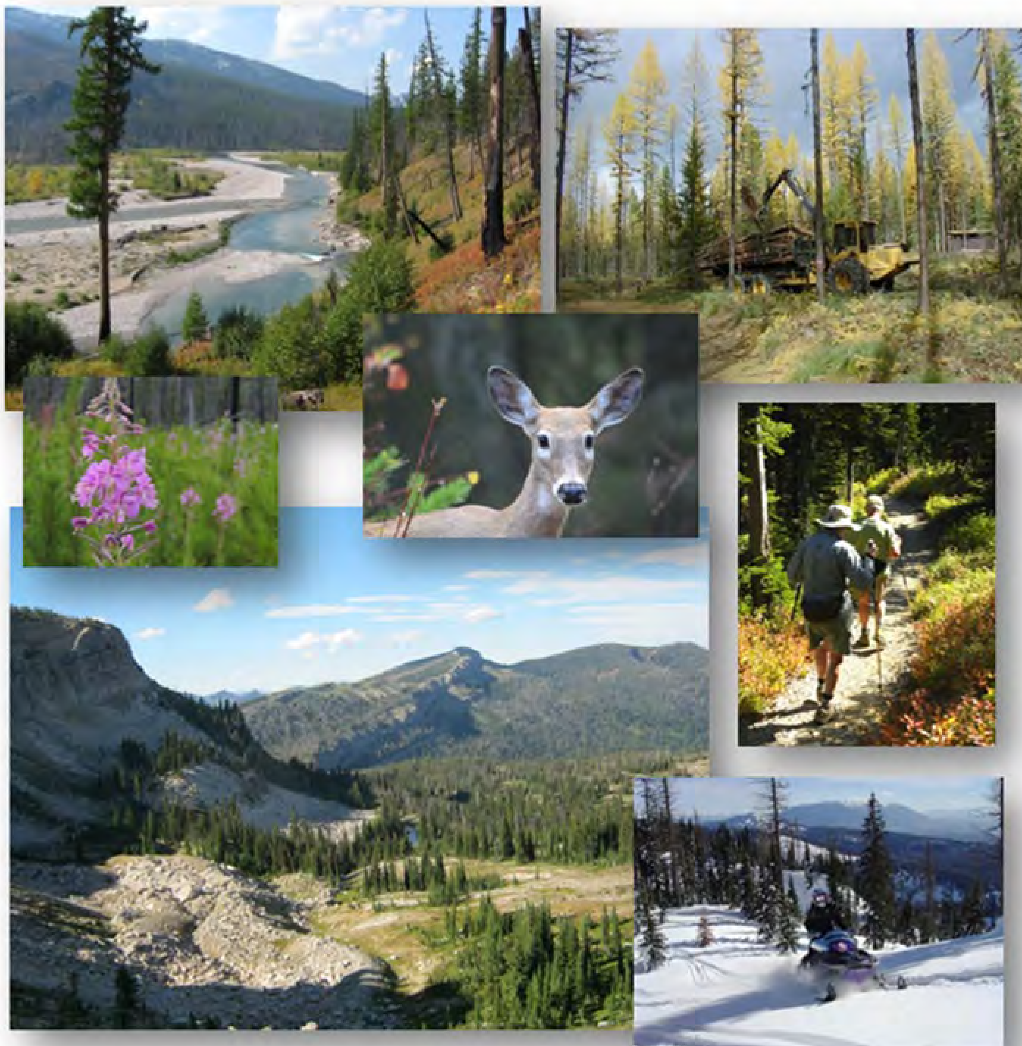
United States Department of Agriculture

Volume 1—Final Environmental Impact Statement for the Land Management Plan

Flathead National Forest



Forest Service **Northern Region** **November 2018**

". . . for the greatest good of the greatest number for the longest time."—Gifford Pinchot, founding Chief of the Forest Service, 1905

Volume 1—Final Environmental Impact Statement for the Land Management Plan

Flathead National Forest

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Abstract: This is the first of four volumes of the final environmental impact statement (EIS) that documents analysis of the preferred alternative, two other action alternatives, as well as a no-action alternative for programmatic management of the land and resources administered by the Flathead National Forest. The Forest Service has identified alternative B modified as the preferred alternative. The Flathead National Forest encompasses 2.4 million acres in Flathead, Lake, Lewis and Clark, Lincoln, Missoula, and Powell Counties, Montana.

The Forest Service is concurrently amending the forest plans of the Helena-Lewis and Clark, Kootenai, and Lolo National Forests to incorporate habitat management direction for the Northern Continental Divide Ecosystem (NCDE) grizzly bear population (refer to volume 3 of the final EIS for the evaluation of effects of the amendments).

Flathead National Forest photo captions (clockwise from upper left):

- South Fork of the Flathead River, Spotted Bear Ranger District
- Forwarder working on the Paint Emery Resource Management Project, Hungry Horse–Glacier View Ranger District
- Two hikers
- Snowmobiler
- View from trail to Pentagon Cabin in the Bob Marshall Wilderness (photo by Peter Borgesen)
- Fireweed
- White-tailed deer (photo by John Littlefield)

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Table of Contents

NOTE: Refer to volume 2 for the remainder of chapter 3, volume 3 for chapters 4 through 7, and volume 4 for appendices and the glossary.

List of Tables

List of Figures

NOTE: The figures listed below are found within this volume. When figure numbers referenced in the document are preceded by 1-, e.g., figure 1-01, this indicates they are located in appendix 1 in volume 4 of the final EIS, and if preceded by B-, e.g., B-01, they are in appendix B of the forest plan.

Terms and Abbreviations

Term	Full name
1986 forest plan	Flathead National Forest Land and Resource Management Plan (1986)
2012 planning rule	National Forest System land management planning rule (effective 2012)
assessment	assessment of the Flathead National Forest
amendment forests	collective term for the Helena-Lewis and Clark, Kootenai, and Lolo National Forests
draft Grizzly Bear Conservation Strategy	Draft Northern Continental Divide Ecosystem Grizzly Bear Conservation Strategy
NCDE Conservation Strategy	Conservation Strategy for the Grizzly Bear in the Northern Continental Divide Ecosystem
the Forest	Flathead National Forest
forest plan	Flathead National Forest Land Management Plan (2018 revision)
Northern Region	USDA Forest Service Northern Region (also known as Region 1)

List of Abbreviations

CFR	Code of Federal Regulations
d.b.h.	diameter at breast height
DC	desired condition (forest plan component)
DCA	demographic connectivity area
EIS	environmental impact statement
FW	forestwide (forest plan component)
GA	geographic area
GDL	Guideline (forest plan component)
GIS	geographic information system
INFISH	Inland Native Fish Strategy
MA	management area
mi	mile
mmbf	million board feet
mmcf	million cubic feet
MFWP	Montana Fish Wildlife and Parks
NCDE	Northern Continental Divide Ecosystem
NEPA	National Environmental Policy Act
NFS	National Forest System
NRLMD	Northern Rockies Lynx Management Direction
PACFISH	Pacific Fish Strategy
PCA	primary conservation area
PIBO	PACFISH/INFISH Biological Opinion
STD	standard (forest plan component)
TMDL	total maximum daily load
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

Summary of Volumes 1 and 2

The Forest Service has prepared this final environmental impact statement (EIS) to describe and analyze in detail four alternatives for managing the land and resources of the Flathead National Forest (hereinafter referred to as "the Forest"). The final EIS describes the affected environment and discloses environmental effects of the alternatives.

Proposed Action

The Flathead National Forest proposes to revise its Land and Resource Management Plan (hereinafter referred to as the "forest plan") (see USDA, 1986), in compliance with the 2012 planning rule (36 CFR § 219.17(3)(b)(1)). The area affected by the proposal includes about 2.4 million acres of public land, shown in figure 1. The Forest Service is concurrently amending the forest plans of the Helena-Lewis and Clark, Kootenai, and Lolo National Forests (referred to as the "amendment forests") to incorporate habitat management direction for the Northern Continental Divide Ecosystem (NCDE) grizzly bear population (refer to volume 3 of the final EIS for the evaluation of effects of the amendments). The Forest is proposing to incorporate the NCDE grizzly bear habitat management direction as part of its plan revision process.

Purpose and Need

The purpose of the proposed action is to revise the Forest's 1986 forest plan. Since the 1986 forest plan was completed, there have been changes in ecological, social, and economic conditions in the area, as well as changes in resource demands, availability of new scientific information, and promulgation of new policy, including the 2012 planning rule. These changes necessitate revising the 1986 forest plan to ensure management direction is responsive to current issues and conditions. In particular, the plan revision addresses the following topics:

- increasing demand for recreation opportunities and their importance in supporting local economies;
- fire and fuels management direction that emphasizes active vegetation management near communities;
- new analyses needed of timber production opportunities, an important historical driver for local economies;
- conservation of wildlife and aquatic habitat, including updating grizzly bear habitat management direction and Inland Native Fish direction; and
- new policy and public interest in identifying areas for recommended wilderness and wild and scenic rivers.

The forest plan will guide natural resource management activities on the Forest and address changed conditions and direction that have occurred since the 1986 forest plan while meeting the requirements of the 2012 planning rule. Findings from the assessment of the Flathead National Forest (USDA, 2014a) (hereinafter "the assessment"), changes in conditions and demands since the 1986 forest plan, and public concerns to date highlighted several areas where changes are needed to the existing forest plan that necessitate a plan revision.

To develop the proposed action to revise the forest plan, the management direction in the 1986 forest plan and its amendments was reviewed. The 2012 planning rule requirements also mandate that new management direction be developed to address sustainability. Chapter 1 summarizes how needs for

change identified in the 1986 forest plan and its amendments, specifically those related to areas of public concern, were addressed during the development of the forest plan.

Engagement of State and Local Governments, Other Federal Agencies, and Indian Tribes

Local tribes and communities depend on the economic, social, and ecological benefits provided by the Forest. The Forest supports jobs and economies, local traditional ways of life, healthy wildlife populations, and clean air and water, among other benefits. Many of the issues and concerns facing the Forest, such as wildfire, require a cohesive management approach across the landscape. It is therefore essential that the representatives of local tribes, counties, as well as other Federal agencies, are actively involved in plan revision.

In addition to the opportunities described in section 2.2.1, which are available to governmental entities, the Forest worked directly with State and local governments, other Federal Agencies, and Indian tribes throughout the planning process.

Interagency meetings were convened as necessary from the beginning of the revision process to provide updates on the planning process as well as to ensure consistency with county, state, federal, and tribal policies, and interests to the extent practicable (Trechsel, 2016b). The planning record exhibits from these meetings (planning record exhibits 00004-00021, 00307-00314; also available at http://www.merid.org/FNFplanrevision.aspx) demonstrate a commitment on the part of the Forest to meaningfully engage with interested and affected agencies but also demonstrate the cooperation of these entities in the development of this forest plan.

Public Engagement

The Forest began public participation when developing the assessment of the Flathead National Forest. To facilitate local participation, the Forest contracted with the U.S. Institute for Environmental Conflict Resolution in 2012 to develop a collaborative stakeholder engagement process. The U.S. Institute for Environmental Conflict Resolution met with Forest Service employees and a representative group of key stakeholders to determine their willingness to engage in a collaborative process convened by a neutral third party. The Meridian Institute was selected to serve in that capacity and facilitated numerous topical work groups, an interagency group, and meetings to bring together all work groups and interested citizens. Beginning with a news release July 19, 2013, as part of the public involvement process, the Forest led field trips and held open house sessions to discuss existing information and trends related to a variety of conditions found on the Forest. From October 2013 through June 2014, the Forest hosted monthly public meetings with the intent to collaboratively develop plan components that the Forest could consider in the development of a proposed action (see Meridian website). The dialogue and recommendations from this public involvement process were used to help develop the forest plan revision proposed action. The notice of intent on the proposed action was published in the Federal Register on March 6, 2015. The notice of intent asked for public comment on the proposal for a 60-day period (until May 5, 2015). The comment period was subsequently extended by 10 days (until May 15, 2015). In addition, as part of the public involvement process, the agency held seven open houses to provide opportunities to better understand the proposed action so that meaningful public comments could be provided by the end of the scoping period. Using the comments from the public, State and local governments, other Federal agencies, and tribes, the interdisciplinary team developed a list of issues to address. The list was then organized by issue applicability, i.e., whether the issue was specific to the revision effort or specific to the amendment

effort or applied to both. Issues that involve the amendment effort are discussed further in section 5.4, Issues used for alternative development.

