sherriff, 2004). This compares with modern tree density in the unlogged and ungrazed (for a century) Cheesman Lake area, southwest of Denver, of 96 to 1,459 trees ha⁻¹ (Kaufmann et al., 2000). In Montana, reconstructions found tree densities in mature ponderosa pine were between 116-249 trees ha⁻¹ near A.D. 1900, but data are lacking for forests of other ages (Arno et al., 1995). In Black Hills ponderosa pine forests, tree densities reconstructed for A.D. 1874 varied from 25 to 1,600 trees ha⁻¹ (McAdams, 1995). Forest-reserve reports support this large variability, documenting tree densities from 17 to 19,760 trees ha⁻¹ in ponderosa pine and 39 to 7,410 trees ha⁻¹ in Douglas-fir forests in the Rocky Mountains near or before A.D. 1900 (Table 2). Qualitative remarks mirror this large

quantitative range (See Table S4 Items 2, 3, 6 in Supplementary Material). Leiberg (1897; See Table S4 Item 6 in Supplementary Material) says “The number of trees to the acre varies so greatly that it is almost impossible to give, even approximately, an estimate.”

Three factors, that explain this great variation in tree density, are identified in the forest-reserve reports: tree species composition, environment, and stand development. Where forests included more Douglas-fir or other trees, density was higher than in pure ponderosa pine forests (See Table S4 Items 2, 6, 7, 12, 14, 17 in Supplementary Material). Tree density was low in lower-elevation stands and on drier sites and was higher in more mesic stands, found on more northerly-facing slopes or at higher elevations (See Table S4 Items 2, 4, 5, 6, 17 in Supplementary Material). Mesic stands often also contained Douglas-fir and other trees, so composition and environment were correlated, but density varied with environment even within forests consistent in composition (See Table S4 Item 5 in Supplementary Material). Pure Douglas-fir forests usually had > 250 trees ha^{-1} , while pure ponderosa pine forests could be, but were not always lower in density (Table 2).

Stand development appears to have strongly affected tree density (See Table S4 Items 1, 3, 6, 8, 10, 11 in Supplementary Material). Young stands (< 100 years old) were naturally dense, having about 1,000-20,000 trees ha^{-1} (Figure 2b, 6a), while older stands typically had < 750 trees ha^{-1} (Table 2). High initial tree density, followed by thinning, is a natural mode of regeneration and stand development in Rocky Mountain ponderosa pine-Douglas-fir forests (Peet, 1981; Lundquist and Negron, 2000; Ehle and Baker, 2003; Sherriff, 2004; See Table S4 Items 8, 11 in Supplementary Material; Figure 6a), unlike under the low-severity model. However, some young stands were not dense (Figure 7). Nonetheless, even park-like Rocky Mountain stands were denser than under the low-severity model (See Table S4 Items 3, 6, 14-16, 18 in Supplementary Material; Table 2), and nearly all Rocky Mountain ponderosa pine-Douglas-fir forests, for which there are data, were much denser, often by a factor of 5-10 times (Table 2).

How do fires of different severity affect spatial and temporal variation in tree density?

Given that stand development strongly influences tree density, how is the fire regime linked to stand development processes? Contemporary observations document that low-severity surface fires kill small ponderosa pine and Douglas-fir trees (Baker and Ehle, 2001). Similar fires killed small trees in the pre-fire exclusion era, based on forest-reserve reports from Idaho to Colorado (See Table S2 in Supplementary Material). One report, on the western Bitterroot reserve, says “a certain percentage of saplings usually pass through a fire unharmed, the amount depending on their age and the quantity of litter on the ground” (Leiberg, 1900a p. 350), which is also evident in an early photograph (Fig. 6b) and is consistent with observations of contemporary fires (Baker and Ehle, 2001).

Although low-severity surface fires kill small trees in ponderosa pine-Douglas-fir forests, tree establishment increases after these fires (Sackett, 1984; Boyce, 1985), because of reduced competition with bunchgrasses for moisture and nutrients, shown experimentally in the Southwest (Pearson, 1942). Seed germination and seedling survival are also favored by bare mineral soils (Sackett, 1984; Boyce, 1985) or scorched needles on top of mineral soil (Bonnet et al., 2005). In Rocky Mountain National Park, regeneration of ponderosa pine in the pre-EuroAmerican era was elevated within the first 10 years after low-severity fires and did not continue during longer intervals after fire (Figure 8). In Southwestern Colorado, regeneration of ponderosa pine occurred almost entirely within 20 years after fires (Wu, 1999). Forest-reserve reports also indicate that low-severity surface fires favor tree regeneration (See Table S3 in Supplementary Material). Reports from Idaho, Montana, and Wyoming-South Dakota suggest that, after surface fires, small trees are often found, sometimes in dense thickets (See Table S3 in Supplementary Material). Small trees of Douglas-fir, white fir (*Abies concolor* (Gord. & Glend.) Lindl. E Hildbr.), or other shade-tolerant species were present as thickets in the understorey of some mature ponderosa pine-Douglas-fir forests and often appear to increase after fire (See Table S3 in Supplementary Material). Short fire-free intervals or episodes of fire were found in other studies to lead to periodic cohorts of shade-tolerant trees in western ponderosa pine-Douglas-fir forests prior to EuroAmerican settlement (Wu, 1999; Agee, 2003). Regeneration may be concentrated within 1-2

decades after fire, since lower competition, bare mineral soil, and other conditions disappear as the understorey recovers. Small trees regenerating after fire can be killed by the next surface fire; long-term survival of ponderosa pine after surface fire requires a fire-free period of several decades or more (Baker and Ehle, 2001).

Ponderosa pine and Douglas-fir also regenerate after high-severity fires, often at high density, although density may vary with site conditions (Peet, 1981). In the Colorado Front Range, regeneration after high-severity fires was abundant and naturally dense (Veblen and Lorenz, 1986; Hadley and Veblen, 1993; Kaufmann et al., 2000; Ehle and Baker, 2003; Sherriff, 2004). Tree-ring dating suggests that tree regeneration also followed high-severity fires in the pre-fire exclusion era in Montana ponderosa pine-Douglas-fir forests (Arno et al., 1995, 1997) and in southwestern Colorado (Wu, 1999). Early forest exams (A.D. 1900-1915) documented dense reproduction of both Douglas-fir and ponderosa pine in places after high-severity fire on several national forests in Idaho (Ogle and DuMond, 1997). Trees generally regenerate even after very large high-severity fires. The Hayman fire in Colorado in 2002, for example, burned in part in dense, young forests that regenerated after large high-severity fires in the late 1800s (Jack, 1900). However, regeneration can sometimes be delayed (Graves, 1899; Leiberg, 1904b), creating openings that may slowly fill in over a century or more (Kaufmann et al., 2000). More typically, forest-reserve reports indicate that dense thickets of small trees naturally followed high-severity fires in both ponderosa pine (e.g., See Table S4 Items 8, 11 in Supplementary Material) and Douglas-fir (Leiberg, 1899a) forests, and this high density often persisted for decades (Table 2), suggesting that the low-severity model is inappropriate.

At the landscape scale (i.e., a few hundred ha or more) in Rocky Mountain ponderosa pine-Douglas-fir forests, variable fire severity and variation in environment led to a mosaic of patches naturally varying in age and tree density. Some patches were large. Extensive areas of old forest (e.g., > 200-year old) covered the Black Hills (Graves, 1899; Shinneman and Baker, 1997), the west side of the Bitterroot (Leiberg, 1900a), and parts of other reserves. Some reserves also had large stands of mature (e.g., > 100-

year old), but not old forest, as in Montana's Little Belt Mountains (Leiberg, 1904b). Expanses of recently burned or young ponderosa pine-Douglas-fir forest also occurred, as in the Black Hills (Graves, 1899) and southern Colorado (Jack, 1900). Some of these were in logged forests, but most were not. Other landscapes had finer-scale mosaics of burned and unburned forest of various ages (Graves, 1899). Some early photos show this finer-scale spatial variability in tree density and patch age (Figure 9). Landscape-scale fire histories with age-structure analysis (Huckaby et al., 2001; Ehle and Baker, 2003) have found similar patchy patterns. Landscape-scale evidence is scanty, but suggests that the uniform, low density, old-growth landscape, expected under the low-severity model, was not the predominant pattern in most areas of Rocky Mountain ponderosa pine-Douglas-fir forest.

Dense patches of tree establishment can often be clearly linked to documented severe fires, but climatic variability may also influence tree establishment and survival. For example, short intervals (i.e. 1-3 years) of abundant ponderosa pine establishment have been linked to short intervals of favorable climate in northern Arizona (Savage et al., 1996). Similarly, in the northern Colorado Front Range, recent (i.e., post-1970) annual episodes of ponderosa pine establishment in grassland ecotones have been linked to 1-2 year periods of wet climate (League, 2004; League and Veblen, 2006). Some retrospective studies of pre-20th century forest conditions have suggested that multi-decadal wet periods are responsible for 30-40 year pulses of tree regeneration evident in age structures in the Rockies (Boyden et al., 2005; Brown and Cook, 2005; Brown and Wu, 2005). However, some of the pulses during wet periods were immediately preceded by fires (e.g., A.D. 1684 and 1818 in Brown and Wu, 2005), and the effects of fire and climate are thus confounded. Furthermore, some wet periods are not associated with above average numbers of tree establishment dates in these studies. Other age-structure studies in the Front Range have not shown a clear association between episodes of establishment of ponderosa pine and climatic variability, independent of fire (Mast et al., 1998; Kaufmann et al., 2001; Ehle and Baker, 2003). However, these retrospective age-structure studies all have limited ability to resolve potential confounding of fire and climate effects over the long-term or of grazing and, in some cases, logging

1 effects during the past c. 150 years. Future studies need to overcome the confounding and potential
 2 complexity of interactions that have limited the ability to retrospectively identify and quantify a climatic
 3 effect on tree regeneration.

4 In summary, under the variable-severity model, which appears to better fit the available evidence for
 5 ponderosa pine-Douglas-fir forests in the Rocky Mountains, the landscape mosaic naturally varies over
 6 time and space as a result of variable-severity fire and other processes that kill trees and facilitate
 7 regeneration. After high-severity fire or other disturbance, a pulse of dense tree regeneration may occur
 8 and, as these trees mature, tree density increases relative to the pre-disturbance forest (Veblen and
 9 Lorenz, 1986; Ehle and Baker, 2003; Sherriff, 2004). Ongoing low-severity fires, as well as insects,
 10 disease, and other small disturbances may kill a tree or small groups, lowering density, but also
 11 encouraging new regeneration, resulting in a fine age mosaic (Lundquist and Negron, 2000). However,
 12 the next moderate or high-severity event may kill larger groups of these trees, reducing tree density again,
 13 though trees remain denser than expected under the low-severity model. Since fires and other events are
 14 spatially variable, adjacent or nearby stands, at an instant in time, may differ significantly in tree density,
 15 age, and fuel loads (Hadley and Veblen, 1993; Ehle and Baker, 2003; Sherriff, 2004).