Based upon the issues identified from the scoping process on the proposed action, the Forest prepared and published a draft EIS with a Notice of Availability in the Federal Register in June 2016. This publication of the Notice of Availability of the draft documents in the Federal Register began the public comment period on the draft forest plan, amendments, and draft EIS. Two open houses were held in Kalispell and Missoula during the 120-day comment period. In addition to the open houses, the planning team continued to provide information throughout the comment period to address questions. The interagency group continued to meet to discuss and provide input with respect to their agencies' concerns.

The comment period ended on October 3, 2016, for the draft EIS, draft forest plan, and draft forest plan amendments. The 120-day comment period resulted in over 33,000 comments, including ~576 unique letters and 33,112 form letters (these are letters identified as having overlapping content and comments) from 18 organizations. The comments were aggregated into unique concern statements, and responses were developed and are included as appendix 8 to the final EIS. The responses were also critical to improving the analysis in the final EIS, refining plan direction, and aiding in developing the draft record of decision.

Significant Issues

Issues serve to highlight effects or unintended consequences that may occur from the proposed action or alternatives. The Forest categorized the issues identified during scoping as either significant or nonsignificant. Significant issues were defined as those that were directly or indirectly caused by implementing the proposed action, involved potentially significant effects, and could be meaningfully and reasonably evaluated and addressed within the programmatic scope of a forest plan.[1] Alternatives were developed around those significant issues that involved unresolved conflicts concerning alternative uses of available resources

The Forest identified the following significant issues during scoping that drove the alternative development:

- vegetation management, timber production, and fire and fuels management
- wildlife habitat
- access and recreation
- recommended wilderness

Alternatives

The significant issues listed above led the agency to develop four alternatives:

Alternative A is the no-action alternative. This alternative is the 1986 forest plan, as amended, and takes into account current laws, regulations, and nondiscretionary terms and conditions from biological opinions for species designated by the USFWS. New information, inventories, and technologies were used to evaluate this alternative. Eligible wild and scenic rivers identified in the

[1] Some issues are best resolved at finer scales, where the site-specific details of a specific action and the resources it affects can be meaningfully evaluated and weighed (as stipulated in NEPA). Conversely, some issues have already been considered through broader programmatic NEPA (e.g., the Northern Rockies Lynx Management Direction). In these cases, the issues are more focused on evaluating the effects unique to and commensurate with the decision being considered.

revision process are included in this alternative. Output levels were recalculated for this alternative based on these new sources of information and amended direction. The no-action alternative retains the 1986 forest plan, as amended, including the goals and objectives, standards and guidelines, and management areas. This alternative serves as the baseline for comparison with the action alternatives. The no-action alternative manages approximately 4 percent of the Forest as recommended wilderness (management area 1b), 16 percent as backcountry (management area 5), and 33 percent as general forest (management area 6). Twenty-two percent of the Forest would be suitable for timber production.

Alternative B modified is based on alternative B from the draft EIS, with modifications in response to comments, and it includes features of the other alternatives that were considered. After reviewing and considering the public comments on the draft EIS, the Flathead National Forest has identified alternative B modified as the preferred alternative. This alternative is the forest plan. It is the result of public engagement efforts since 2013 and responds to the identified purpose and need. This alternative emphasizes moving towards desired future conditions and contributing to ecological, social, and economic sustainability. Alternative B modified manages approximately 8 percent of the Forest as recommended wilderness (management area 1b), 13 percent as backcountry (management area 5), 29 percent as general forest (management area 6), and 3 percent as focused recreation areas. Nineteen percent of the Forest would be suitable for timber production.

Alternative C emphasizes wilderness values and the protection of backcountry nonmotorized values while moving towards desired conditions. This alternative has a greater emphasis on wildlife habitat security and fish habitat. Under this alternative, achieving desired conditions would rely more on natural disturbance processes, such as unplanned wildfire ignitions or prescribed burning, to meet multiple objectives. Mechanical treatments (e.g., timber harvest, fuels reduction) would also be used in order to move towards social, economic, and ecological sustainability, but the acreage suitable for timber production would be lower than under alternatives A, B modified, and D. Alternative C would provide more opportunities for backcountry and nonmotorized recreation because this alternative has more acres in backcountry management areas (6 percent in management area 5) and recommended as wilderness (21 percent in management area 1b) combined than any other alternative. About 25 percent of the Forest would be allocated to general forest (management area 6) and 1 percent as focused recreation areas. Thirteen percent of the Forest would be suitable for timber production.

Alternative D emphasizes a more active management approach to achieving or moving towards desired future conditions and social, economic, and ecological sustainability. Greater emphasis is placed on the use of timber harvest and other mechanical means to achieve desired conditions. This alternative would have the most acres suitable for timber production and available for timber harvest as well as for motorized access Alternative D would allocate 30 percent of the Forest to general forest (management areas 6), with a higher proportion in moderate and high-intensity vegetation management (24 percent in management areas 6b and 6c). No acres would be allocated to recommended wilderness, and inventoried roadless areas would be allocated mostly to backcountry (management area 5) with a small portion allocated to general forest low-intensity vegetation management (management area 6a). Twenty percent of the Forest would be suitable for timber production.

Comparison of Alternatives

Table 1 compares alternatives by management area allocation and indicates only one management area allocation for each acre based upon the established hierarchy listed below. Lands with dual or multiple management area allocations would be managed in accordance with applicable plan

direction. To view the actual acres vs. the single allocation based upon the established hierarchy, refer to table 5 in chapter 2. For a comparison of the key differences among the alternatives, refer to table 6.

In instances where management area allocations overlap—e.g., an area that is management area 1b (recommended wilderness) may also be management area 4a (a research natural area)—the acres were calculated based upon the following hierarchy:

1. Designated wilderness (management area 1a)
2. Designated wild and scenic river (management area 2a)
3. Recommended wilderness (management area 1b)
4. Research natural area (management area 4a)
5. Eligible wild and scenic river (management area 2b)
6. Experimental or demonstration forest (management area 4b)
7. Special area (management area 3)

Table 1. Comparison of alternatives by management area acres and percent allocation[a] (single allocation based upon established hierarchy)

Management Area	Alternative A acres[b] (percent)	Alternative B modified acres (percent)	Alternative C acres (percent)	Alternative D acres (percent)
1a Designated wilderness	1,072,040 (45%)	1,072,040 (45%)	1,072,040 (45%)	1,072,040 (45%)
1b Recommended wilderness	98,388 (4%)	190,403 (8%)	506,905 (21%)	0
2a Designated wild and scenic rivers	17,605 (1%)	17,592 (1%)	17,605 (1%)	17,605 (1%)
2b Eligible wild and scenic rivers	0[c]	20,473 (1%)	15,725 (1%)	30,867 (1%)
3a Administrative areas	1,918 (< 1%)	435 (< 1%)	435 (< 1%)	435 (< 1%)
3b Special areas	226 (< 1%)	1,579 (< 1%)	1,579 (< 1%)	14,787 (1%)
4a Research natural areas	9,870 (< 1%)	7,820 (< 1%)	2,423 (< 1%)	9,870 (< 1%)
4b Experimental and demonstration forests	6,602 (< 1%)[d]	11,544 (< 1%)	11,544 (< 1%)	11,544 (< 1%)
5a Backcountry nonmotorized year-round primitive	--	149.258 (6%)	61,052 (3%)	290,262 (12%)
5b Backcountry motorized year-round (motorized vehicle use only on designated roads, trails, and areas)	--	50,002 (2%)	441 (< 1%)	50,365 (2%)
5c Backcountry motorized over-snow vehicle opportunities (on designated routes and areas)	--	107,656 (4%)	73,426 (3%)	117,650 (5%)
5d Backcountry motorized wheeled vehicle use on designated roads, trails, and areas from April 1 to November 30	--	9,854 (< 1%)	0	9,855 (< 1%)
5a-5d Backcountry **total**	381,685 (16%)[e]	316,770 (13%)	134,919 (6%)	468,132 (20%)
6a General forest low-intensity vegetation management	93,714 (4%)	123,693 (5%)	214,595 (9%)	116,659 (5%)
6b General forest medium-intensity vegetation management	--	298,770 (12%)	258,056 (11%)	292,872 (12%)

Management Area	Alternative A acres[b] (percent)	Alternative B modified acres (percent)	Alternative C acres (percent)	Alternative D acres (percent)
6c General forest high-intensity vegetation management	--	270,799 (11%)	125,946 (5%)	297,095 (12%)
6b-6c General forest **total**	703,454 (29%)[e]	569,569 (24%)	384,002 (16%)	589,967 (25%)
6a-6c General forest **total**	797,168 (33%)	693,262 (29%)	598,597 (25%)	706,626 (30%)
7 Focused recreation areas	7,305 (< 1%)[f]	60,888 (3%)	31,035 (1%)	60,901 (3%)
Total Forest **acres**	2,392,807	2,392,807	2,392,807	2,392,807

a. Acres and percentages are from the GIS data set. The official acres for NFS lands and wilderness areas can be found in the USFS Land Areas of the National Forest System, available at http://www.fs.fed.us/land/staff/lar-index.shtml.
b. Alternative A, the no-action alternative, is included even though it does not use the management areas defined for the forest plan. See table 3 for a crosswalk of the 1986 forest plan management areas to those used in the forest plan and the action alternatives.
c. Acres of eligible wild and scenic rivers in the existing 1986 forest plan are the same as in the action alternatives (see table 5). However, they were not assigned a management area in the existing 1986 forest plan and were not mapped for the draft EIS.
d. The Miller Creek Demonstration Forest (4,942 acres) was not assigned a management area in the existing 1986 forest plan.
e. The 1986 forest plan does not differentiate backcountry areas as the action alternatives do; thus, all backcountry acres are combined. The 1986 forest plan does not differentiate between general forest medium- and high-intensity management; therefore, they are combined.
f. There is no management area in the 1986 forest plan equivalent to focused recreation areas. These acres are the Round Meadow and Essex cross-country ski areas and the mapped developed recreation sites.

Chapter 1. Purpose and Need for Action

1.1 Proposed Action

The Forest Service has prepared this final environmental impact statement (EIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This EIS discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives.

The Forest Service proposes to revise the Flathead National Forest Land and Resource Management Plan (hereinafter referred to as the "forest plan") in compliance with the National Forest System (NFS) land management planning rule (36 CFR § 219), hereinafter referred to as the "2012 planning rule." The Forest Service is concurrently amending the land management plans (forest plans) of the Helena-Lewis and Clark, Kootenai, and Lolo National Forests (also referred to as "the amendment forests") to incorporate habitat management direction for the Northern Continental Divide Ecosystem (NCDE) grizzly bear population (refer to volume 3 of the final EIS for the evaluation of effects of these amendments). The Flathead National Forest is proposing to incorporate the NCDE grizzly bear habitat management direction as part of its plan revision process.

For ease of discussion throughout this document, the Flathead National Forest will be referred to as "the Forest" when referencing the single administrative unit, the staff that administers the unit, or the NFS lands within the unit.

The need for the proposed action is twofold: (1) to address significant changes that have occurred in ecological, economic, and social conditions in the area as well as changes in resource demands, availability of new scientific information, and promulgation of new policy, including the 2012 planning rule, and (2) to provide consistent direction that will support continued recovery of the NCDE grizzly bear population. On March 6, 2015, the Forest released the proposed action with a notice of intent to prepare an EIS in the Federal Register. Based upon the issues identified during the scoping process on the proposed action, the Forest prepared and published a draft EIS, with a notice of availability in the Federal Register in June 2016. This publication of the notice of availability of the draft documents in the Federal Register began the public comment period on the draft forest plan, draft amendments, and draft EIS. Over 33,000 comments were received during the 120-day comment period. The comments and responses by the Forest served to improve the analysis in the final EIS by refining the plan direction and aiding the forest supervisor in developing the draft record of decision.

Additional documentation, including detailed analyses of project area resources, public involvement information, and various documents used in developing alternatives and as background information for the resource specialists' analyses, may be found in the planning record located at the Flathead National Forest Supervisor's Office.

1.2 Document Organization

The documents are organized as follows:

Volume 1: Final Environmental Impact Statement for the Forest Plan for the Flathead National Forest

- Summary of Volumes 1 and 2
- Chapter 1. Purpose and Need for Action outlines the purpose and need for the forest plan revision, the plan area, the scope of the analysis, and the decisions to be made.
- Chapter 2. Alternatives, including the proposed action, describes the public involvement process, identifies key issues used for alternative development, and describes the alternatives. Alternatives considered but eliminated from detailed study are listed. A summary comparison of alternatives is provided at the end of the chapter.
- Chapter 3. Affected Environment and Environmental Consequences describes current conditions on the Forest and the environmental consequences of implementing each alternative. The physical and biological sections of chapter 3 are in volume 1.

Volume 2: Final Environmental Impact Statement for the Forest Plan for the Flathead National Forest

- Chapter 3 (continued). Affected Environment and Environmental Consequences contains the sections on human uses, benefits, and designations of the Forest, production of natural resources, and the social and economic environment.

Volume 3: Final Environmental Impact Statement for the Forest Plan Amendments to Incorporate Habitat Management Direction for the Northern Continental Divide Ecosystem Grizzly Bear Population on the Helena-Lewis and Clark, Kootenai, and Lolo National Forests

- Chapter 4. Purpose and Need for Action—Forest Plan Amendments includes the history of grizzly bear habitat conservation efforts and outlines the purpose and need for the forest plan amendments and the decisions to be made.
- Chapter 5. Alternatives Considered for the Forest Plan Amendments describes the public involvement process, identifies key issues used for alternative development, and describes the alternatives. Alternatives considered but eliminated from detailed study are listed. A summary comparison of alternatives is provided at the end of the chapter.
- Chapter 6. Affected Environment and Environmental Consequences of the Forest Plan Amendments describes current conditions on the Helena-Lewis and Clark, Kootenai, and Lolo National Forests and the environmental consequences of implementing each alternative.
- Chapter 7. Preparers and Contributors and Distribution of the EIS provides a list of the individuals who prepared the EIS and a list of the individuals, agencies, and organizations who were sent compact disks or hard copies of the final EIS.

Volume 4: Appendices

- Appendix 1—Maps (the majority of the maps are on the disk accompanying the final EIS)
- Appendix 2—Vegetation and Timber Analysis Process
- Appendix 3—Modeled Wildlife Habitat Assessment

- Appendix 4—Wilderness Recommendation Process
- Appendix 5—Wild and Scenic River Eligibility Study Process
- Appendix 6—Species, Plan Components, and Habitat Associations
- Appendix 7—Climate Adaptation Strategies
- Appendix 8—Response to Public Comments
- Glossary

The **Forest Plan for the Flathead National Forest** is a separate document and includes the following appendices:

- Appendix A— Northern Rockies Lynx Management Direction
- Appendix B—Maps
- Appendix C—Potential Management Approaches and Possible Actions
- Appendix D—Potential Vegetation Types
- Appendix E—Watershed Condition Framework and Conservation Watershed Network
- Appendix F—Scenic Character Descriptions
- Appendix G—Wilderness Recommendation Process
- Glossary

1.3 The Planning Area

The Forest, located in the northern Rocky Mountains amidst the mountains and valleys of western Montana, includes approximately 2.4 million acres of public land in portions of Flathead, Lake, Lewis and Clark, Lincoln, Missoula, and Powell Counties. The Forest has five ranger districts: Glacier View, Hungry Horse, Spotted Bear, Swan Lake, and Tally Lake. The Forest's supervisor's office is located in Kalispell. Encircled by the Kootenai, Lewis and Clark, and Lolo National Forests, Glacier National Park, and Canada, the Forest is the true heart of the Northern Continental Divide Ecosystem (Figure 1). Large designated wilderness areas, such as the Bob Marshall Wilderness Complex and the Mission Mountains Wilderness, in concert with other special areas such as wild and scenic river systems, the Jewel Basin Hiking Area, and other undeveloped backcountry areas, provide habitat strongholds for a host of plant and animal species. The Flathead National Forest.

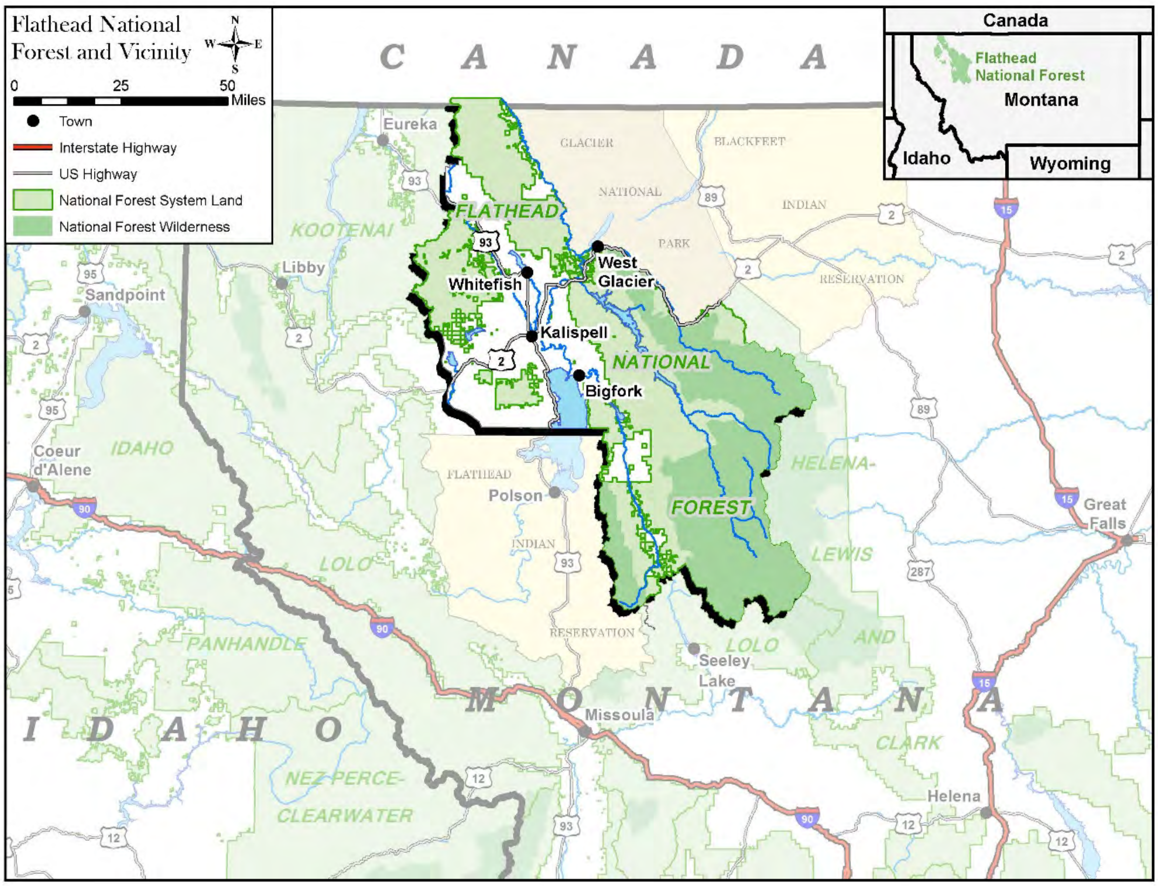

Figure 1. The Flathead National Forest and vicinity.

The Flathead National Forest is divided into six geographic areas, which provides a means for describing conditions and trends at a more local scale if appropriate. Geographic areas are ecological and place-based areas that are synonymous with certain basins and watersheds. Table 2 displays the acres of the Forest by geographic area, and figure 2 shows the location of the geographic areas.

Table 2. Acres within the six geographic areas on the Flathead National Forest

Geographic Area	Total Acres (all ownerships)	Total Acres (Forest)	Percent of geographic area in NFS Lands
North Fork	389,682	320,044	82%
Middle Fork	375,354	370,156	99%
Hungry Horse	331,752	286,234	86%
South Fork	790,585	789,074	100%
Swan Valley	533,139	364,440	68%
Salish Mountains	836,482	262,859	31%
TOTAL ACRES	3	2,392,807	73%

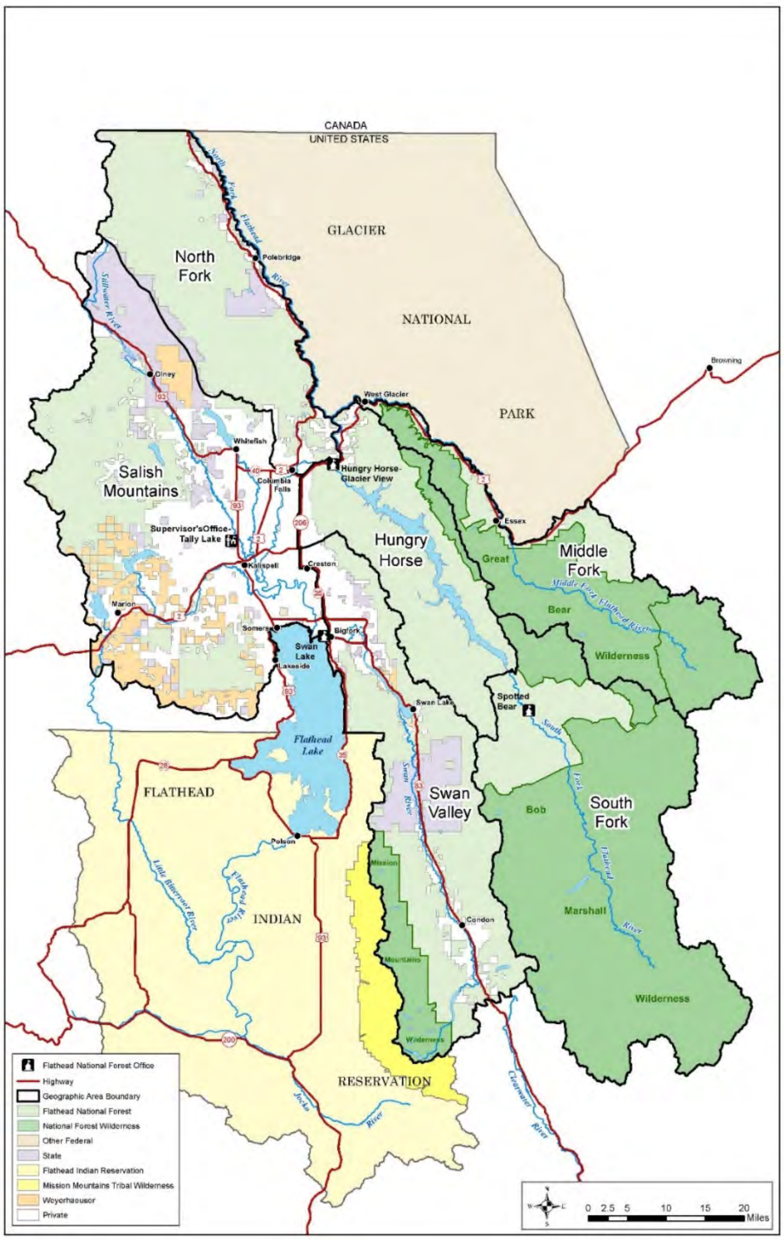

Figure 2. The six geographic areas on the Flathead National Forest

1.4 Purpose and Need for Action

The purpose of the proposed action is to revise the 1986 forest plan for the Forest. The existing forest plan is more than 30 years old, dramatically exceeding the 10-15 year duration of plans directed by NFMA. Since the 1986 forest plan was completed, there have been changes in ecological, social, and economic conditions in the area, as well as changes in resource demands, availability of new scientific information, and promulgation of new policy, including the 2012 planning rule. These changes necessitate a plan revision to ensure management direction is responsive to current issues and conditions. In particular, the plan revision addresses the following topics:

- Increasing demand for recreation opportunities and their importance in supporting local economies;
- Fire and fuels management direction that emphasizes active vegetation management near communities;
- New analyses needed of timber production opportunities, an important historical driver for local economies;
- Conservation of wildlife and aquatic habitat, including updating grizzly bear habitat management direction and Inland Native Fish direction; and
- New policy and public interest in identifying areas for recommended wilderness and wild and scenic rivers.