17 **How did historical fire regimes affect fuels?**

18 Ideas about how fuel loads fluctuated during the pre-fire exclusion era must be inferred from
 19 contemporary observations of trends in fuel with time since fire and inferences about changes in the
 20 processes that produce and consume fuels, since there are no direct data on fuel loads in the pre-fire
 21 exclusion era. Under the low-severity model, large, dead wood should be maintained at relatively low
 22 levels by low-severity surface fires. Since fire is a principal fuel-load regulator, fuel accumulation would
 23 be relatively more homogeneous than where fire severity is highly variable. Under a variable fire-severity
 24 model, fuel beds would tend to be strongly spatially heterogeneous, and not accumulate consistently after
 25 fires. Moreover, other processes (e.g., disease, windstorms) may so affect fuel production rates and

patterns that a consistent response to fire or fire exclusion is clouded or not at all evident.

In the Rocky Mountains, large data sets from the northern Rockies (n=6706 plots; Brown and See, 1981) and Colorado (n=328 plots; Robertson and Bowser, 1999) indicate that the particulars of a stand's history (e.g., timing of fires or windstorms) determine fuel loads, and these loads are spatially heterogenous. Specifically, the multiple processes that produce dead fuels, such as disease and disturbances (e.g., root disease, beetles, lightning, wind, fire, and frosts), damage and kill trees of all ages. Spatio-temporal variability in these processes prevents consistent trends in fuel buildup (Knight, 1987; Robertson and Bowser, 1999; Lundquist and Negron, 2000; Harmon, 2002). The available evidence appears more consistent with the variable-severity model, which emphasizes variability in the landscape fuel mosaic and the multiple fuel-producing processes.

THE EFFECTS OF LAND USES ON FOREST CONDITIONS

The effects of land uses on forest structure are comparatively well known for the low-severity model (e.g., Friederici, 2003), and are likely similar in the Rocky Mountains where this model is appropriate. However, in most of the region, where the variable-severity model is more appropriate, tree density, age, and fuels were highly variable, making responses to land use difficult to detect or attribute to a land use. Rephotography shows that tree cover has increased in some Rocky Mountain ponderosa pine-Douglas-fir forests over the last century (e.g., Veblen and Lorenz, 1991), and there is also evidence of density increase from tree-ring reconstructions (e.g., McAdams, 1995). There are many plausible explanations of these changes, including natural processes (e.g., recovery after disturbance), reviewed earlier, as well as land-use effects (fire exclusion, logging, and livestock grazing), which are now discussed in turn.

Effects of fire exclusion on tree density and fuels

Researchers have commonly assumed that long intervals between fires will lead to increased survival of tree regeneration, so excluding fires is thought to increase tree density (e.g., Arno et al., 1997). This

1 may be true under the low-severity model, but, in the variable-severity model, the effects of fire
2 exclusion are more complex. After severe fires, both ponderosa pine and Douglas-fir typically establish
3 abundantly. Less fire in the 20th century (Brown et al., 1999; Veblen et al., 2000) has resulted in
4 comparatively fewer opportunities for tree establishment. This is reflected in tree population age
5 structures indicating abundant establishment for several decades following severe fires in the 19th
6 century and relatively little establishment during the 20th century (Veblen and Lorenz, 1986; Ehle and
7 Baker, 2003; Sherriff, 2004). Some ponderosa pine-Douglas-fir fires in the late-1800s and early 1900s
8 burned severely during regional drought years (e.g., 1851, 1872, 1879, 1880, 1889, 1910, 1919) that
9 affected large parts of the Rocky Mountain region (Barrett et al., 1997; Brown et al., 1999; Veblen et al.,
10 2000; Sherriff, 2004). Thus, the high stand densities, that are interpreted as effects of fire exclusion in the
11 low-severity model, in the variable-severity model may reflect recovery after these widespread, severe
12 fires and also logging (see below) in the late-19th century.

13 Exclusion of low-severity fire, under the variable-severity model, can reduce, not increase ponderosa
14 pine regeneration (Ehle and Baker, 2003), but can also enhance seedling survival under certain
15 circumstances. Elsewhere in the West, relict mesas that were never grazed by livestock, but that had long
16 intervals without fire, show that tree regeneration may be low where surface fires are rare or are excluded
17 and disturbances from human activities do not occur (Rummell, 1951; Madany and West, 1983). Fire
18 exclusion in undisturbed forests may reduce ponderosa pine regeneration (Ehle and Baker, 2003), but in
19 the post-settlement era, where soil disturbance associated with mining or road construction promotes
20 ponderosa pine establishment (Sherriff, 2004), the survival of these juveniles would be enhanced by
21 subsequent fire exclusion. At low elevation sites in the Front Range, where the low-severity model more
22 likely applies, climatic variation in ecotonal areas also promoted seedling establishment (League, 2004)
23 and ponderosa pine generally survived abundantly in the 20th century following the exclusion of low-
24 severity fires which otherwise could have killed the seedlings (Mast et al., 1998; Sherriff, 2004).
25 However, the relative importance of livestock grazing and other disturbances in triggering this tree

establishment is not known. Overall, available evidence suggests that, where the variable-severity model applies, observed post-settlement tree density increases are most typically recovery from past mixed- or high-severity fires or logging. Exclusion of low-severity fires may only have facilitated tree regeneration on otherwise disturbed sites, or where the low-severity model applies on low elevation xeric sites (Sherriff, 2004).

Has fire exclusion resulted in unnatural fuel buildups that have shifted the fire regime towards significantly more severe fires? The complexity of this question is illustrated here for the example of large, dead wood, only one of several types of fuel. Fire exclusion affects not only the rate of consumption of fuels, but the rate of processes that produce fuels (e.g., tree mortality). Excluding fires lowers consumption of wood on the forest floor, but also shuts down the damage and mortality process, potentially decreasing the production of dead fuels from live trees (Harmon, 2002). Excluding fires reduces the input of snags and dead wood that are the largest dead fuels in these forests (Brown and See, 1981), leaving this wood in live trees that are less flammable. Large, dead wood and associated smaller branchwood and twigs can increase fire intensity and severity (Agee, 1993; Brown et al., 2003), so the contribution of dead wood to fire severity could be reduced, not increased by fire exclusion. Is there empirical evidence that dead wood has or has not built up? In Rocky Mountain National Park, the deaths of 110 down or standing dead trees dated in 9 plots in ponderosa pine forests did not support the hypothesis that dead wood had built up since fire exclusion in 1915 (Fig. 9; Ehle and Baker, 2003). Furthermore, substantial amounts of large, dead wood on the floor in Colorado ponderosa pine-Douglas-fir forests are not recent inputs, but have been there for hundreds of years (Fig. 9; Brown et al., 1999).

Present loadings of large, dead wood (generally > 3" dia.) in Rocky Mountain ponderosa pine-Douglas-fir forests range widely. The mass of large, dead wood in mature Colorado ponderosa pine-Douglas-fir forests is low (mean = 3.4 Mg ha⁻¹ for 328 plots--Robertson and Bowser, 1999) relative to similar forests in the northern Rockies (9-23 Mg ha⁻¹--Brown and See, 1981), Black Hills (mean = 12.7 Mg ha⁻¹ for 151 plots in a variety of forests--Reich et al., 2004), and Southwest (18 Mg ha⁻¹--Sackett,

1979). At one site in southwestern Colorado, large wood averaged 17.7 Mg ha^{-1} (Romme et al., 1992).

Since there are no direct data on fuel loads in the pre-fire exclusion era, present fuel loads can only be evaluated in a relative sense. For example, in the northern Rockies, Brown and See (1981) estimated the wood needed for wildlife habitat and mycorrhizal activity, indicators of ecosystem health, and said "...ponderosa pine and Douglas-fir cover types are deficient in downed woody material or contain only slight excesses," (p. 9) as $22\text{-}34 \text{ Mg ha}^{-1}$ were considered by these authors to be necessary, above most existing fuel levels in these forests. Brown et al. (2003) recommended $11\text{-}45 \text{ Mg ha}^{-1}$ in warm, dry ponderosa pine and Douglas-fir, and up to 67 Mg ha^{-1} in cool Douglas-fir forests, as an optimum to maintain soil health, while keeping fire hazard low. They also suggest that high fire hazard occurs if large dead fuels exceed about 55 Mg ha^{-1} , well above present fuel loads in most Rocky Mountain ponderosa pine-Douglas-fir forests.

The notion, under the low-severity model, that fire exclusion leads to fuel buildup to hazardous levels is not supported in the case of large, dead wood in most Rocky Mountain ponderosa pine-Douglas-fir forests. Nor does tree density, often considered a fuel, necessarily increase with only fire exclusion in these forests, as reviewed earlier. Available evidence suggests that, in most Rocky Mountain ponderosa pine-Douglas-fir forests where the variable-severity model applies, there is no need to decrease large, dead wood (> 3 " dia.), if the goal is to offset effects of fire exclusion in ecological restoration. Retaining or increasing large, dead wood may be a more common restoration need in forests affected by fire exclusion or by logging, reviewed next.

Effects of logging and livestock grazing on tree density and fuels

It has long been known that logging of large overstory trees in ponderosa pine forests can lead to a pulse of tree regeneration, often concentrated within one to a few decades after logging, and this pulse, if it occurs, later can become a dense, young understorey in the forest (Curtis and Wilson, 1958; Smith and Arno, 1999). For example, the Lick Creek study in Montana documented that an original stand of about

125 trees ha⁻¹ before logging in 1907-1911 had over 1,500 trees ha⁻¹ by 1948 (Smith and Arno, 1999). Logging is favorable to the establishment of the relatively shade-intolerant ponderosa pine by opening up the stand and exposing bare mineral soil suitable for tree seedling establishment, but the density of establishment after logging is highly variable (Schubert, 1974; Veblen and Lorenz, 1986; Heidmann, 1988). Kaufmann et al. (2000), for example, found total tree densities were significantly higher on only about half of a logged landscape relative to the comparable, unlogged Cheesman Lake landscape of Colorado. Many ponderosa pine-Douglas-fir forests had been high-grade logged by about A.D. 1900 (e.g., Graves, 1899; Romme et al., 2000), leading to potential tree-density increases during recovery, a process that continues today. In the northern Colorado Front Range, most sites of ponderosa pine-Douglas fir forests logged in the late 19th or early 20th centuries now support dense populations of young trees, although many of these sites were also burned and grazed (Veblen and Lorenz, 1986, 1991).

Logging may increase or decrease fuels, depending on whether stumps and residual material (slash) are burned or removed, but large, dead wood is clearly reduced since tree boles are removed. In the early days, slash was routinely left, greatly increasing the loadings of small and fine fuels that most directly affect fire severity (Dodge, 1972; Harmon, 2002). As wood became more valuable, less was left, and sanitation-salvage operations also removed snags and dead wood, so that wood fell below historical levels, leading eventually to minimum standards for retention after harvest (Harmon, 2002). Where logging removes larger, more fire-resistant trees, the smaller fuels (including small, live trees) that contribute to fire severity may still be increased (Weatherspoon and Skinner, 1995). Logged forests today may often be deficient in large, dead wood, since tree boles were removed, and this wood may often need to be increased when restoring logged stands.