To develop the proposed action to revise the forest plan, the management direction in the 1986 forest plan and its amendments was reviewed. The 2012 planning rule requirements also mandate that new management direction be developed to address sustainability. This section summarizes how needs for change identified in the 1986 forest plan and its amendments, specifically those related to areas of public concern, were addressed during the development of the forest plan.

1.4.1 2012 planning rule requirements

The 2012 planning rule supports ecological, social, and economic sustainability as a goal for management of NFS lands. To address this requirement, new management direction was developed in several areas. For ecological sustainability, management direction was developed to address ecosystem diversity, connectivity, integrity, and key ecosystem characteristics in light of climate changes and anticipated future environments. Forest plan components focus on maintaining or restoring aquatic and terrestrial ecosystem resilience.

The plan adopts a complementary ecosystem and species-specific approach to maintaining the diversity of plant and animal communities and the persistence of native species in the plan area (see appendix 6 for species lists), including but not limited to at-risk species. At-risk species for planning are threatened, endangered, proposed, and candidate species designated by the U.S. Fish and Wildlife Service and species of conservation concern that are identified by the regional forester. Threatened, endangered, proposed, and candidate species native to the Forest are the grizzly bear (*Ursus arctos horribilis*), Canada lynx (*Lynx canadensis*), wolverine (*Gulo gulo luscus*), bull trout (*Salvelinus confluentus*), water howellia (*Howellia aquatilis*), meltwater stonefly *(Lednia tumana*), Spalding's catchfly (*Silene spaldingii*), and whitebark pine (*Pinus albicaulis*). For the species of conservation concern identified by the regional forester, see http://bit.ly/NorthernRegion-SCC.

The Forest developed comprehensive management direction to address access and sustainable recreation. This direction considers the suitability of certain areas for particular uses, recreational

opportunities and settings, and motorized and nonmotorized travel to provide for the management of existing and anticipated uses as well as resource protection needs.

The role of timber harvest in meeting ecosystem management and social and economic objectives has changed since the Flathead's 1986 forest plan was developed. The 2012 planning rule requires the Forest to undertake a process to identify lands within the plan area that are suitable for timber production. The forest plan includes plan components for lands suitable for timber production and for lands where timber harvest is appropriate for purposes other than timber production (e.g., removal of hazard trees in campgrounds). These plan components are intended to facilitate an active vegetation management program of work to meet ecosystem and socioeconomic objectives.

The 2012 planning rule requires land management plans to provide information regarding possible actions that may occur on the plan analysis area during the life of the plan, including the planned timber sale program, timber harvesting levels, and the proportion of probable methods of forest vegetation management practices expected to be used (16 U.S.C. 1604(e)(2) and (f)(2)). The forest plan addresses this requirement through the allocation of management areas, objectives reflecting anticipated budget levels, and disclosure of potential management approaches and possible actions (see appendix C of the forest plan).

To address social and economic sustainability, management direction was developed to provide people and communities with a range of social and economic benefits for present and future generations. The benefit to people (i.e., the goods and services provided) are the "ecosystem services" from the ecosystem. The Forest's key ecosystem services, as discussed and identified in the assessment, are carbon sequestration and climate regulation; forest products such as wood products and huckleberries; water quality and quantity and flood control; clean air; outdoor recreation; scenery; fish and wildlife, i.e., habitat for these species; cultural and heritage values, inspiration, spiritual values and solitude; hunting, trapping, fishing, and wildlife viewing; and research and education.

The 2012 planning rule requires the identification and evaluation of lands that may be suitable for inclusion in the National Wilderness Preservation System and of eligible rivers and streams for inclusion in the National Wild and Scenic Rivers System. The recommended wilderness evaluation and wild and scenic river eligibility study process resulted in management area allocations and forest plan components. Refer to appendix 4 for the wilderness recommendation process and appendix 5 for the wild and scenic river eligibility study process.

The forest plan revision process begins with the preparation of an assessment to identify the need for change. The assessment of the Flathead National Forest was published in April 2014 (USDA, 2014a). This assessment, developed in accordance with the 2012 planning rule, evaluated existing information about relevant ecological, economic, and social conditions, trends, and sustainability and their relationship to the land management plan within the context of the broader landscape. This information was used in describing current conditions and trends and identifying the need for change, and it also served as the basis for the proposed action as well as the alternatives.

1.4.2 Grizzly bear habitat management

Under the Endangered Species Act of 1973, Federal agencies are directed to use their authorities to seek to conserve endangered and threatened species. The 1986 Flathead National Forest plan contained management direction related to grizzly bear habitat to provide specifically for the recovery of the threatened grizzly bear. Amendment 19 to the Flathead National Forest plan was completed in 1995 and resulted in the establishment of management direction related to trails, the

motorized use of roads, and security for grizzly bears. Forest plan amendment 19 established limits on open motorized access density, total motorized access density, and the security core for 54 of the 73 grizzly bear subunits across the Flathead National Forest portion of the NCDE.

The purpose of revising grizzly bear habitat management on the Forest is to provide consistent direction that will support continued recovery of the NCDE grizzly bear population. In particular, habitat conditions and management actions on the national forests have contributed importantly to the increased population size and improved status of the grizzly bear across the NCDE. But, supporting a healthy, recovered grizzly bear population will depend on the Forest Service's continued effective management of the NCDE grizzly bear habitat.

In 2013, the USFWS announced the availability of a draft grizzly bear conservation strategy (hereinafter referred to as the draft Grizzly Bear Conservation Strategy) (USFWS, 2013a) for the NCDE population for public review and input. When finalized, the draft Grizzly Bear Conservation Strategy will become an interagency management strategy for the NCDE grizzly bears and their habitat after they have been delisted. The stated intent of chapter 3 ("Habitat Management and Monitoring") of the draft Grizzly Bear Conservation Strategy was to formulate habitat standards applicable to the management of public lands. The Forest developed plan components to incorporate desired conditions, standards, and guidelines as well as monitoring items in the forest plan related to grizzly bear habitat management on NFS lands. These plan components and monitoring items were informed by the draft Grizzly Bear Conservation Strategy and provide consistent direction that will contribute to the continued recovery of the NCDE grizzly bear population.

Under the forest plan, NFS lands would no longer be designated as management situation 1, 2, or 3. The forest plan incorporates the following management zones within the Flathead National Forest portion of the NCDE (see figure B-10):

- **Primary conservation area**: the same as the recovery zone identified in the Grizzly Bear Recovery Plan (USFWS, 1993, p. 36);
- **Management zone 1**: a defined area surrounding the primary conservation area, within which grizzly bear population status and trends would be monitored;
- **Salish demographic connectivity area**: a portion of management zone 1 that has specific habitat measures to allow female grizzly bear occupancy and eventual dispersal to other ecosystems in the lower 48 states (i.e., the Cabinet-Yaak and Bitterroot ecosystems).

Within the NCDE recovery zone/primary conservation area on the Forest, grizzly bear habitat management direction is incorporated into the forest plan, including but not limited to secure core, open and total motorized route densities, administrative use, temporary use for projects; number and capacity of developed recreation sites; number of livestock allotments; food/wildlife attractant storage special orders; minerals and energy development; and vegetation management.

Within the Flathead National Forest portion of NCDE zone 1, habitat protections focus on limiting the miles of motorized routes and managing the current inventoried roadless area in the Salish demographic connectivity area as an area through which grizzly bears might move to the Cabinet-Yaak grizzly bear ecosystem.

The forest plan would replace amendment 19 in its entirety once adopted, following consultation with the USFWS. The Swan Valley Grizzly Bear Conservation Agreement, which the Forest is currently following in its management of the agreement area in the Swan Valley, would also be replaced by the management direction in the forest plan.

The Flathead National Forest planning team also coordinated the NEPA effort to amend the grizzly bear habitat-related management direction in the Helena, Lewis and Clark, Kootenai, and Lolo forest plans. Informed by the draft Grizzly Bear Conservation Strategy, the amendments ensure consistent direction across the primary conservation area and provide habitat management direction for bear management zones 1 and 2 and the demographic connectivity areas on NFS lands throughout the NCDE (refer to volume 3 of the final EIS for the evaluation of effects of the amendments).

1.4.3 Inland native fish habitat

The 1986 forest plan was amended by the Inland Native Fish Strategy (INFISH) in 1995. INFISH was designed to maintain populations of inland native fish by reducing negative impacts to aquatic habitat (USDA, 1995b). The implementation of INFISH riparian management objectives, standards, guides, and monitoring requirements has contributed to the recovery of aquatic habitats in eastern Oregon and Washington, Idaho, western Montana, and portions of Nevada. INFISH was originally expected to last 18 months to three years while an effort similar to the Northwest Forest Plan, the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 1996, 2014), was completed for the Interior Columbia River Basin. That strategy was never completed, but science from that effort has been retained in the form of guidance for plan revisions occurring in areas covered by INFISH and the Pacific Fish Strategy (PACFISH). Interior Columbia Basin Ecosystem Management Project science and guidance is followed in this forest plan revision. In addition to following this guidance, this plan also follows direction in the 2012 planning rule. Specifically, greater emphasis is placed on meeting improved and more refined desired conditions, and “standards and guidelines” that were not differentiated in PACFISH/INFISH are separated into standards and/or guidelines in this plan.

Since INFISH was implemented, there have also been numerous changes to policy, best available scientific information, and the condition of listed species. Tremendous advances in knowledge regarding physical habitat and ecological interactions at many scales and across scientific disciplines have been made, as well as advances in spatial database management. Scientists’ findings disclosed in best available scientific information urge managers and biologists working to maintain and improve aquatic habitat to look beyond the stream reach when considering how best to plan and implement project activities. Climate change science has also emerged as an important aspect of forest and river management since INFISH was adopted. These topics are further discussed in sections 3.1.2 and 3.3 of this final EIS and appendices C and E of the forest plan.

1.4.4 Canada lynx habitat management

The 1986 forest plan contains direction designed to conserve and promote the recovery of Canada lynx that was incorporated into the plan in 2007 (USDA, 2007). Since 2007, new information on Canada lynx has been published, including designation of critical habitat for Canada lynx (USFWS, 2009a), an updated version of the Lynx Conservation and Assessment Strategy (ILBT, 2013), and scientific research results relevant to Canada lynx in northwest Montana (see the references section).

The habitat direction from the Northern Rockies Lynx Management Direction (NRLMD) is retained in the forest plan through standard FW-STD-WL-04. The Forest retains the NRLMD from the current forest plan (see appendix A), with two Forest-specific modifications:

- VEG S6 has an additional exception category aimed at protecting mature rust-resistant whitebark pine trees (a candidate species for listing, identified as an important component of the restoration program). The intent is to reduce the risk of loss of these seed-producing trees due to fire, insects, and disease and to make them more resilient in the face of anticipated future environments (see FW-STD-TE&V-02). Standard VEG S5 already has an exception that

allows precommercial thinning to restore whitebark pine, but VEG S6 does not provide a comparable exception.

- Human use guideline HU G11 modifies the areas identified as suitable for motorized over-snow vehicle use (see FW-GDL-REC-03). This guideline provides a strategy for management of over-snow motorized vehicle use that will be more adaptive in the future compared to the current guideline for addressing designated routes and play areas and areas of consistent snow compaction.

The Forest will manage critical habitat to contribute to the recovery of Canada lynx.

1.4.5 Inventoried roadless areas

Inventoried roadless areas are designated under the 2001 Roadless Area Conservation Rule (36 CFR § 294 Subpart B). The Roadless Area Conservation Rule prohibits road construction or reconstruction and cutting, selling, or removing timber in inventoried roadless areas unless a listed exemption applies. For example, one exemption allows the cutting, sale, or removal of generally small-diameter timber when it is needed to improve threatened, endangered, proposed, or sensitive species habitat or to maintain or restore the characteristics of ecosystem composition and structure that would be expected to occur under natural disturbance regimes. The forest plan cannot modify Roadless Area Conservation Rule direction.

Currently, about 20 percent (478,757 acres) of the Forest is comprised of inventoried roadless areas (see figure B-25 and figure B-26). The proposed change to management direction of inventoried roadless areas from the 1986 forest plan is to remove inventoried roadless areas from lands suitable for timber production and determine the recreation opportunity spectrum classification and the desired management area delineation.

1.4.6 Old-growth forests

Amendment 21 to the 1986 forest plan, completed in 1999, established goals, standards, and objectives related to the management of old-growth forests and important associated stand structural components such as snags and downed wood. The key features and intent of this direction have been retained in the forest plan, with refinements and augmentation based on new analysis and methodology; the desire to increase emphasis on future old-growth forest development and connectivity; and the need to be consistent with the approach used with other vegetation management direction. These key features include maintaining and protecting existing old-growth forest both at the stand and landscape level, limiting treatment activities within old-growth forest, retaining snags and downed wood within timber harvest areas, and managing to develop future old-growth forest. A notable change from the existing old-growth forest direction is that the Forest is no longer required to manage landscapes to achieve 75 percent of the median amount of historical old-growth forest. This change is due to old-growth forest being site-specifically defined at the stand level and to the lack of an acceptable means of quantifying historical old-growth forest at this level. In addition to plan components for old-growth forest, plan components associated with forest size classes, very large tree components, and snags and downed wood provide a basis for managing landscapes for desired old-growth forest conditions and for monitoring trends over time.

1.4.7 Winter motorized recreation

Amendment 24 to the 1986 forest plan was implemented in 2006 to provide direction for over-snow winter motorized recreation, including when and where motorized over-snow vehicle use could occur. The amendment designated specific routes and play areas as well as seasons for motorized over-snow vehicle use per §212.81 of the 2001 Travel Management Rule. In the forest plan, the

designated routes and play areas and associated dates for motorized over-snow vehicle use identified in amendment 24 are retained, but changes are proposed to the boundaries of specific areas, as shown in figures 1-43 to 1-45 in appendix 1, as suitable or not suitable for motorized over-snow vehicle use in order to address recreation sustainability.

The Forest received input from the Whitefish Range Partnership collaborative group expressing a desire to have a larger area open to motorized over-snow vehicle use in the area between Big Creek in the North Fork of the Flathead River and Columbia Falls, Montana. In addition, other members of the public expressed a need to adjust the boundaries of areas that are currently open because some have grown in with vegetation, because the public has difficulty recognizing some boundaries on the ground, and because it would assist the Forest Service in enforcing closure boundaries. In order to avoid impacting key wildlife habitats, changes were identified in areas suitable for motorized over-snow vehicle use so that there would be no net increase in designated routes for motorized over-snow vehicle use or acres of play areas open to motorized over-snow vehicle use across the Forest. As shown in figures 1-43 to 1-45 in appendix 1, the largest shift in acres would be an area in the vicinity of Lookout Creek, Deep Creek, Depuy Creek, and McGinnis Creek in the North Fork of the Flathead River south of Big Creek that is identified as suitable for motorized over-snow vehicle use. An equivalent acreage in the vicinity of upper Slide Creek, upper Sullivan Creek, and upper Tin Creek in the South Fork of the Flathead River is identified as not suitable for motorized over-snow vehicle use. Some of this shift in suitability is due to recommended wilderness allocation because mechanized transport and motorized uses is not suitable in recommended wilderness. These suitability changes would need to undergo site-specific analysis in order to be implemented and to comply with 36 CFR §§ 212 and 261.

1.5 Decision Framework

The responsible official who approves the record of decision for the forest plan is the forest supervisor. After reviewing the results of the analysis evaluated in the final EIS, the responsible official issues a draft record of decision, in accordance with agency decisionmaking procedures (40 CFR § 1505.2) that will

- disclose the decision (identifying the selected alternative) and reasons for the decision,
- discuss how public comments and issues were considered in the decision, and
- discuss how all alternatives were considered in reaching the decision, specifying which one is the environmentally preferable alternative (defined in 36 CFR § 220.3).

Approval of the forest plan will identify management areas and will include recommendations for areas that can only be designated by statute, such as wilderness.

The forest plan will set a framework for managing the Forest for the next 10 to 15 years. However, project-level environmental analysis will still need to be completed for specific proposals to implement the direction in the forest plan.

The decision framework for the amendments is discussed in section 4.5.

1.6 Relationship to Other Entities

The 2012 planning rule (36 CFR § 219.4(b)) requires the review of the planning and land use policies of other Federal agencies, State and local governments, and Indian tribes. This review includes (1) consideration of the objectives of these entities as expressed in their plans and policies, (2) the compatibility and interrelated impacts of these plans and policies, (3) opportunities for the

plan to address the impacts identified or contribute to joint objectives, and (4) opportunities to resolve or reduce conflicts, within the context of developing the plan's desired conditions or objectives.

The Forest invited Federal, tribal, State, and local entities from around the region to participate in interagency group meetings beginning in 2013 (Meridian Institute, 2017). These included the National Park Service (Glacier National Park), U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, U.S. Border Patrol, Confederated Salish and Kootenai Tribes, Montana Department of Natural Resources and Conservation, Montana Fish, Wildlife and Parks, and five counties: Flathead, Missoula, Lake, Sanders (did not attend), Lincoln (did not attend). Not all entities participated in every meeting, but a core group of people attended regularly. The process enabled the Forest to better evaluate whether each interagency group member's respective planning and land use documents were or were not consistent with the forest plan. The interagency group meetings also provided an opportunity for the Forest and its interagency partners to exchange updates and information about an array of relevant policies, planning processes, and other activities of general interest to jurisdictions around the Forest. In addition, the Forest reviewed the objectives of other agency and tribal planning documents to determine consistency with the forest plan (USDA, 2017a).

1.6.1 County governments

Beginning with the initiation of the planning process, local government officials from four of the counties that have lands within the Flathead National Forest (Flathead, Missoula, Lake, and Lincoln Counties) were invited to participate in the development of the draft forest plan (Meridian Institute, 2017). Both Flathead and Missoula Counties were active participants in the interagency meetings. Three counties (Flathead, Missoula, and Lake) commented on the forest plan.

The related and equivalent county plans were considered and evaluated for consistency with the forest plan during the planning process (USDA, 2017a). There are a number of similarities between the goals of the county plans and the goals of the forest plan, specifically "conserving vital natural resources including surface and groundwater, air quality, agricultural resources, iconic landscapes, fish and wildlife species and their habitats, and native plant communities" and "sustaining and promoting the land- and resource-based industries of agriculture, timber, restoration, and recreation that are part of the local economy and heritage" (see Missoula County goals in USDA, 2017a). Missoula County updated their guiding principles, goals, objectives, and actions in 2016, many of which closely align to the forest plan. Other commonalities between county plans and the forest plan include an emphasis on protecting rural character and reducing safety risks and costs associated with wildland fire, flooding, and other hazards.

The Forest has determined that the forest plan is generally compatible with the Flathead, Missoula, Lake, and Lincoln County growth policies, specifically the natural resource components. Certain goals and objectives related to forest management, recommended wilderness, fire and fuels management, recreation, and roads are not fully compatible with the growth policies, but the Forest is committed to working with the counties to address the impacts and benefits from management of the Forest.

1.6.2 State

Several Montana State agencies are affected by, or affect, Forest Service management. These include Montana Fish, Wildlife, and Parks, Montana Department of Environmental Quality, Montana Department of Natural Resources and Conservation, and Montana Department of Transportation. The Forest coordinated information with Montana Fish, Wildlife, and Parks during all phases of the

process. These offices provided formal comments during the public comment period and other public involvement stages. In addition, Montana's statewide wildlife action plan and forest resource strategy were reviewed for compatibility with the forest plan (USDA, 2017a).

1.6.3 Tribes

The forest supervisor and members of the planning team met a number of times with tribal representatives from the Confederated Salish and Kootenai Tribes during development of the draft forest plan. Specific tribal comments were considered in developing the EIS and forest plan, and tribal planning documents were reviewed for compatibility with the forest plan (USDA, 2017a).

1.6.4 Federal

The management of Federal lands adjacent to the Flathead National Forest was considered in the formulation of alternatives and their cumulative effects. Consideration of national scenic trails, utility corridors, designated wilderness, and other management concerns across boundaries were discussed with Glacier National Park, the U.S. Department of Homeland Security, and the U.S. Bureau of Reclamation as well as adjacent national forests (Helena-Lewis and Clark, Kootenai, and Lolo National Forests). Federal land management plans were reviewed for compatibility with the forest plan (USDA, 2017a). The Forest coordinated information with the regional office of the Environmental Protection Agency during all phases of the process.

1.7 Levels of Forest Service Planning

Forest Service planning takes place at different organizational levels and geographic scales. Planning occurs at three levels—national strategic planning, NFS unit planning, and project or activity planning. The Chief of the Forest Service is responsible for national planning, such as preparation of the Forest Service strategic plan that established goals, objectives, performance measures, and strategies for management of the NFS. National Forest System unit planning results in the development, amendment, or revision of a land management plan, such as the Flathead National Forest's forest plan. The supervisor of the national forest is the responsible official for the development and approval of a plan, plan amendment, or plan revision for lands under the responsibility of the supervisor. The forest supervisor or district ranger is the responsible official for project and activity planning (§ 219.2).

1.7.1 National strategic planning

The USDA Forest Service Strategic Plan: FY 2015-2020 contains four outcome-oriented goals for the Forest Service, each with strategic objectives. The strategic plan can be accessed online (www.fs.fed.us/strategicplan). The first two goals and related objectives are directly related to the current planning effort:

1. Sustain our Nation's forests and grasslands
   - Foster resilient, adaptive ecosystems to mitigate climate change
   - Mitigate wildfire risk
   - Conserve open space
2. Deliver benefits to the public
   - Provide abundant clean water
   - Strengthen communities

- Connect people to the outdoors

The Forest Service continues to use the results of the 2010 Resources Planning Act Assessment (USDA, 2012b), a report on the status and projected future trends of the nation's renewable resources on all forests and rangelands, as required by the 1974 Forest and Rangeland Renewable Resources Planning Act. The assessment includes analyses of forests, rangelands, wildlife and fish, biodiversity, water, outdoor recreation, wilderness, urban forests, and the effects of climate change on these resources. The assessment provides a snapshot of current U.S. forest and rangeland conditions (all ownerships), identifies drivers of change for natural resource conditions, and projects the effects of those drivers on resource conditions 50 years into the future. This assessment uses a set of future scenarios that influence the resource projections, allowing the exploration of a range of possible futures for U.S. renewable natural resources. Alternative future scenarios were used to analyze the effects of human and environmental influences on U.S. forests and rangelands, including population growth, domestic and global economic growth, land use change, and climate change.

In addition, the USDA strategic plan for fiscal year 2014-2018 has specific goals that also align with the 2012 planning rule, including (1) assist rural communities to create prosperity so they are self-sustaining, repopulating, and economically thriving; and (2) ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change while enhancing our water resources. The USDA strategic plan can be accessed on the USDA's Web site (www.usda.gov).

1.7.2 National Forest System unit planning

The National Forest Management Act of 1976 (Pub. L. 94-588) amended the Forest and Rangeland Renewable Resources Planning Act of 1974. The National Forest Management Act requires the preparation of an integrated land management plan by an interdisciplinary team for each unit of the NFS (national forests and grasslands). The public must be involved in preparing and revising forest plans. Forest plans must provide for multiple use and sustained yield of products and services and include coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness. The forest plan does not authorize site-specific prohibitions or activities; rather, it establishes broad direction, similar to zoning in a community.

The 2012 planning rule for land management planning for the NFS sets forth process and content requirements to guide the development, amendment, and revision of land management plans to maintain and restore NFS land and water ecosystems while providing for ecosystem services (the benefits people obtain from the NFS planning area) and multiple uses (USDA, 2012a). The final planning directives, effective January 30, 2015, are the key set of agency guidance documents that direct implementation of the 2012 planning rule (USDA, 2015e).

1.7.3 Project or activity planning

Previously approved and ongoing projects and activities are not required to meet the direction of the forest plan and will remain consistent with the direction in the 1986 forest plan, as amended. Project and activity consistency with the forest plan (§ 219.15) will be achieved through application to projects or activities authorized after the plan decision, determining and resolving inconsistency of a proposed project or activity to applicable plan components, and evaluating the consistency of other resource plans within the planning area with the land management plan, and updating if needed. Refer to page 3 of the forest plan for additional information about project and activity consistency. The forest plan direction will apply to all projects and or activities that have a decision made on or after the effective date of the final record of decision. Projects and activities authorized after approval of the forest plan will be consistent with applicable plan components in the forest plan. A

project or activity approval document will describe how the project or activity is consistent with the applicable plan components.