Livestock grazing may have complex effects, but generally increases tree density in formerly open stands and thereby increases the fine fuels that contribute most to fire intensity and severity. Removal of grass reduces competition, allowing more trees to successfully regenerate, shown experimentally in the Southwest (Pearson, 1942), and also by paired comparisons in other parts of the West, in which mesas

1 subject to livestock grazing have much higher tree density than do comparable nearby ungrazed mesas
2 (Rummell, 1951; Madany and West, 1983). Grazing can also initially reduce the quantity of fine grass
3 fuels needed for surface fires, and the onset of heavy grazing in southwestern ponderosa pine landscapes
4 is temporally associated with a marked reduction in surface fires (e.g., Savage and Swetnam, 1990).
5 However, fine fuels likely did not remain low for long. Higher tree density increases fine fuels that lead
6 to faster fire spread and increases ladder fuels that lead fire into the canopy (Zimmerman and
7 Neuenschwander, 1984), together increasing the potential for more fires and more severe fires. However,
8 this potential effect is most important in mature and old-growth forests, which are rare today, and in
9 younger forests, evidence of tree density increase is difficult to detect or is minor, as explained later.

10 In Rocky Mountain ponderosa pine-Douglas-fir forests, most of the apparent increase in tree density
11 over the last century is not in undisturbed mature forests, but in the younger forests that predominate
12 today that may not be overly dense for their age, as explained later. These young forests regenerated after
13 burning and/or logging, accompanied in some places by overgrazing, since EuroAmerican settlement, and
14 are now recovering from these disturbances, as is well documented in the Black Hills and southern
15 Rockies (Gary and Currie, 1977; Veblen and Lorenz, 1986; Shinneman and Baker, 1997; Romme et al.,
16 2000). Extreme droughts in these areas during the second half of the 19th century promoted widespread
17 fires, ignited either by humans or by lightning, which today are reflected in extensive areas of dense,
18 post-fire stands (Veblen et al., 2000; Schoennagel et al., 2004). However, every forest-reserve report
19 (Figure 1) documents wasteful logging as well as large fires, that were thought to have been set by early
20 settlers, so this pattern occurs throughout the Rockies..

21 Ponderosa pine-Douglas-fir landscapes in the Rocky Mountains today have increased tree density
22 and tree size due in part to normal recovery from these past natural (fire) and human disturbances. Tree
23 regeneration may continue for 30-50 years after these major disturbances (Veblen and Lorenz, 1986), and
24 density may appear to increase for some time after that, as trees grow taller and crowns expand, filling in
25 the canopy. Early historical photographs reveal many burned and/or logged ponderosa pine-Douglas-fir

forests that were already dense at the time of their disturbance in the 19th century (e.g., Veblen and Lorenz, 1991). Tree density increase, due to recovery from past disturbance, does not necessarily require restoration, as explained further in the next section.

RESTORATION

Identifying the restoration model for a particular landscape

The goal of ecological restoration is to enhance the resilience and sustainability of ecosystems through management decisions that return them to a state considered within the historical range of conditions prior to significant impacts from EuroAmerican land uses (Landres et al., 1999). To achieve ecological restoration, as well as ecosystem-based management in general, managers need to understand how past disturbances shaped landscapes prior to permanent EuroAmerican settlement (Veblen, 2003a).

It is impossible to determine the correct restoration model for a particular place without some collection of information on the site to be restored (White and Walker, 1997; Veblen, 2003a). In ponderosa pine-Douglas-fir ecosystems of the Rocky Mountains, over short distances, such as on slopes of opposite aspect, either the low-severity or the variable-severity model may apply (Ehle and Baker, 2003; Sherriff, 2004). How is the model to be determined? The key criterion to distinguish these two models is the presence or absence of high-severity or variable-severity fires prior to logging and fire exclusion. Abundant fire scars of different dates are required to document the low-severity model, but it is necessary to sample sufficient age structure, along with fire scars, to determine whether trees regenerated in a pulse, suggesting high-severity fire occurred (Kaufmann et al., 2000; Ehle and Baker, 2003; Sherriff, 2004). Dating down wood to identify episodes of synchronous tree death (Ehle and Baker, 2003) and dating growth releases on surviving trees (Goldblum and Veblen, 1992) can help date past high-severity fires. It is also essential to cross-date fires, so individual fires can be traced, as well as to have multiple, unbiased sampling locations across a landscape (e.g., Bekker and Taylor, 2001). Once a set of sites has been classified by fire regime, it is possible to produce a predictive map of fire regimes

(Sherriff, 2004). Of course, site-specific and local fire-history data may lead to new models, or allow more definition of these two models. For example, more data are needed to be able to specify the relative importance of high-severity or mixed-severity fire where the variable-severity model is appropriate.

Identifying land-use effects, followed by reversal and modification

Under the variable-severity model, to determine if tree density in a particular stand is outside the range of historical variability requires comparison with historical data from stands at the same stage of development (Table 2), not with more mature or old-growth forests. Forests logged around A.D. 1900, that are roughly a century old today, are compared to 100-year old stands around A.D. 1900, which had up to about 750 trees ha⁻¹ (Table 2), a density not likely to be exceeded today in many cases. For example, an 80-year old ponderosa pine stand in Montana had 593 trees ha⁻¹ in the 1990s (Arno et al., 1995), a density not exceptional in forests of this age in the northern Rockies near A.D. 1900 (Table 2). Similarly, present densities of trees in relatively undisturbed mature forests in Colorado average 241 trees ha⁻¹, ranging from 40 to 810 trees ha⁻¹ (n=328 plots; Robertson and Bowser, 1999), comparable to the range of variability in tree densities for similar mature stands near or before A.D. 1900 (Table 2). Local tree-density estimates must be used, but thinning today's forests, whether young or old, to dramatically lower tree densities, is not likely to be warranted at the stand level in most Rocky Mountain ponderosa pine-Douglas-fir forests where the variable-severity model applies.

Although livestock grazing and logging or physical disturbances (e.g., roads, mining) are expected to have increased tree density, the pattern and magnitude of this increase is difficult to quantify at the stand level, given high natural variability in density. To determine this requires detailed analysis of age-structure for comparison of nearby logged and unlogged forests (e.g., Kaufmann et al., 2000), and analysis of livestock grazing records or records of other disturbance. Relatively undisturbed mature forests are likely not far outside historical variability for tree density and fuels, as suggested above. Thus, this type of research may not be cost-effective for these forests, particularly since as these stands age,

1 natural thinning processes and passive restoration of low-severity fire may accomplish some reduction in
 2 density. The most effective restoration strategy for undisturbed mature and old-growth forests is likely a
 3 passive approach, in which fire is restored, but natural processes (from fire and other sources of
 4 mortality) accomplish gradual restoration of tree density and fuels.

5 A complex restoration problem that does require research is the matter of shade-tolerant trees (e.g.,
 6 white fir, Douglas-fir), which are often thought to have increased in ponderosa pine forests because of
 7 fire exclusion or logging (e.g., Arno et al., 1995; Wu, 1999; Kaufmann et al., 2001; Keane et al., 2002a).
 8 Livestock grazing has also been shown, in an exclosure study, to favor Douglas-fir regeneration in mixed
 9 forests (Zimmerman and Neuenschwander, 1984). The hypothesis for increased Douglas-fir, based on the
 10 low-severity model, is that cessation of frequent surface fires is allowing Douglas-fir to invade ponderosa
 11 pine stands. However, fire-scar and tree age data do not support that hypothesis, at least for the northern
 12 Colorado Front Range (Sherriff, 2004). Evidence was also presented earlier that these trees were present
 13 in other Rocky Mountain forests near or before A.D. 1900 as a component of the canopy of some mature
 14 forests, as thickets in the understorey of some forests, and often appear to increase after fire (See Table
 15 S3 in Supplementary Material). Moreover, past episodes of high-severity fires associated with droughts
 16 also would have resulted in patchy stand ages across landscapes (Veblen et al., 2000), and therefore
 17 varying relative abundances of ponderosa pine and Douglas-fir (Agee, 2003). Since multiple explanations
 18 exist for the presence and abundance of young, shade-tolerant trees, these trees need to be dated and
 19 linked definitively to a particular land use (e.g., livestock grazing, logging, fire exclusion) before their
 20 removal is ecologically appropriate in restoration, and so that the correct land use, as discussed later, can
 21 be modified.

22 Where the low-severity model applies, restoration at the stand level is appropriate. At low elevations
 23 in the northern Colorado Front Range, near the ecotone with the Plains grassland, thinning to restore
 24 more open conditions is consistent with evidence of past fire and landscape structure (Sherriff, 2004).
 25 We caution, however, that the extent of the landscape in this area that fits this more low-severity model

1 for ponderosa pine is only about 20% of the ponderosa pine zone. Relatively little of the area suitable for
2 restoration through thinning is on Forest Service land, which is the main source of funding for both
3 restoration and fire hazard reduction (Platt, 2004).

4 Under the variable-severity model, the proportions of the historical landscape that contained patches
5 of different age and tree density would have varied substantially over time due to relatively long periods
6 with minimal fire occurrence followed by episodes of widespread and severe burning at landscape scales
7 (Brown et al., 1999; Veblen et al., 2000). This is an important contrast with the low-severity model in
8 which low-severity fires are believed to have occurred often enough to maintain a relatively uniform
9 uneven-aged old-growth landscape (Covington and Moore, 1994). For the variable-severity fire regime,
10 more research is needed to characterize historical spatial variability in the proportions and configurations
11 of particular categories of forest age, fuel loads, and tree density across landscapes. However, any fixed
12 restoration target (e.g., crown closure in A.D. 1900–Kaufmann et al., 2001), under the variable-severity
13 model is inappropriate, as it may just be an instant when crown closure happened to be low due to
14 preceding fires that were particularly high in severity. Instead a multi-century, landscape-scale restoration
15 framework is needed. Although the variable-severity restoration model is incomplete at the landscape
16 scale, it can still guide management response to severe fires. For example, the modern occurrence of
17 extensive and severe fires in the Rocky Mountains should not be perceived as outside the historical range
18 of variability for ponderosa pine-Douglas-fir forest forests, and should not trigger efforts to create forest
19 structures that would exclusively support low-severity fires.

20 Current knowledge is sufficient for guiding efforts to restore old-growth structures today which are
21 scarce due to widespread logging and anthropogenic burning in the late 19th to early 20th centuries
22 (Veblen and Lorenz, 1986; Schoennagel et al., 2004). Slight thinning and prescribed fire could be used to
23 encourage development of structures (e.g., large trees, down wood) typical of later stages of stand
24 development in some of these young stands as a step in the direction of restoration at the landscape scale
25 (Kaufmann et al., 2001). The resulting increase in sizes of ponderosa pine will result in larger seed crops

favorable to wildlife and also in nesting sites for cavity-nesting birds (Krannitz and Duarlia, 2004). However, in management aimed at accelerating the recovery of old-growth structures, protection of all pre-EuroAmerican trees is needed to ensure that this restoration truly leads to old forests, and the wood from thinning is generally needed to replenish wood lost to logging or burning.

If even the modest landscape restoration warranted now is begun without identification of land-use effects at the stand level and modification of those land uses, restoration may be futile. Identification of which land uses affected a stand proposed for restoration is essential. Fire exclusion, logging, and livestock grazing do not have the same effects on these forests, their effects vary with environment, and they require different restoration actions. Before restoration begins, it makes sense to modify or minimize the particular land-uses that led to the need for restoration, to avoid repeating degradation and ongoing, periodic subsidies that merely maintain land uses at non-sustainable levels (Hobbs and Norton, 1996). For example, thinning an overgrazed forest, without restoring native bunchgrasses lost to grazing, may simply lead to a new pulse of tree regeneration that will have to be thinned again. Moreover, if bunchgrasses are restored, new grazing methods that will sustain restored native bunchgrasses are needed. These bunchgrasses have been shown in Southwestern forests to be a key ecosystem component that discourages or prevents tree regeneration (Pearson, 1942).

CONCLUSIONS

The data available to address the applicability of the variable-severity and low-severity models include about 80 observations from 16 forest reserve reports (Figure 1), supplementary historical analyses (e.g., Shinneman and Baker 1997), 10 fire scar/age structure studies (Figure 3a), and 20 direct measurements or reconstructions of tree density near A.D. 1900 (Figure 3b, Table 2). Based on these data together, the variable-severity model, which emphasizes an important role for severe fires in the historical fire regime, appears to apply to a larger portion of the ponderosa pine-Douglas-fir zone in the Rocky Mountains than does the low-severity model. In most Rocky Mountain ponderosa pine-Douglas-fir

1 forests, the variable-severity model, in which forest structures were shaped mainly by infrequent severe
2 fires, is consistent with the evidence of fire history and tree age structures in these forests. Only limited
3 areas of ponderosa pine-Douglas-fir forests in the Rocky Mountains, primarily at low elevations and on
4 xeric sites, appear to have been shaped primarily by low-severity fires. To assess which model may best
5 fit a potential management area, site-specific information on fire history and forest conditions is required.

6 For the purpose of ecological restoration in Rocky Mountain ponderosa pine-Douglas fir landscapes,
7 the most appropriate action at the present time is a mixture of modest passive and active approaches.
8 Undisturbed mature forests require little or no restoration—a passive approach is best. Active approaches
9 may include a little thinning of young stands to enhance structures typical of later stages of development,
10 combined with protection of old trees, reversal of adverse effects of logging and livestock grazing, and
11 changes in land uses so they do not continue to cause degradation. Reintroduction of both low-severity
12 surface fires and high-severity fires may be feasible under some circumstances of land use. However,
13 reintroduction of fire should not be based on converting dense, mature stands into sparse open woodlands
14 based on the false premise that surface fires previously maintained tree populations at low densities.
15 Thinning these forests is likely to lead to renewed tree regeneration, hence a need for renewed thinning,
16 in a potentially endless, costly, and futile cycle that does not restore the forest. Large, dead wood in most
17 of these forests does not need reduction; certainly, raking, piling, and burning large, dead wood is mis-
18 directed, as these fuels may be ancient and are more likely to be in deficit than in surplus. A modest suite
19 of reversal-reform approaches will provide benefits for both people and the ecosystem, and can begin
20 today, even without needed research at the landscape scale. Ponderosa pine-Douglas-fir forests in the
21 Rocky Mountains, where the variable-severity model applies, are not in seriously degraded condition,
22 compared to forests in which the low-severity model applies, and do not require much costly thinning and
23 other active restoration actions. The variable-severity model, which applies to most of these forests,
24 suggests that Rocky Mountain ponderosa pine-Douglas-fir landscapes historically were dense, have long
25 been naturally fire-prone, dangerous places to live, and will remain so after restoration.

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3
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12
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Table 1. Comparison of two models of fire and forest structure in ponderosa pine and ponderosa pine-Douglas-fir forests.

Low-Severity Model

Old-growth trees dominant

Low-severity surface fires only

Trees widely spaced, tree density low

Low-severity fires kill few canopy trees

Tree regeneration commonly

linked to climate

Frequent surface fires:

1. kill most small trees

2. prevent fuel buildup

Fire exclusion leads to:

1. high tree regeneration

2. fuel buildup

3. uncharacteristic high-severity fires

Variable-Severity Model

Old-growth patches common, but patches of other ages occur

Variable fire severity: low-severity surface fires, mixed severity, and high severity

Trees varying from dense to widely spaced

Moderate and high-severity fires kill canopy trees in groups or over large areas

Tree regeneration enhanced after fires and

sometimes linked to climate

Surface fires:

1. kill some small trees, leaving some patches

2. have varied effects on fuels

3. enhance tree regeneration

Fire exclusion leads to:

1. low tree regeneration

2. varied fuel effects

3. decrease in natural high-severity fires

Table 2. Estimates of tree density in Rocky Mountain ponderosa pine (PIPO)-Douglas-fir (PSME) forests near or before A.D. 1900. These estimates are either (1) direct reports from near A.D. 1900 by scientists or (2) reconstructions, based on current trees that were alive near A.D. 1900.

Fig.

3b	Range	Range					
no.	(trees acre⁻¹)	(trees ha⁻¹)	Notes	Forest Type	Age of Forest	Reference	
1	7-288	17-710	larger trees only (e.g., > 30 cm)	PIPO	Variable	Brown and Cook, 2005 ^a	
2	10-294	25-725	mean=344 trees ha ⁻¹	PIPO	Unknown	McAdams, 1995 (< 2,000 bf/acre forests) ^b	
3	16-1,380	39-3,410	trees > 4 cm	PIPO & PSME	100-250 years	Sherriff, 2004 ^c	
4	20-30	49-74	trees > 70 cm	PIPO & PSME	Unknown	Table S4 Item 6 in Suppl. Material	
5	28-116	68-286	trees > 5 cm	PIPO	100-200 years	Ehle & Baker, 2003 ^d	
6	47-101	116-249	pre-1900 trees only	PIPO & PSME	205-445 years	Arno et al., 1995 ^e	
7	81	200	trees > 1.37 m tall	PIPO	ca. 90 years	Boyden et al., 2005	
8	88	217	trees > 12.7 cm	PIPO	Likely > 200 years	Pinchot, 1908 Table 1	
9	93	230	trees > 12.7 cm	PIPO & PSME	Likely > 300 years	Pinchot, 1908 Table 3	
10	100-120	247-296		PSME	Unknown	Table S4 Item 12 in Suppl. Material	
11	107-143	264-353	From ratios in description	PIPO	“Orig. forest” (old growth)	Table S4 Item 10 in Suppl. Material	

1	12	111-648	275-1,600	mean=633 trees ha ⁻¹	PIPO	Unknown	McAdams, 1995 (2-5,000 bf/acre forests) ^b
2	13	150-200	370-494		PIPO	100 years	Table S4 Item 10 in Suppl. Material
3	14	200-300	494-741	trees > 10 cm in “second growth”	PIPO	Likely < 100 years	Table S4 Item 7 in Suppl. Material
4	15	200-300	494-741		PSME	100-150 years	Table S4 Item 4 in Suppl. Material
5	16	402-1,236	992-3,052	trees > 5 cm	PIPO	20-40 years	Ehle & Baker, 2003 ^c
6	17	800-1,500	1,976-3,705	“in some localities”	PIPO & PSME	Unknown	Table S4 Item 1 in Suppl. Material
7	18	800-1,500	1,976-3,705	trees > 10 cm in “second growth”	PSME	Likely < 100 years	Table S4 Item 7 in Suppl. Material
8	19	1,000-3,000	2,470-7,410		PSME	Young	Table S4 Item 4 in Suppl. Material
9	20	7,000-8,000	17,290-19,760		PIPO	Young	Table S4 Item 11 in Suppl. Material
10							

11 ^a This estimate excludes goshawk plots, since some of those were not forested in A.D. 1900. Tree density in 1900 is likely underestimated due to loss of
12 small trees present in 1900 (Brown and Cook, 2005).

13 ^b This estimate is tree density in A.D. 1874, not 1900. Tree density in 1874 is likely underestimated due to loss of small trees present in 1874.

14 ^c This estimate is tree density in A.D. 2003, not A.D.1900, but stand age was estimated for A.D. 1900. These trees were all alive in A.D. 1900, but
15 others likely died and have disappeared, so this is an underestimate of A.D. 1900 density.

16 ^d This estimate is tree density in A.D. 1999, not A.D.1900, but stand age was estimated for A.D. 1900. These trees were all alive in A.D. 1900, but
17 others likely died and have disappeared, so this is an underestimate of A.D. 1900 density.

1 ^e The estimate was derived by adding “number of overstory trees per acre in 1991-93” and “estimated number of overstory trees per acre that died after
2 1900” from their Table 2, excluding Flathead stands, which have a mixture of tree species.

3

Figure Headings

Figure 1. Location of forest-reserves and the reports used in this study. The boundary of the Rocky Mountains is shaded as a backdrop.

Figure 2. (a) Old-growth ponderosa pine forest is the restoration target under the Southwestern model. This is an example of an open, park-like old-growth stand in the Bitterroot forest-reserve in the late 1800s (Reproduced from Leiberg, 1899a, plate LXX). Patches of these old, low-density trees and (b) young, high-density trees in the late 1800s (Reproduced from Graves, 1899, plate XXXIV) are included in the restoration target under the Rocky Mountain model.

Figure 3. Data sources include (a) tree-ring studies of fire history and (b) direct measurements and tree-ring reconstructions of tree density near A.D. 1900. In (a) fire-history studies that lack age structure and include only fire scar data are not used, as they do not provide evidence about fire severity; citations for those studies not identified on the map are in Baker and Ehle (2003). Eight of the 10 studies that do include both age structure and fire scars document stands in each sample area in which both the variable- and the low-severity models apply, but two other studies are here considered uncertain (see text); In (b) see Table 2 for the data corresponding to each number.

Figure 4. High-severity fire in a ponderosa-pine forest in the Black Hills in the late 1800s (Reproduced from Graves, 1899, plate XXXV).

Figure 5. Variation in fire severity, Hayman Fire, Colorado, 2002. Derived from U.S. Geological Survey composite image of differenced normalized burn ratio from Landsat TM (<http://edc2.usgs.gov/fsp/severity>).

Figure 6. (a) Dense, young ponderosa pine trees regenerating naturally after high-severity fire in the late 1800s (reproduced from Graves, 1899 plate XXI A), and (b) a surface fire and a small, dense group of regenerating ponderosa pine trees in the Black Hills in the late 1800s (reproduced from Graves, 1899 plate XXI B).

Figure 7. Young, open, low-density ponderosa-pine forest in the Lewis and Clarke forest reserve in the late-1800s (Reproduced from Ayres, 1900a, plate IX, part B).

Figure 8. Observed (solid bars) and expected (shaded bars) density of tree regeneration versus interval since fire for (a) low-severity surface fires and (b) high-severity fires in ponderosa pine forests in Rocky Mountain National Park, Colorado. Expected density is the same total density assigned proportion to the actual frequency of fire intervals. Reproduced from Ehle and Baker (2003--*Ecological Monographs*, 73, 558) with permission of the Ecological Society of America.

Figure 9. A ponderosa pine landscape in A.D. 1903 along Hermosa Creek about 25 km north of Durango, Colorado. Photo by E. Howe (No. 204) courtesy of the U.S. Geological Survey Photographic Library, Denver, Colorado.

Figure 10. Estimated fifty-year period when dead wood died in 9 plots in ponderosa pine forests in Rocky Mountain National Park, Colorado. The null hypothesis, that tree deaths are independent of fifty-year period since 1650, cannot be rejected ($\text{Chi-square} = 3.102$, $p = 0.796$).