Any resource plans developed by the Forest that apply to the resources or land areas within the planning area will be consistent with the plan components. Resource plans developed prior to the plan decision will be evaluated for consistency with the plan and updated if necessary.

When a proposed project or activity would not be consistent with the applicable plan components, the responsible official shall take one of the following steps, subject to valid existing rights (36 CFR § 219.15(c)):

- modify the proposed project or activity to make it consistent with the applicable plan components,
- reject the proposal or terminate the project or activity,
- amend the plan so that the project or activity will be consistent with the plan, as amended, or
- amend the plan contemporaneously with the approval of the project or activity so that the project or activity will be consistent with the plan, as amended. This amendment may be limited to apply only to the project or activity.

The forest supervisor or district ranger is the responsible official for project and activity planning. In order for prohibitions or activities that take place on the ground, project or activity decisions will need to be made following appropriate procedures (e.g., site-specific analysis in compliance with NEPA).

Chapter 2. Alternatives

2.1 Introduction

This chapter describes and compares the alternatives considered for the forest plan. It includes a discussion of how the alternatives were developed, the primary issues raised, a description of each alternative considered in detail, and elements common to all alternatives. This chapter also includes a discussion of the alternatives that were considered but not analyzed in detail and the rationale for not considering each alternative in detail. It is important to note that forest plans do not make budget decisions. Should Congress emphasize specific programs by appropriation, a redistribution of priorities would follow, regardless of the alternative implemented.

The Council on Environmental Quality's regulations on NEPA procedures and specifically on alternative development (36 CFR 40 § 1502.14) are fundamental to the process, as outlined below:

> Based on the information and analysis presented in the sections on the affected environment (§ 1502.15) and the environmental consequences (§ 1502.16), it should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public. In this section agencies shall:
>
> a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.
> b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.
> c) Include reasonable alternatives not within the jurisdiction of the lead agency.
> d) Include the alternative of no action.
> e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.
> f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

2.2 Development of Alternatives

Alternatives represent a range of possible management options from which to evaluate the comparative merits of the proposal. Each alternative emphasizes specific land and resource uses and de-emphasizes other uses in response to the significant issues, primarily by changing management area allocations. All reasonable alternatives to the proposed action must meet the purpose and need for change and address one or more of the significant issues. For this forest plan, not all possible alternatives were considered in detailed as the list of options would have been prohibitively large. Instead, the responsible official identified those alternatives that meet both the purpose and need for change and that create a reasonable range of outputs, direction, costs, management requirements, and effects from which to choose.

2.2.1 Public engagement

The Forest began public engagement during the assessment phase of the revision process. To facilitate local participation, the Forest contracted with the U.S. Institute for Environmental Conflict Resolution in 2012 to develop a collaborative stakeholder engagement process. The Institute met with Forest Service employees and a representative group of key stakeholders to determine their willingness to engage in a

collaborative process convened by a neutral third party. The Meridian Institute was selected to serve in that capacity and facilitated numerous topical work groups, an interagency group, and meetings to bring together all work groups and interested citizens. Beginning with a news release July 19, 2013, as part of the public involvement process Forest staff led field trips and held open houses to discuss existing information and trends related to a variety of conditions found on the Forest. From October 2013 through June 2014, the Forest hosted monthly meetings with the intent to collaboratively develop plan components for consideration in the development of a proposed action. The dialogue and recommendations from this public involvement process were used to help develop the draft forest plan's proposed action.

The notice of intent on the proposed action was published in the Federal Register on March 6, 2015. The notice of intent asked for public comment on the proposal for a 60-day period (until May 5, 2015). The comment period was subsequently extended by 10 days (until May 15, 2015). In addition, as part of the public involvement process, the agency held seven open houses to provide opportunities for the public to better understand the proposed action so that meaningful public comments could be provided by the end of the scoping period. Using the comments from the public, other agencies, tribes, and organizations, the Forest's interdisciplinary team developed a list of issues to address. The list was then organized by issue applicability, i.e., whether the issue was specific to the revision effort or specific to the amendment effort or applied to both. Issues that involve the amendment effort are discussed further in section 5.4.

Based upon the issues identified from the scoping process on the proposed action, the Forest prepared and published a draft EIS with a notice of availability in the Federal Register in June 2016. This publication of the notice of availability of the draft documents in the Federal Register began the public comment period on the draft forest plan, draft amendments, and draft EIS. Two open houses were held in Kalispell and Missoula during the 120-day comment period. In addition to the open houses, the planning team continued to provide information throughout the comment period to address questions. The interagency group continued to meet to discuss and provide input with respect to their agencies' concerns.

The comment period ended on October 3, 2016, for the draft EIS, draft forest plan, and draft forest plan amendments. The 120-day comment period resulted in over 33,000 comments. The comments were aggregated into unique concern statements, and the Forest developed responses to the concerns (see appendix 8). The responses were also critical to improving the analysis in the final EIS, refining plan direction, and aiding the forest supervisor in developing the draft record of decision.

Another key component of the involvement and transparency of the public involvement efforts associated with this planning effort has been the information made available to the public through the forest plan revision Web site (www.fs.udsa.gov/goto/flathead/fpr). The Forest also utilized collaborative mapping tools, an online forum for gathering public comments and input on specific areas of the Forest, throughout the planning process and specifically for input on the wilderness inventory and evaluation process. The availability to provide equal opportunities to anyone who wanted to participate in the planning process was greatly enhanced by the Forest's ability to provide Web-based information for the public to comment on the process as well as plan components. The forest plan revision Web site is an excellent source of information; it includes the current information and documents as well as the record of all the previous public involvement efforts.

Engagement of State and Local Governments, other Federal Agencies, and Indian Tribes

Local tribes and communities depend on the economic, social, and ecological benefits provided by the Forest. The Forest supports jobs and economies, local traditional ways of life, healthy wildlife populations, and clean air and water, among other benefits. Many of the issues and concerns facing the

Forest, such as wildfire, require a cohesive management approach across the landscape. It is therefore essential that the representatives of local tribes, counties, as well as other Federal agencies, are actively involved in plan revision. In addition to the opportunities described in section 2.2.1, which were available to governmental entities, the Forest worked directly with State and local governments, other Federal Agencies, and Indian tribes throughout the planning process.

Interagency meetings were convened as necessary from the beginning of the revision process to provide updates on the planning process as well as to ensure consistency with county, state, federal, and tribal policies, and interests to the extent practicable (planning record exhibit 00649). The planning record exhibits from these meetings (planning record exhibits 00004-00021, 00307-00314; also available at http://www.merid.org/FNFplanrevision.aspx) demonstrate a commitment on the part of the Forest to meaningfully engage with interested and affected agencies but also demonstrate the cooperation of these entities in the development of this forest plan.

2.2.2 Issues used for alternative development

Issues serve to highlight effects or unintended consequences that may occur as a result of the proposed action or alternatives. The Forest's planning team categorized the issues identified during scoping as either significant or nonsignificant. Significant issues were defined as those directly or indirectly caused by implementing the proposed action, that involved potentially significant effects, and that could be meaningfully and reasonably evaluated and addressed within the programmatic scope of the forest plan.[2] Alternatives were developed around the significant issues that involved unresolved conflicts concerning alternative uses of available resources.

The planning team identified the following significant issues during the public involvement process that drove the subsequent development of alternatives:

- vegetation management, timber production, and fire and fuels management
- wildlife and aquatic habitat
- access and recreation
- recommended wilderness

Vegetation management, timber production, and fire and fuels management

Some commenters would prefer an emphasis on the use of natural ecosystem processes to achieve desired vegetation conditions, which they indicated would provide greater benefits to wildlife and less emphasis on mechanical treatment methods and timber harvest. They would like to see fewer acres suitable for timber production. Others stated there is not enough emphasis on the use of mechanical methods and timber harvest to achieve desired conditions and expressed concern regarding the appropriate balance between the social, economic, and ecological aspects of the forest plan. Some also noted that this low level of treatments would not meet the forest fuel reduction needs for the purpose of reducing fire intensity in proximity to private lands. They would like to see more lands allocated to higher-intensity timber management and/or an increase in the acres suitable for timber production. Related to this issue is the desire by some to see an increase in the potential timber sale quantity to provide what they feel would be a better balance between the social, economic, and ecological aspects of the plan.

[2] Some issues are best resolved at finer scales where the site-specific details of a specific action and the resources it affects can be meaningfully evaluated and weighed, subject to the NEPA process. Conversely, some issues have already been considered through a broader programmatic NEPA process (e.g., the NRLMD). In these cases, the issues are more focused on evaluating the effects unique to and commensurate with the decision being considered.

Wildlife and aquatic habitat

Some commenters stated that the proposed action does not include adequate protections for wildlife and aquatic habitat, but others stated that the protections are adequate and that more management flexibility is needed to move towards all desired conditions on the Forest, including those that support biodiversity. Some commended the Forest for addressing connectivity in the desired conditions but wanted greater consideration of habitat connectivity at multiple scales. Some wanted all wildlife plan components to be mandatory with measurable standards, whereas others wanted broad desired conditions or guidelines that would allow for site-specific application at the project level.

Access and recreation

Some people stated that the proposed action is too limiting to motorized opportunities and promotes nonmotorized opportunities; they felt the Forest should have more motorized opportunities. Other people stated that there should be additional closures on roads and trails to protect wildlife and increase the amount of nonmotorized recreation; they felt the Forest should offer fewer motorized opportunities.

Recommended wilderness

Some people stated the proposed action includes areas as recommended wilderness that do not meet the definition of the Wilderness Act and thus should not be recommended as wilderness, and others felt the proposed action did not include enough areas as recommended wilderness. Some people did not want to see any additional recommended wilderness areas.

Some people stated that the proposal to allow existing mechanized transport and motorized use in recommended wilderness areas would not allow the areas to be designated for wilderness by Congress or would not protect the social and ecological characteristics that formed the basis for its recommendation. Some people felt that by not allowing existing mechanized transport and motorized use in areas recommended for wilderness, the Forest is creating de facto wilderness; they felt that social and ecological characteristics would be protected and maintained by allowing existing motorized use and mechanized transport to continue.

2.3 Elements Common to All Alternatives

All action alternatives (B modified, C, and D) are based on the concepts of multiple use and ecological, social, and economic sustainability. Multiple-use management is characterized by harmonious and coordinated management of the various resources without impairment of the productivity of the land, with consideration being given to the relative values of the various resources; it is not necessarily characterized by the combination of uses that will give the greatest dollar return or the greatest unit output, consistent with the Multiple-Use Sustained-Yield Act of 1960 (see 16 U.S.C. 528–531). Ecological sustainability refers to the capability of ecosystems to maintain ecological integrity; economic sustainability refers to the capability of society to produce and consume or otherwise benefit from goods and services, including contributions to jobs and market and nonmarket benefits; and social sustainability refers to the capability of society to support the network of relationships, traditions, cultures, and activities that connect people to the land and to one another and support vibrant communities (36 CFR § 219.19).

Each alternative would

- meet law, regulation, and policy;
- contribute to ecological, social, and economic sustainability;
- meet the purpose and need for change and address one or more significant issues;

- provide integrated management direction as included in the forestwide, management area, and geographic area desired conditions, objectives, standards, guidelines, and suitability; and
- provide sustainable levels of products and services.

Forestwide, geographic area, and management area direction identified in the forest plan would apply to all action alternatives, with some exceptions in regards to grizzly bear, suitability of activities in recommended wilderness areas, timber objectives, and suitability for motorized over-snow vehicles. The primary difference between alternatives is in allocation of acres by management area to meet the purpose and need for change and address one or more of the identified issues.

The following would be the same under all alternatives:

- Management area and forestwide direction for desired conditions, standards, and guidelines remains constant for all action alternatives, with the exceptions noted above.
- Existing developed recreation sites and recreation residence special-use permits are allowed under all alternatives. None of the alternatives make decisions to remove or to create developed recreation sites.
- Management direction for and location of utility and road rights-of-way, easements, and communications sites remain constant under all alternatives.
- National Wilderness System lands and plan components remain constant under all alternatives.
- Designated and eligible wild and scenic rivers remain constant under all action alternatives.

2.4 Description of Alternatives

Alternative A, the no-action alternative, reflects current management practices under the 1986 forest plan, as amended and implemented, and provides the basis for comparing alternatives to current management and levels of output. Although all alternatives provide a wide range of ecosystem services and multiple uses, some give slightly greater emphasis to selected resources based on the theme of the alternative and response to revision topics.

Alternatives to the no-action alternative were developed based on the need for change, information in the Forest's assessment (2014), implementation and monitoring of the current forest plan, collaborative meetings (2013-2014), and comments received during the public involvement period, interagency meetings, and meetings with tribal partners. The alternatives represent a range of possible management options. Each alternative emphasizes specific land and resource uses and de-emphasizes other uses in response to the revision topics. This is done primarily by changing management area allocations on the Forest, resulting in trade-offs between the alternatives. In volume 1 of the final EIS, some plan components related to recommended wilderness and the grizzly bear do vary between alternatives to address the issues identified in public comments. See the descriptions of the alternatives for details.

2.4.1 Management areas

The forest plan designates seven management area categories across the Forest. Allocation to a specific management area does not mandate or direct the Forest Service to propose or implement any action. The management areas provide additional direction that is specific to individual parcels of land within the Forest that represent a management emphasis for that parcel of land. The management area direction includes desired conditions, objectives, standards, guidelines, and suitability of certain uses within that management area.

Under the action alternatives, management area prescriptions are grouped into categories that have similar management characteristics. For example, management area 1 is broken down into subcategories that represent designated wilderness (management area 1a) and recommended wilderness (management area 1b). Management areas range from those with little human-caused alteration to the Forest (management area 1, wilderness) with a focus on passive management to those with more human-caused change (management area 7, focused recreation areas) and a focus on active management. Each alternative allocates different amounts of land to the management areas. For a more complete description of categories and management area prescriptions, see the modified proposed action. Refer to figures 1-01 through 1-04 for maps of the management areas by alternative. Management areas in alternative A (the no-action alternative, which is based on the 1986 forest plan, as amended) were matched as closely as possible to the management areas in the forest plan for purposes of mapping and analysis (see table 3 for a comparison of the current and proposed management areas).

Table 3. Proposed management areas and equivalent 1986 forest plan management areas

Proposed Management Area	Name	Description	Current Management Area (1986 forest plan)
1a	Designated Wilderness	The Forest manages three congressionally designated wilderness areas—the Bob Marshall, Great Bear, and Mission Mountains—as part of the National Wilderness Preservation System. If, over the life of this plan, Congress designates any additional wilderness areas on the Forest, those areas would be allocated to this management area.	21, 22
1b	Recommended Wilderness	These areas are recommended as additions to the National Wilderness Preservation System. The wilderness characteristics and potential for each area recommended to be included in the National Wilderness Preservation System are to remain intact until congressional action is taken.	Not a management area[1]
2a	Designated Wild and Scenic Rivers	These river segments and adjacent lands have been designated as part of the Wild and Scenic Rivers System under the authority granted by the Wild and Scenic Rivers Act of 1968, as amended. If, over the life of this plan, Congress designates any additional wild and scenic rivers on the Forest, those areas would be allocated to this management area.	18
2b	Eligible Wild and Scenic Rivers	These river segments and adjacent lands have been identified as eligible for inclusion in the Wild and Scenic Rivers System under the authority granted by the Wild and Scenic Rivers Act of 1968, as amended. The wild, scenic, or recreational characteristics and potential for each river segment recommended to be included in the National Wilderness Preservation System are to remain intact until congressional action is taken.	Not a management area[2]
3a	Administrative Areas	These areas are mapped Forest administrative sites.	10
3b	Special Areas	These are administratively designated areas that are managed to protect and conserve the values for which they were identified. The Forest currently has one special area, the Condon Creek Botanical Area.	3A
4a	Research Natural Areas	These areas are established to provide for research, observation, study, and conservation of biological diversity. Research natural areas are designated jointly with the appropriate Forest Service research station.	3A

Proposed Management Area	Name	Description	Current Management Area (1986 forest plan)
4b	Experimental and Demonstration Forests	Coram Experimental Forest was established in 1933, and its management is the responsibility of the Rocky Mountain Research Station. The Miller Creek Demonstration Forest was set aside in 1989, and its management is the responsibility of the Forest. The 1986 forest plan did not designate the demonstration forest as a management area.	14
5a, 5b, 5c, 5d	Backcountry	These areas provide a variety of backcountry recreational experience, ranging from nonmotorized year-round to motorized summer and over-snow areas and routes. They also include areas from the 1986 forest plan that have a high level of other amenity values or site conditions that would limit vegetation treatments and are unsuitable for timber production (e.g., high scenic value in elk winter range, non-forest vegetation types, riparian areas).	1, 2, 2A, 2B, 2C, 3, 11, 11A
6a	General Forest Low-Intensity Vegetation Management	In these areas, timber management is expected to be at a low level of intensity due to other resource conditions; these areas are not suitable for timber production. Most of these areas have roads, trails, structures, and other signs of forest management activities, and they provide a variety of recreation opportunities, both motorized and nonmotorized.	12, 13A, 13D,
6b and 6c	General Forest Medium- And High-Intensity Vegetation Management	In these areas, timber management is expected to be at a moderate to high level of intensity. These areas are suitable for timber production, with timber harvest contributing to regulated timber harvest estimates. These areas have roads, trails, structures, and other signs of forest management activities, and they provide a variety of recreation opportunities, both motorized and nonmotorized.	5, 7, 8, 9, 11C, 13, 15, 15A, 15C, 15D, 15E, 16, 16A, 16B, 16C, 17
7	Focused Recreation Areas	These are areas where certain types of recreational uses are featured and receive special attention.	4, 15B, 20

1. The 1986 forest plan identified five areas as recommended wilderness (see description of alternative A below and table 4), but they were not designated as a management area. A variety of management areas in the 1986 forest plan occur within recommended wilderness areas (management area 1b in the forest plan).
2. See table 5.

2.4.2 Alternative A—No action

This alternative reflects the 1986 forest plan, as amended to date, and accounts for current laws and regulations. New information, inventories (e.g., lands suitable for timber production), and technologies (e.g., the Spectrum model) were used to evaluate this alternative. Output levels were recalculated for this alternative based on forest plan amendments and new sources of information. The no-action alternative retains the 1986 management direction, as amended, including management area prescriptions. This alternative serves as the baseline for comparison with the action alternatives.

Alternative A relationship to significant issues

Vegetation management, timber production, and fire and fuels management

The 1986 forest plan (as amended) incorporates an ecologically based approach in many of the goals, standards, and objectives related to vegetation conditions and associated wildlife habitat, both forestwide and in relation to potential vegetation types. This includes the concept of managing for vegetation conditions that would be expected to occur under natural succession and disturbance regimes to reduce

the risk of undesirable effects from disturbances and maintain a resilient forest. In contrast to the action alternatives, this direction is mostly general descriptions, with no specific or quantitative desired conditions that would allow progress towards their achievement to be determined. For example, the desired species, forest structural characteristics, and objectives for treatment of acres to achieve plan objectives have not been quantified on the Forest level. The Forest's ability to use naturally ignited fire as a potential tool to manage vegetation outside wilderness is limited. Fuel reduction objectives to protect values on private lands are lacking.

In the 1986 forest plan, direction associated with timber production and outputs is largely focused on maximizing growth and yield, with a high proportion of regeneration harvest expected. Based on adjustments for plan amendments, new planning direction, and new data, lands suitable for timber production are 534,600 acres (22 percent of the Forest). Based on modeling for the 1986 forest plan, the projected timber sale quantity for the first decade would be 28.2 million board feet per year, and the projected wood sale quantity would be 6.6 million cubic feet per year.

Wildlife and fish habitat

The ecological description and focus of many of the goals, standards, and objectives related to vegetation composition, structure, and function are directly linked to providing or protecting habitat for wildlife species associated with these forest communities, particularly old-growth-associated species. This direction contributes to maintaining and improving habitat conditions for wildlife over time. However, there are no desired conditions or direction for certain vegetation communities that contribute to biodiversity and are important to species needing those habitats (e.g., burned forest, deciduous forest, and non-forested types of vegetation). Little direction related to habitat connectivity is provided.

The 1986 forest plan (as amended) has forestwide goals, objectives, standards, and/or guidelines for species listed as threatened, endangered, or sensitive; management indicator species (e.g., big game species, species associated with old-growth forests); and species associated with dead and defective tree habitat. Some management areas also have a focus and direction to manage and protect specific wildlife habitat values, such as management area 11 (high-quality grizzly bear habitat), management area 9 (white-tailed deer winter range), and management area 13 (mule deer and elk winter range).

Under this alternative, the number of miles of roads and trails open to public motorized vehicle use would need to be further reduced in order to fully meet amendment 19 in each grizzly bear subunit, unless site-specifically amended. The Forest estimates that approximately 518 miles of roads would need to be reclaimed (see glossary). Approximately 57 miles of trails would no longer allow wheeled motorized vehicle use. The estimated miles of roads and trails are based upon a programmatic analysis. The actual number may be higher or lower depending upon changing access conditions on adjacent lands and the site-specific factors that must be considered when evaluating access and grizzly bear habitat. Amendment 19 does not apply to portions of the Salish geographic area west of U.S. Highway 93, so motorized use would not need to be reduced there.

Access and recreation

Alternative A would continue to provide both motorized and nonmotorized recreational opportunities as well as opportunities for mechanized transport (e.g., mountain bikes) and motorized over-snow vehicle use. As described above under wildlife and fish habitat, additional roads and motorized trails would need to be evaluated and additional restrictions applied. Existing developed recreation sites would be maintained, and there would not be limits on future development on overnight developed recreation sites other than those resulting from budget limitations or other forest plan direction. To fully implement alternative A, the Forest estimates that public motorized vehicle use would be suitable on about 1,376 miles of NFS roads and public wheeled motorized use would be suitable on about 169 miles of NFS trails.

Additionally, motorized over-snow vehicle use would be suitable on about 1,964 miles of routes. Motorized over-snow vehicle use would be suitable on 31 percent of NFS lands, and mechanized transport would be suitable on 836 miles of NFS trails over 52 percent of NFS lands.

Recommended wilderness

The 1986 forest plan recommended about 98,440 acres for wilderness designation. The five areas are Alcove (9,998 acres), Jewel Basin (32,972 acres), Limestone Cave (5,076 acres), Slippery Bill (5,585 acres), and the Swan Front (44,815 acres). Alcove, Limestone Cave, the Swan Front, and Limestone Cave recommended wilderness areas are adjacent to the Bob Marshall and Great Bear designated wilderness areas. Alcove, Limestone Cave, and the Swan Front have closure orders that prohibit mechanized transport (mountain bicycles or game carts) and motorized use (wheeled and motorized over-snow vehicles). Slippery Bill recommended wilderness area is open to mechanized transport. The Jewel Basin Hiking Area (15,315 acres) would continue to be within the Jewel Basin recommended wilderness area (32,972 acres). Under this alternative, the Jewel Basin Hiking Area would still retain prohibitions on stock and pack animals, mechanized transport, and motorized uses. Outside of the Jewel Basin Hiking Area but within the Jewel Basin recommended wilderness area (17,657 acres), an area is identified as having 26 miles of trails suitable for mechanized transport, and the existing wheeled motorized use on 2 miles of trail in this area would continue.

2.4.3 Alternative B modified

This alternative was based on alternative B from the draft EIS, with modifications and features from other alternatives incorporated after review and consideration of public comments. Alternative B modified is the preferred alternative and the forest plan. This alternative is the result of public engagement efforts since 2013, and it addresses the identified purpose and need. Features of alternative B modified are discussed in relationship to significant issues below.