Figure 1



Figure 2



Figure 3

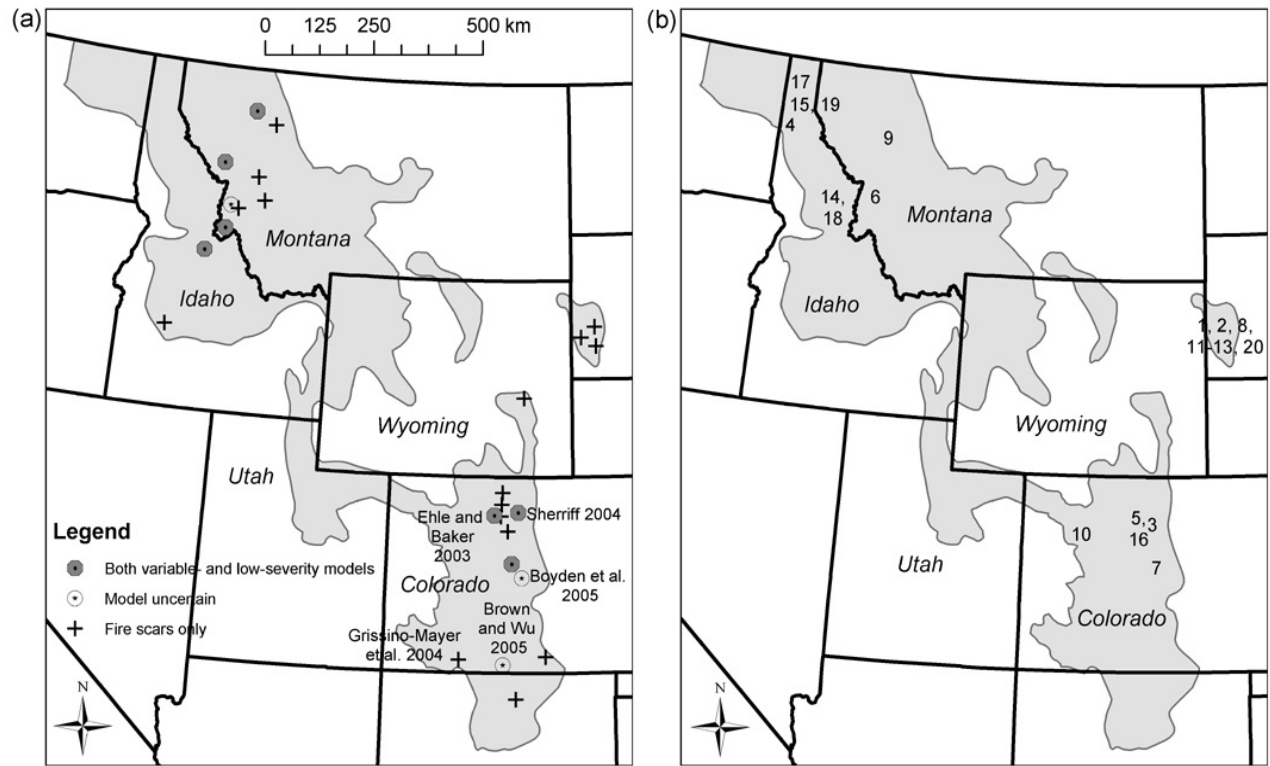


Figure 4



Figure 5

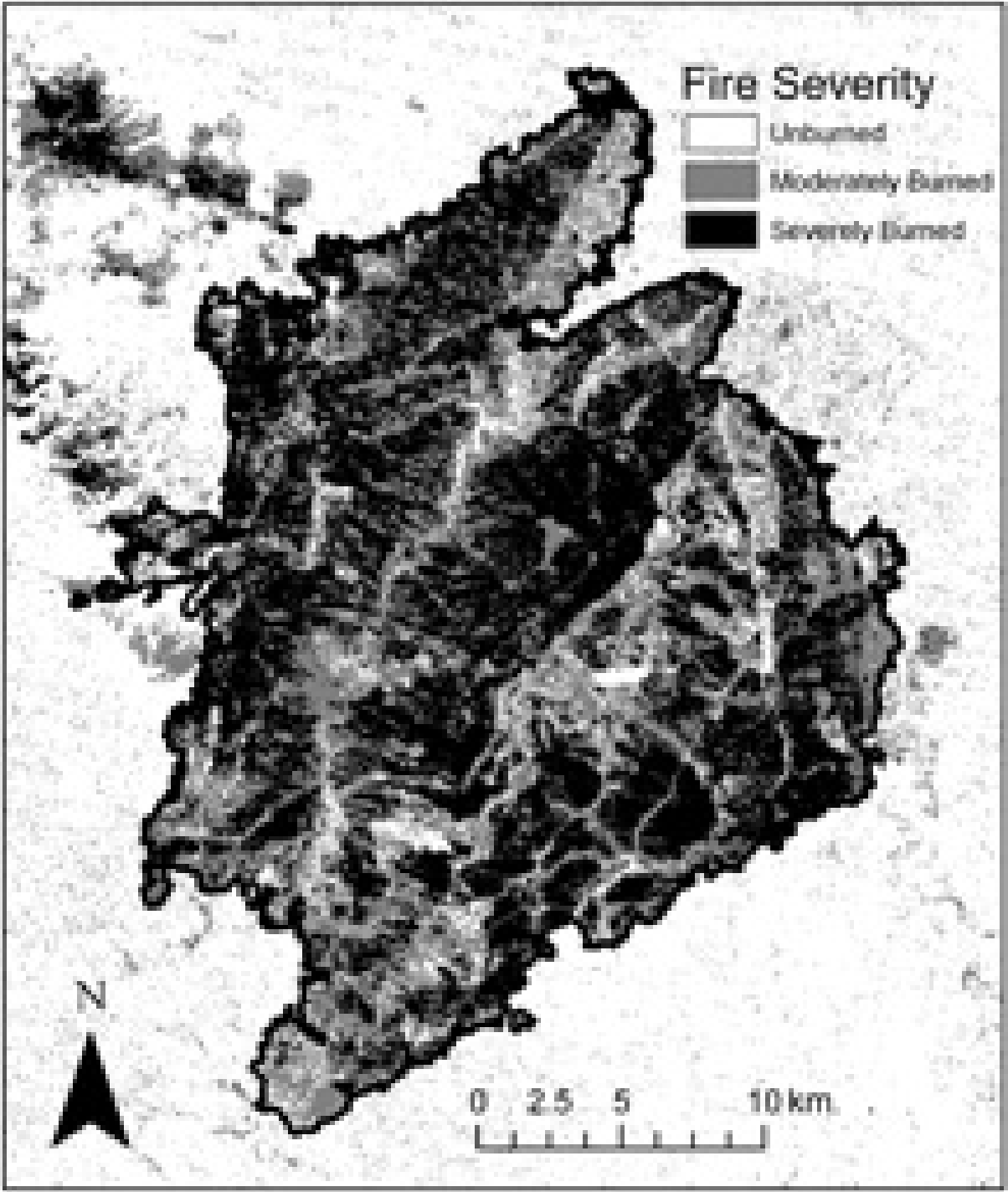


Figure 6

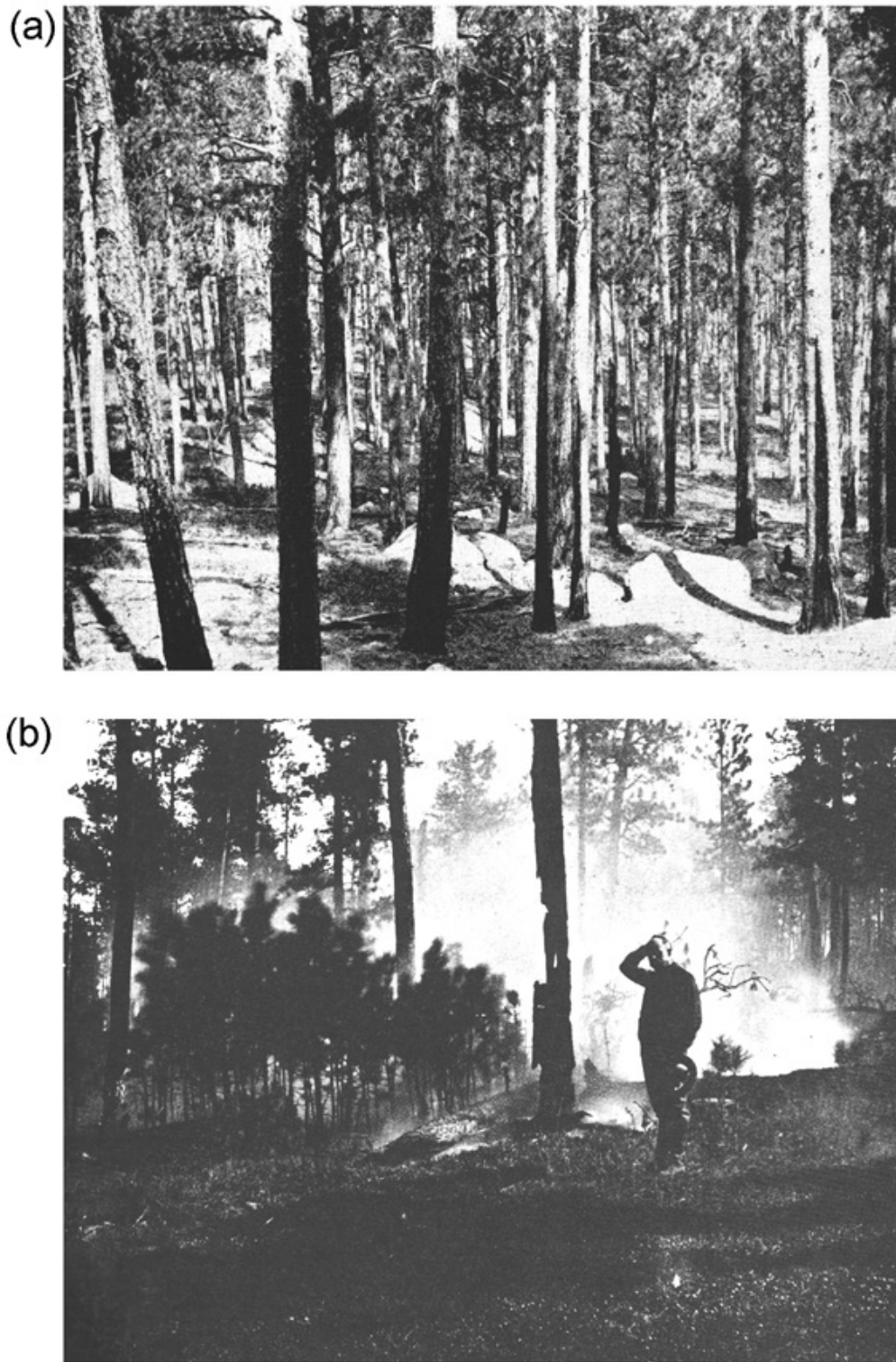


Figure 7



YELLOW PINE ON SHORE OF PLACID LAKE.

Figure 8

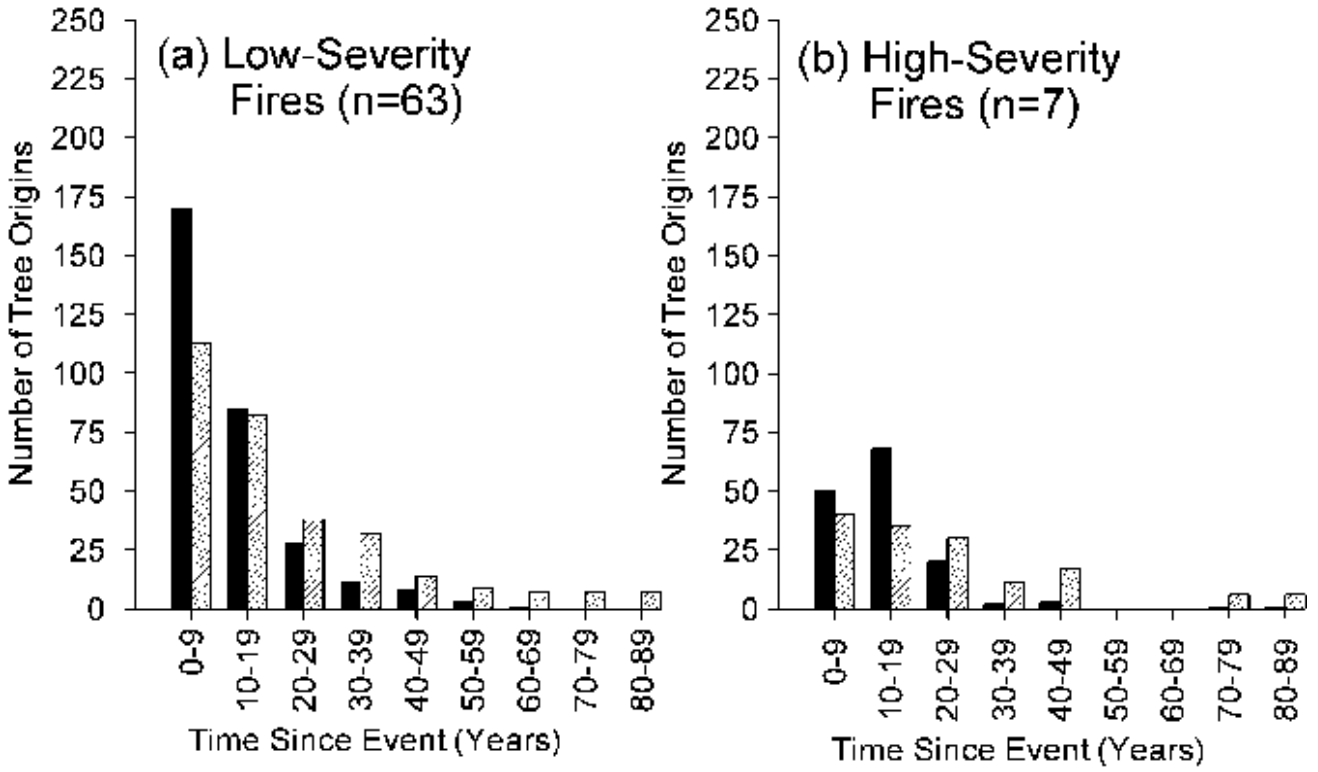
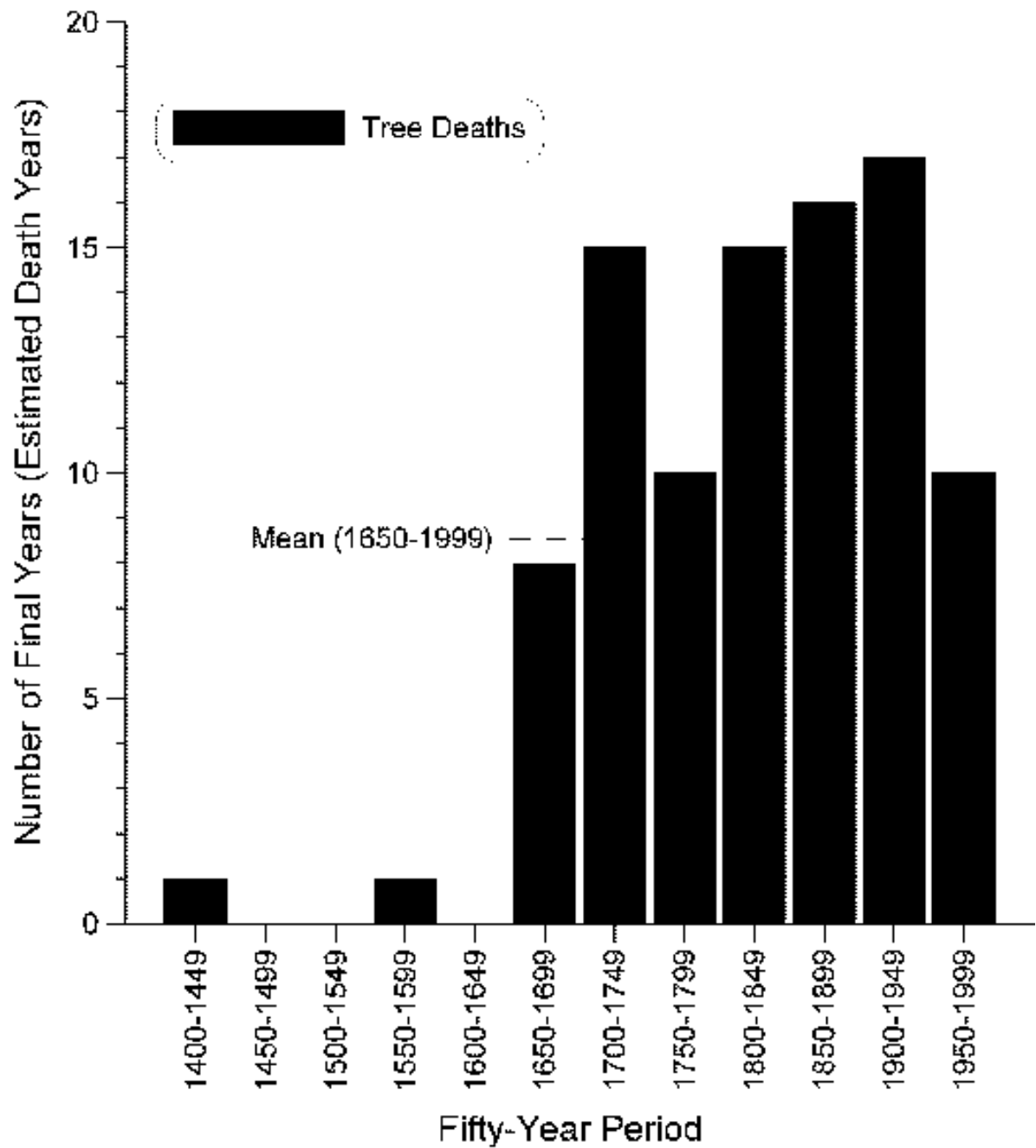


Figure 9



Figure 10



5	Supplementary Material: Table S1. Observations in forest reserve reports on fire severity in ponderosa pine-Douglas-fir forests^a. Interpretation is based upon			
6	tables and narrative evidence of forest types.			
7				
8	Forest Reserve			
9	(present National			
10	Forest)	Quote or Photograph	Source	Interpretation
11	IDAHO			
12	Priest River	1. "Of the 540,000 acres that make up the white-pine and yellow-pine zones, there are not	Leiberg 1899c	High-severity (ponderosa
13	(Idaho Panhandle)	80,000 acres that are not seared by fire. Excepting a small area of about 1,600 acres along the Lower West Fork, there is no body of timber of 1,000 acres, or even 500 acres, extent not scorched by fire. In the two lower zones there are over 200,000 acres on which the destruction is practically complete."	p. 232-233	part of the 200,000 acres that were destroyed) and possibly other severities (ponderosa part of the 260,000 acres that were "seared" or "scorched")
14		2. "The yellow-pine zone has little humus—often none at all. Fires in these areas burn rapidly, and always with a flame. The grass that covers the forest floor is the chief agency in spreading the conflagrations...The destruction is greater where the red fir prevails than where the yellow pine is the principal species. The yellow pine resists the fire better than any other forest tree in this region, while the red fir is readily killed...Where the yellow pine grow the forest is open and the ground supports a grassy growth. The fire runs rapidly, but does not kill out the grass...Where red fir prevails in the zone there is a heavier growth of timber and brush, with some humus. The fires often sweep such areas entirely clean of living timber."	Leiberg 1899c p. 239	Low-severity surface fires more common in ponderosa; high-severity fires in Douglas-fir
15	N. Idaho outside Priest	3. "On the areas west of the mountains, fronting directly on the open plain, a large	Leiberg 1899b	Mostly low-severity surface
16	River (Idaho	proportion of the stand of timber belongs to the yellow-pine type, and has not suffered so	p. 382	fires or mixed-severity fires
17	Panhandle)	seriously as the white-pine and the subalpine types in the mountain regions, not because fires have been lacking, but solely because the timber in this type of forest is not so readily injured or destroyed as in the two other types."		in ponderosa
18		4. "The district [No. 7—containing 308,000 acres of Yellow-pine] appears to have been peculiarly exposed to destructive fires far back in time...modern years have furnished conflagrations enough to wipe out all the heavy white-pine forest and much of the other types"	Leiberg 1899b p. 383	High-severity fires in much of the 308,000 acres of ponderosa
19		5. Summarizing the total timber "amount destroyed" for the Yellow-pine type of forest in all 8 districts in a table, the amount given is 3.9 billion board feet of 8.3 billion board feet in the 1 million acre area surveyed.	Leiberg 1899b p. 385	High-severity fires or mixed-severity fires in ponderosa

1	Sandpoint Quadrangle, Kootenai County (Idaho Panhandle)	6. "Owing to the fire-resisting quality of the yellow pine the damage, while considerable, has not been so great or extensive as in the white-pine type for example. Still the destruction has involved a good deal of timber"	Leiberg 1900b p. 586	Mixed-severity or a mosaic of low-severity and high-severity fires in ponderosa
2				
3				
4	Coeur d'Alene Mts. (Idaho Panhandle)	7. "The fires in the Yellow Pine Zone spread with greater rapidity than in any of the other sections. The country is open and the ground more or less covered with grass, through which the fire runs. As the growth of grass is thin, the duration of the fire in any locality is short and neither the yellow pine nor the Douglas spruce suffers very much the first few times"	Leiberg 1897 p. 68	Low-severity surface fires in ponderosa & Douglas-fir
5				
6				
7		8. "If the damage done here was as great and complete as elsewhere, there would now be nothing left of this [zone] but charred logs. Luckily, however, this, the most accessible portion, suffers the least...most of the burns are on the west bank in the Yellow Pine belt. They are, as before, of varying size, dotting the country here and there and separated from each other by bands of living forest."	Leiberg 1897 p. 72	Mixed-severity fires or a mosaic of small crown fires and surface fires in ponderosa & Douglas-fir
8	Bitterroot-West (Clearwater, Bitterroot, Nez Perce)	9. "...the yellow-pine areas which, whilst overrun by fires, did not lose their forests"	Leiberg 1900a p. 386	Low-severity surface fires in ponderosa
9				
10				
11		10. "Fires in the yellow-pine areas have destroyed much of the red fir, sparing only the yellow pine by reason of its superior fire resisting qualities."	Leiberg 1900a p. 377	Low-severity surface fires in ponderosa; high-severity fires in Douglas-fir
12		11. "In the upper areas of this type of forest [yellow-pine zone], where the red fir predominates, the destruction has been the most severe"	Leiberg 1900a p. 384	High-severity fires more in Douglas-fir
13		12. "Where they are burned over, red fir and western yellow pine are the first trees in the reforestation process"	Leiberg 1900a p. 384	High-severity fires in ponderosa & Douglas-fir
14		13. "The areas of modern burns on which the forest is destroyed amount to 23 per cent, or 103,040 acres. The burned tracts are confined almost entirely to the upper portions of the yellow-pine zone and to the subalpine tracts"	Leiberg 1900a p. 385	High-severity or mixed-severity fires in upper montane zone (ponderosa-Douglas-fir)
15		14. "At the lower levels in the interior of the Selway Basin vast quantities of old growths, consisting of Pacific arbor vitae, western yellow pine, red and great silver firs have vanished in smoke or been reduced to ashes, while in the upper portion of the basin much of the red-fir and lodgepole-pine growths have shared the same fate."	Leiberg 1900a p. 388	High-severity fires in both ponderosa & Douglas-fir

1		15. "Some of the northern slopes in this basin bore stands of mixed western yellow pine and red fir. One finds a few acres here and a few acres there of these stands that the fires have spared...Thousands of acres of forest of this character have been swept clean by the fires of recent years and are now bare hillsides, without a vestige of living timber"	Leiberg 1900a p. 388	High-severity fires in ponderosa-Douglas-fir forests
2				
3	MONTANA			
4	Flathead	16. "Owing to the frequent fires there is but little young growth...fires have, until recently, swept over the plains and crept through the woods"	Ayres 1900b p. 263	Low-severity surface fires in ponderosa
5	(Flathead, Glacier			
6	National Park)			
7		17. "North of Independence Creek the mountain side is even more bare, and north of the international line a severe fire swept over a large area in the year 1896."	Ayres 1900b p. 263	High-severity fire in ponderosa
8		18. "The upper portion of the valley [Edna and Fortin Creeks], however, has suffered from more recent fires, and these fires have been so severe as to kill a great proportion of even the fire-resisting larch, red fir, and yellow pine..."	Ayres 1900b p. 261	High-severity fire in ponderosa & Douglas-fir
9	Lewis & Clarke	19. "As a rule these species [Douglas-fir, larch, spruce] do not reach tree size, being killed while small by repeated fires, while the yellow pine standing over them, protected by its thick bark, remains..."	Ayres 1900a p. 77	Low-severity surface fire in ponderosa
10	(Lewis & Clark,			
11	Flathead)			
12		20. "On the yellow-pine lands the effect, while never harmless, is often hardly noticeable after the fire has passed"	Ayres 1900a p. 78	Low-severity surface fire in ponderosa
13		21. Photo with legend "yellow pine frequently and lightly burnt" (Plate XI)	Ayres 1900a p. 44-45	Low-severity surface fire in ponderosa
14		22. Photo with legend "lodgepole pine following larch and yellow pine killed by fire" (Plate XVI)	Ayres 1900a p. 50-51	High-severity fire in larch-ponderosa
15	Bitterroot-East	23. "The fires in the Bitterroot Basin have been as extensive as elsewhere in the West, but have done far less damage to the merchantable timber. This is due to the resistance offered by the yellow pine and to the small quantity of litter and humus in the forest...in consequence fire runs through the forest rapidly."	Leiberg 1899a p. 275	Low-severity surface fires in ponderosa
16	(Bitterroot)			
17		24. "Comparatively little of the pure yellow-pine or the mixed yellow-pine and red fir growths has been destroyed, probably not more than 5 per cent, or about 10,000 acres of the entire zone. The destruction has been greatest in the pure, or nearly pure, red-fir forest, where we estimate that upon more than 50,000 acres the forest has been destroyed from 60 per cent to total"	Leiberg 1899a p. 276	High-severity fires, but small, in ponderosa and more so in Douglas-fir; some fires may have been mixed severity

1	Little Belt Mts.	25. "In this region fires almost invariably totally destroy the forest, except in the thin	Leiberg 1904b	High-severity fires in
2	(Lewis & Clark)	subalpine stands."	p. 24	Douglas-fir
3				
4	WYOMING &			
5	SOUTH DAKOTA			
6	Yellowstone--	26. "Formerly the extreme southern and most of the western areas were forested. Fires	Leiberg 1904a	High-severity fires in
7	Absaroka (Shoshone)	have swept the timber out of existence, with the exception of 1,000 acres in the valley of West Rosebud Creek. The stands on this tract consist of thin lines of scrubby yellow pine and red fir, with small proportions of limber pine and a low growth of aspen"	p. 78	ponderosa-Douglas-fir
8		27. "On tracts burned over thirty or forty years ago close-set stands of red fir are coming in abundantly."	Leiberg 1904a	High-severity fires in
9	Black Hills	28. "Where the country is broken by sharp ridges and deep canyons or ravines fires are	Graves 1899	Low-severity surface fire in
10	(Black Hills)	checked and merely burn on the surface of the ground."	p. 84	ponderosa
11		29. "Surface fires cause very serious injury by unfitting the soil for germination of seed and the growth of young plants	Graves 1899	Low-severity surface fire in
12		30. "Fires of considerable extent burned over this region in 1888, 1889, and 1893. The direct injury by these recent fires has been chiefly confined to the destruction of young growth"	p. 84	ponderosa
13		31. "There have been periods, separated by about half a century, when the whole or a large part of the hills has been burned over...There are, further, a large number of trees about 160 to 170 years old, which presumably started in the openings made by fires at that time."	Graves 1899	Mixed-severity or high-severity fires in ponderosa
14		32. "...no fire of so great extent occurred until about 1790 to 1800, when a great fire, or series of fires, burned over a large part of the range. The second-growth forest in the Limestone Range and northern hills...dates from that time...patches of forest 100 to 110 years old are everywhere to be found. No fire since this period has burned over so large areas or proved so disastrous to the timber...In 1881 a large section of the Limestone Range...was burned over, and this may have been the fire which destroyed the timber about the Spearfish Canyon"	Graves 1899	High-severity fire or possibly some mixed-severity fire in ponderosa
15		33. "Very large areas were entirely denuded by these fires..."	Graves 1899	High-severity fires in ponderosa
			p. 83	

1		34. "On limestone formations there are apt to be extensive areas of level and rolling ground where a fire attains great proportions and burns in the crowns of trees and destroys everything in its path."	Graves 1899 p. 84	High-severity fires in ponderosa
2		35. "Forest fires often destroy large tracts of timber, and the trees which seed up the area are so far away that the reproduction is scant"	Graves 1899 p. 85	High-severity fires in ponderosa
3		36. "Of recent fires, that which occurred in 1896 has done the most damage. It burned over several hundred acres...This fire killed every tree in its path."	Graves 1899 p. 113	High-severity fire in ponderosa
4		37. "There are about 61 square miles [39,000 acres] which are practically devoid of any timber whatever, or covered with a more or less scattering growth of young pines 15 to 20 years old."	Graves 1899 p. 152	High-severity fire in ponderosa
5		38. "The condition of the country about the Black Buttes has, it is believed, been brought about by forest fires, and reforestation prevented by condition of the soil...A most destructive fire occurred in 1894...An area of about 200 square miles [128,000 acres] was burned over."	Graves 1899 p. 160	High-severity fire in ponderosa
6				
7	COLORADO			
8	Battlement Mesa	39. "A small amount of yellow pine has been killed by surface fires. The usually scattered stands of this species appear to admit only of this kind of burning, as there is little debris or litter among the trees except dry grass...with their inflammable crowns high above the ground, these pines often escape with little more than a harmless scorching."	Sudworth 1900a p. 235	Low-severity surface fires in ponderosa
9	(Grand Mesa,			
10	Uncompahgre,			
11	Gunnison)			
12		40. "On the east boundary of the reserve the yellow pine, once plentiful...is almost entirely burned off..."	Sudworth 1900a p. 224	High-severity fire in ponderosa
13	Pikes Peak, Plum	41. "In the more open woodland evidences of surface or ground fires are common"	Jack 1900 p. 78	Low-severity surface fires in montane zone
14	Creek, & South Platte			
15	(Pike)			
16		42. "Excepting a comparatively small area...more than one-third of the total area of the reserve, may be classed as practically destitute of living timber of any kind except small aspen. This ground, after being cut over, is said to have been burned about the year 1880, only a few small belts, groups, or individuals of the timber then standing escaping the flames [an area > 60,000 acres]	Jack 1900 p. 68	High-severity fire in ponderosa-Douglas-fir

- 1 43. “The most widespread of these conflagrations occurred in 1868 or 1869 and burned Jack 1900 High-severity fire in
over the larger portion of the Tarryall Mountains...The burning here was very complete p. 97 ponderosa-Douglas-fir
over many thousands of acres...This fire covered a stretch of mountains over 20 miles in
length and 6 or 8 miles wide at the widest parts [about 90,000 acres mostly ponderosa-
Douglas-fir]
- 2
- 3 ^aPonderosa pine (*Pinus ponderosa*) is also called “yellow pine”, Douglas-fir (*Pseudotsuga menziesii*) is also called “red fir”

1	Supplementary Material: Table S2. Observations in forest reserve reports on killing of small trees by surface fires^a.		
2			
3	Forest Reserve (present		
4	National Forest)	Quote or Photograph	Source
5	IDAHO		
6	Priest River	“The fires, however, destroy the year’s seedling plants, thus preventing reproduction...”	Leiberg 1899c
7	(Idaho Panhandle)		p. 239
8		“Where the yellow pine predominates, entire cessation of reproduction by the repeated burning of the seedlings and very young trees...”	Leiberg 1899c p. 240
9	N. Idaho outside Priest	“...fires are of very frequent occurrence during the summer and fall. In consequence, the young growth in the	Leiberg 1899b
10	River (Idaho Panhandle)	zone stands but a small chance of attaining valuable dimensions.”	p. 384
11	Coeur d’Alene Mts.	“In the Yellow Pine section, as before explained, the trees are not fire-killed as extensively as in the other	Leiberg 1897
12	(Idaho Panhandle)	sections, but the action on the young growth is the same. The second fire therefore frustrates any attempt of	p. 69
13		nature to replace the cut off or burned up older growth by a new one.”	
14	Bitterroot-West	“The most disastrous of the results that follow fires in the yellow-pine growths is the burning of its seedlings	Leiberg 1900a
15	(Clearwater, Bitterroot,	and saplings, and of the seeds as they rest on the soil after liberation from the cones. A certain percentage of	p. 350
16	Nez Perce)	saplings usually pass through a fire unharmed, the amount depending on their age and the quantity of litter	
		on the ground, but seeds and seedlings are sure to be destroyed.”	
17			
18	MONTANA		
19	Flathead (Flathead,	“Owing to the frequent fires there is but little young growth, apart from what may be called seedlings...fires	Ayres 1900b
20	Glacier National Park)	have, until recently, swept over the plains and crept through the woods, preventing a new growth...”	p. 263
21	Lewis & Clarke (Lewis &	“As a rule these species [Douglas-fir, larch, spruce] do not reach tree size, being killed while small by	Ayres 1900a
22	Clark, Flathead)	repeated fires, while the yellow pine standing over them, protected by its thick bark, remains...”	p. 77
23		“On the yellow-pine lands the effect, while never harmless, is often hardly noticeable after the fire has	Ayres 1900a
		passed. Such lands are seldom without small seedlings, and as a light fire is sufficient to kill and even	p. 78
		consume them the evidence of damage done is difficult or impossible to find, even when, from the foresters’	
		point of view, it is serious”	
24	Bitterroot-East (Bitterroot)	“The damage consequent upon fires in the yellow-pine stands has consisted not only of the fire scars already	Leiberg 1899a
		described but, of greater moment, the check on the reproduction of the species. The absence or comparative	p. 277
		scarcity of young trees from 5 to 20 years old is very striking...”	

1	WYOMING & SOUTH		
2	DAKOTA		
3	Black Hills (Black Hills)	“Fires of considerable extent burned over this region in 1888, 1889, and 1893. The direct injury by these recent fires has been chiefly confined to the destruction of young growth”	Graves 1899 p. 117
4			
5	COLORADO		
6	Pikes Peak, Plum Creek,	“In the more open woodland evidences of surface or ground fires are common, and on these areas there are	Jack 1900
7	& South Platte (Pike)	few or no seedling trees”	p. 78
8			
9	^a Ponderosa pine (<i>Pinus ponderosa</i>) is also called “yellow pine”, Douglas-fir (<i>Pseudotsuga menziesii</i>) is also called “red fir”		

1	Supplementary Material: Table S3. Observations in forest reserve reports on tree regeneration after surface fires^a.		
2			
3	Forest Reserve		
4	(present National		
5	Forest)	Quote or Photograph	Source
6	IDAHO		
7	Priest River	“The after effects of the fires here also depend on the moisture supply. Both the yellow pine and the red fir will germinate without the humus layer, provided there is sufficient seepage under the soil. Seeds of the yellow pine will germinate if there be but a moderately grassy forest floor for their reception”	Leiberg 1899c p. 239
8	(Idaho Panhandle)		
9			
10	MONTANA		
11	Flathead (Flathead,	“After the light fires run through the woods, seedlings spring up wherever the fires have made suitable conditions by killing part of the old stock, letting in light, and removing the small plants from the soil [refers to several species, including ponderosa and Douglas-fir].”	Ayres 1900b p. 257
12	Glacier National Park)		
13		“The light fires which prevailed in the valley up to 20 or 25 years ago seem to have left very favorable conditions for reproduction, as evidenced by the young trees now growing...” [refers to several species, including ponderosa and Douglas-fir]	Ayres 1900b p. 260
14	Bitterroot-West	“The yellow-pine forest at lower elevations is open, and the forest floor is grass or sedge covered. Here, likewise, the grass assists in spreading the fires, which in this type of forest kill the yellow-pine saplings, but appear to promote the spread of the red fir, a tree that everywhere in this zone crowds the growth of the yellow pine on the fire-swept areas.”	Leiberg 1900a p. 378
15	(Clearwater,		
16	Bitterroot, Nez Perce)		
17	Lewis & Clarke (Lewis	“...some of the trees often grow in such a manner as to practically form an underbrush in the forest, especially after a light fire that has not seriously thinned the forest, yet has permitted seedlings to start.” [refers to several species, including ponderosa and Douglas-fir]	Ayres 1900a p. 45
18	& Clark, Flathead)		
19			
20	WYOMING & SOUTH		
21	DAKOTA		
22	Black Hills	“The most favorable condition for the germination of the seed and life of the seedling is where the mineral soil with an admixture of vegetable humus is exposed. This condition is found where the upper layer of litter has been removed by fire or otherwise...” [ponderosa]	Graves 1899 p. 92
23	(Black Hills)		
24		“Pine reproduces itself well after a light surface fire...in almost all cases where good reproduction is found after lumbering there have been light fires.” [ponderosa]	Graves 1899 p. 92
25			
26	^a Ponderosa pine (<i>Pinus ponderosa</i>) is also called “yellow pine”, Douglas-fir (<i>Pseudotsuga menziesii</i>) is also called “red fir”		

Supplementary Material: Table S4. Observations in forest reserve reports on the density of trees in ponderosa pine-Douglas-fir forests^a.

4	Forest Reserve		
5	(present		
6	National Forest)	Quote or Photograph	Source
7	IDAHO		
8	Priest River	1. "The forest growth is dense, in some localities ranging from 800 to 1,500 trees to the acre, but where such density	Leiberg 1899c
9	(Idaho	exists the diameters of the individual tree [sic] are small." [Douglas-fir and ponderosa pine in ponderosa pine zone]	p. 227
10	Panhandle)		
11	N. Idaho outside	2. "The growth is open, and consists mainly of yellow pine on the drier areas"	Leiberg 1899b
12	Priest River		p. 374
13	(Idaho		
14	Panhandle)		
15	Sandpoint	3. "The aspect of the type [ponderosa] varies from open and park-like stands to those of medium density. Stands	Leiberg 1900b
16	Quadrangle,	composed of veterans or well-advanced standards present the open aspect; stands composed of young or middle-	p. 586
17	Kootenai County	aged standards or saplings are more thickly set; sometimes, as in reforestations after fire, the young growth becomes	
18	(Idaho	excessively dense. In the park-like stands of the type the trees stand well apart and admit plenty of light to the	
19	Panhandle)	ground...The type rarely assumes this open aspect short of one hundred and seventy-five years of fairly	
20		uninterrupted growth"	
21		4. "The aspect of the type [Douglas-fir], where soil and moisture conditions are the best, is that of a forest above	Leiberg 1900b
22		medium density. The trees are thickest, in the sapling and young standard growth varying from 1,000 to 3,000 trees	p. 588
23		per acre, while the 100 to 150 year old growth contains from 200 to 300 trees per acre."	
24		5. "In stands of the type [Douglas-fir] growing on rocky or gravelly land, the aspect of the type is often as open and	Leiberg 1900b
		park-like as in the yellow-pine type; more frequently, however, the trees stand well apart, but between them the	p. 588
		ground is covered with dense masses of underbrush..."	
25	Coeur d'Alene	6. "There is first the Lower, or Zone of Yellow Pine...It is marked by its open character. The trees stand far	Leiberg 1897
26	Mts. (Idaho	apart...Where the growth is pure the forest is park-like and has a clean and open appearance. Usually, however, the	p. 58
27	Panhandle)	growth is mixed, and here and there among the yellow pines are more or less extensive groves of Douglas spruce,	
28		white fir, and the lowlands form of the black pine...In such cases the forest growth is dense...The number of trees to	
29		the acre varies so greatly that it is almost impossible to give, even approximately, an accurate estimate. I should	
		consider that in a yellow-pine forest untouched by the ax, 20 to 30 trees of <i>Pinus ponderosa</i> or of <i>Pseudotsuga</i> , 70	
		cm (28 inches) and upward in diameter, would be a fair average. Where the timber is mixed the diameters of the	
		trees will average much less and the number is greatly increased."	

1	Bitterroot-West	7. "In those of red fir...the number runs from 800 to 1,500 trees per acre...The stands of western yellow pine, when	Leiberg 1900a
2	(Clearwater,	nearly pure, are always low in the number of trees per acre, not often exceeding 200 to 300. In these estimates only	p. 363
3	Bitterroot, Nez	trees with basal diameters above 4 inches are considered....In comparison with stands composed of the same species	
4	Perce)	of trees in growths of equal age, the Clearwater areas are much below those of the State further north"	
5			
6	MONTANA		
7	Little Belt Mts.	8. "Below the middle of the subalpine zone all reforestations after fires begin with stands stocked excessively close.	Leiberg 1904b
8	(Lewis & Clark)	As the forest becomes older and the natural processes of pruning set in, great quantities of dead wood begin to litter	p. 24
		the ground and furnish material for future disastrous fires." [Douglas-fir, and minor amounts of ponderosa pine, in	
		montane zone]	
9			
10	WYOMING &		
11	SOUTH		
12	DAKOTA		
13	Black Hills	9. "The natural forest of yellow pine is dense and composed of trees of about the same age"	Graves 1899
14	(Black Hills)		p. 73
15		10. "In many places the second growth [about 100 years old] is very dense, with as many as 150 to 200 trees per	Graves 1899
		acre. Comparing the forest to one in which the forest floor is entirely under shade and may be said to have a density	p. 76
		of 1.0, the second-growth forest is estimated to have an average density of 0.7 within the timber limits. The original	
		forest has an average density of 0.5." [ponderosa]	
16		11. "The young growth [ponderosa] comes up in compact masses and is so dense in favorable conditions as to	Graves 1899
		compare with the lodgepole pine in the Rocky Mountains. One such dense growth of saplings about 10 feet high was	p. 91
		estimated to have between 7,000 and 8,000 trees per acre."	
17			
18	COLORADO		
19	White River	12. "In the densest stands [Douglas-fir]—100 to 120 trees to the acre—the trees have broad crowns, with limbs down	Sudworth 1900b
20	(White River,	to within 2 feet of the ground...As is common elsewhere in the Rockies, this tree [ponderosa pine] nowhere forms a	p. 128
21	Routt)	dense stand, but is very scattered..."	
22	Battlement Mesa	13. "The only notable growth of this pine [ponderosa] in the reserve...consisted of 20 to 25 acres. The stand is very	Sudworth 1900a
23	(Grand Mesa,	dense for this species, the trees being 8, 10, 15, and 20 feet apart."	p. 201
24	Uncompahgre,		
25	Gunnison)		

1	Pikes Peak, Plum Creek, & South Platte (Pike)	14. “The best of the remaining timber [ponderosa & Douglas-fir] can not be called large...Such forests as exist are	Jack 1900 p. 43
2		generally open and may be traversed by wagon or on horseback, and it is only on comparatively limited areas that	
3		any close or dense growth of trees is encountered...occasionally a dense growth of small red fir and its	
4		accompanying species is found on some locally favored northern slope.”	
5		15. “As the timber [ponderosa] is more or less open, the stems of the trees are usually well furnished with	Jack 1900 p. 47
6		branches...”	
7		16. “On the slopes and hills about Fountain Creek, for several miles northwest of Manitou, there is still left a	Jack 1900 p. 68
8		generally open, irregular growth of small-sized or medium-sized yellow pine and Douglas spruce.”	
9		17. “As in most other parts of this region, it is common to find slopes facing the south almost bare or producing a	Jack 1900 p. 76
10		very scattered growth of yellow pine, while the opposite northern slopes are much more closely timbered with	
		Douglas spruce and yellow pine...”	
		18. “Upon a good deal of the area the yellow pine is more plentiful than the Douglas spruce, and it commonly	Jack 1900 p. 94
		occurs in very open or scattered growth and well furnished with branches...”	
		^a Ponderosa pine (<i>Pinus ponderosa</i>) is also called “yellow pine”, Douglas-fir (<i>Pseudotsuga menziesii</i>) is also called “red fir” or “Douglas spruce”	