Alternative B modified in relationship to significant issues

Vegetation management, timber production, and fire and fuels management

Desired conditions for vegetation are based on maintaining and promoting forest conditions that are resilient in the face of potential future disturbances and climate change and that contribute to social and economic sustainability. Under alternative B modified, a variety of vegetation management techniques would be employed, including timber harvesting, planting, thinning, fuel treatments, natural unplanned ignitions, and prescribed burns. The role of fire, both planned and unplanned ignitions, as a tool to achieve desired vegetation and wildlife habitat conditions is articulated in the plan, and direction related to its use and management is provided. Direction is also provided for fuels management to protect identified values, such as in wildland-urban interface areas. Biodiversity is addressed by providing desired conditions and management direction associated with a diverse array of plant communities and species, including deciduous forests, burned forests, grasslands and shrublands, whitebark pine, and species of conservation concern. Fens and other unique botanical or geological areas are given special emphasis by their recommendation for designation as special areas (management area 3b).

Timber harvest is conducted to provide societal goods and to move the vegetation towards desired conditions. Approximately 465,200 acres (19 percent of the Forest) are suitable for timber production. A slightly higher proportion is allocated to management areas where medium-intensity vegetation management is expected (i.e., management area 6b) compared to high-intensity vegetation management (i.e., management area 6c). Under alternative B modified, the projected timber sale quantity for the first decade would be 27.3 million board feet per year and the projected wood sale quantity would be 6.3 million cubic feet per year.

Wildlife and fish habitat

Alternative B modified has forestwide desired conditions, objectives, standards, and guidelines to support the long-term persistence of species listed as threatened or endangered or species of conservation concern and to support key ecosystem characteristics for species of interest for hunting, trapping, observing, and subsistence. This alternative includes 1,072,040 acres in designated wilderness (management area 1a), 190,403 acres in recommended wilderness (management area 1b), and 316,770 acres in backcountry (management areas 5a through 5d) that would provide habitat security and connectivity of large land areas for species that are sensitive to human disturbance (e.g., grizzly bear). These management areas also emphasize natural processes; they have relatively high levels of habitat created by natural disturbances such as wildfire, insects, or disease. The close interrelationship of vegetation conditions and wildlife habitat is emphasized, and forest plan components related to vegetation conditions provide key ecosystem characteristics that support wildlife habitat needs and diversity (e.g., species associated with old-growth forests, species associated with dead and defective tree habitat, and habitat connectivity). Management direction is proposed to address key aquatic and riparian ecosystem characteristics and their integrity and to improve resilience in light of the changing climate and the anticipated future environment. Along with fish habitat and water quality, wildlife habitat is emphasized in riparian management zones. Outside of riparian management zones, coniferous forests in management areas 6b and 6c, some management area 7 lands, and the Miller Creek Demonstration Forest (management area 4b) are suitable for timber production and would provide opportunities for active management of vegetation to move towards desired vegetation composition, structure, function, and distribution.

Alternative B modified would adopt the habitat-related management direction of the draft Grizzly Bear Conservation Strategy, including limits on new grazing allotments, vegetation management guidelines, and mitigation for mineral development on some lands. It would maintain baseline conditions for motorized road access across the Forest that have supported recovery of the grizzly bear but would not require additional closure of roads and trails currently open to public motorized vehicle use. This alternative would carry forward the objectives, standards, and guidelines that were developed to conserve the Canada lynx (see forest plan appendix A), with modifications: to add an exception category aimed at protecting mature rust-resistant whitebark pine trees; and of the areas identified as suitable for motorized over-snow vehicle use.

Access and recreation

Existing or slightly reduced levels of motorized road access could be expected to support social and economic sustainability while addressing desired ecological conditions for soils, water, fish, or wildlife. Some additional motorized trail access could occur in grizzly bear management zone 1, outside of the Salish demographic connectivity area and primary conservation area. Alternative B modified would provide the opportunity for public motorized vehicle use (suitable on designated roads and trails) on about 1,427 miles of NFS roads on the Forest. Motorized over-snow vehicle use would be suitable on 31 percent of the Forest, and mechanized transport (e.g., mountain bikes) would be suitable on 740 miles of NFS trails, or on over 52 percent of the Forest. Based upon public collaboration and comment as well as on site-specific ecological conditions, the areas suitable for motorized over-snow vehicle use would be shifted from some parts of the Forest to others, resulting in a net increase of about 567 acres. To reduce the risk of grizzly bear-human conflicts on NFS lands in light of increasing human use of national forests, the number and capacity of new developed recreation sites designed for overnight use would be limited in the primary conservation area for grizzly bears. Outside of the primary conservation area, the number of developed recreation sites designed for overnight use could be increased or the capacity of existing recreation sites could be expanded to meet increased use.

Recommended wilderness

This alternative has eight areas totaling 190,403 acres of recommended wilderness. The Forest included the following suitability direction (MA1b-SUIT-06) in the forest plan: Mechanized transport and motorized uses are not suitable. The existing uses in the areas being recommended for wilderness do not currently have significant mechanized transport use in them now, and 344 acres are suitable for motorized over-snow vehicle use in the recommended wilderness areas.

- In the North Fork geographic area, one area is recommended for wilderness: Tuchuck-Whale (79,821 acres). This area was reduced by 887 acres from alternative B in the draft EIS to remove the portion of the Pacific Northwest Scenic Trail within this area in order to provide flexibility to allow mechanized transport because a comprehensive management plan is currently being developed for the trail.
- In the Swan Valley geographic area, one area is recommended for wilderness to be added to the Mission Mountains Wilderness: Elk Creek (1,442 acres), There is one area recommended for wilderness to be added on to the Bob Marshall Wilderness: Swan Front (42,534 acres). The Elk Creek recommended wilderness area was reduced by 590 acres from alternative B to adjust the northern boundary to follow Elk Creek. The Swan Front recommended wilderness area was reduced by 2,796 acres from alternative B to match sections of the inventoried roadless area boundary and to increase the distance from recommended wilderness to private property within the wildland-urban interface.
- In the Middle Fork geographic area, two areas are recommended for wilderness: Java-Bear Creek (1,824 acres) and Slippery Bill-Puzzle (12,393 acres). The Java-Bear Creek recommended wilderness area stayed the same as described in alternative B. The Slippery Bill-Puzzle recommended wilderness area increased by 5,168 acres from alternative B to provide a primitive experience adjacent to the Badger-Two Medicine area on the Helena-Lewis and Clark National Forest.
- In the Hungry Horse geographic area, one area is recommended for wilderness: Jewel Basin (18,462 acres). This area was reduced by 3,534 acres from alternative B to minimize the effects on mechanized transport.
- In the South Fork geographic area, two areas are recommended for wilderness to be added to the Bob Marshall Wilderness: Limestone-Dean (15,026 acres) and Alcove-Bunker (18,901 acres). The Alcove-Bunker recommended wilderness area was increased by 6,274 acres from alternative B to include a portion of the Bunker Creek area as recommended wilderness.

Modifications to alternative B

The following modifications to alternative B (as published in the draft forest plan, May 2016) were incorporated into alternative B modified in the final EIS and forest plan. This is not a comprehensive list of the differences in management area delineations or management direction between alternative B and alternative B modified. Comparison of the draft revised forest plan (May 2016) with the forest plan (December 2017) is necessary for a full understanding of all modifications.

Management area adjustments

The following notable adjustments to management area allocation under alternative B were made to alternative B modified.

Recommended wilderness areas (management area 1b)

- Tuchuck-Whale recommended wilderness area excluded the Pacific Northwest National Scenic Trail and buffer, allocated as management area 5a.
- Slippery Bill-Puzzle recommended wilderness area added an area to the northeast edge along the Continental Divide, and the name of the area was changed from Slippery Bill to Slippery Bill-Puzzle to reflect this addition.
- Alcove-Bunker recommended wilderness area added an area between upper Bunker Creek and Middle Creek, excluding a buffer (allocated as management area 5a) along the main stream channels to the ridgeline where mechanized transport occurs. The name of the area was changed from Alcove (Bunker Creek) to Alcove-Bunker to reflect this addition.
- Jewel Basin recommended wilderness area excluded a portion in the south end where mechanized transport occurs.
- Swan Front recommended wilderness area excluded a strip along the boundary at the south end of the Swan Valley and excluded a buffer adjacent to private lands to address public concerns with management options in areas closest to private lands in the wildland-urban interface.
- Fatty Creek recommended wilderness area was dropped due to existing motorized over-snow vehicle use.
- Elk Creek recommended wilderness area excluded the area north of Elk Creek.

Eligible wild and scenic rivers (management area 2b)

- Twin Creek (also known as Upper Twin) was added as an eligible river segment from the confluence of Twin Creek and Nanny Creek to the South Fork of the Flathead River.

Backcountry (management areas 5a to 5d)

The following changes in motorized over-snow vehicle use suitability were made:

- In the Middle Fork geographic area, an area by Marias Pass was changed to management area 5c to provide motorized over-snow vehicle use on designated routes and areas.
- In the South Fork geographic area, most of the area between Soldier Creek and Bruce Creek was changed from management area 5a (backcountry nonmotorized year-round primitive) to management area 5c (backcountry motorized over-snow vehicle opportunities [on designated routes and areas]), except that the upper headwaters of Tin Creek were kept closed as management area 5a.

General Forest low-, medium-, and high-intensity management (management areas 6a, 6b, and 6c)

- Management area 6b was changed to management area 6c within portions of the wildland-urban interface, except in areas identified as key wildlife corridors or due to other factors influencing timber management intensity.
- Areas of management area 6b were changed to management area 6a or in a few cases to management area 5 to more realistically reflect areas considered suitable for timber production (mainly within grizzly bear secure core).

Focused recreation areas (management area 7)

- An additional six areas of management area 7 that were in alternative D in the forest plan were added to alternative B modified.

Plan component wording

A number of changes in the wording of plan components occurred between the draft forest plan (May 2016) with the forest plan (December 2017). Changes in the plan components occurred for various reasons, including to improve clarity and in response to comments. Additionally, in the draft forest plan some plan components varied by alternative.

The following list indicates the plan component wording for alternative B modified when alternative variations were proposed:

- The guidelines FW-GDL-TE&V-01, 02, 03, 04, and 05 are applicable within the NCDE primary conservation area, not within the Salish demographic connectivity area. Therefore the wording of alternatives B and D wording was adopted, not that of alternative C.
- FW-STD-REC-04 (initially for alternative C only) was adopted as revised: "Within the NCDE primary conservation area, new or re-authorized permits for ski areas on NFS lands that operate during the non-denning season shall include measures to limit the risk of grizzly bear-human conflicts (e.g., a requirement to store garbage in a bear-resistant manner)."
- FW-STD-REC-05 (initially for alternative C only) was adopted as revised: "Within grizzly bear denning habitat modeled by MTFWP in the NCDE primary conservation area, there shall be no net increase in percentage of area or miles of routes designated for motorized over-snow vehicle use on NFS lands during the den emergence time period (see glossary)."
- FW-DC-GR-01 adopted the wording of alternatives B and D, not that of alternative C; therefore, the desired condition is within the NCDE primary conservation area and does not include zone 1.
- FW-STD-GR-01, 03, 04, and 06 adopted alternative C wording; therefore, the standards are applicable within both the NCDE primary conservation area and zone 1 (including the Salish demographic connectivity area).
- FW-STD-GR-02 was changed to read: "Within the NCDE primary conservation area and zone 1, a sheep grazing permit in non-use status shall not be allowed to increase allowable animal unit months beyond what was previously permitted prior to being in non-use when it is returned to use. Note: The Flathead National Forest does not have any sheep allotments."
- FW-GDL-GR-01 was replaced by: "During allotment management planning, grazing practices (e.g., length of grazing season, stocking levels, timing of grazing) should be adjusted if needed to achieve desired conditions for riparian management zones (this varies on a site-specific basis)."
- Recommended wilderness suitability, MA1b-SUIT-06 (initially for alternative C only), was adopted: "Mechanized transport and motorized use are not suitable in recommended wilderness areas."
- GA-MF-DC-02 for alternatives B and D was adopted: "The Challenge-Skyland groomed trail and area (see figure B-12) provide quality motorized over-snow vehicle recreational opportunities, including a late-season motorized over-snow vehicle use area."

- GA-NF-DC-02 (now 01) adopted the wording of alternatives B and D: "Motorized over-snow vehicle use opportunities exist in designated areas in the McGinnis, Deep, and Lookout Creek areas."
- GA-SV-DC-11 (now 10) was adopted: "The Six Mile area provides motorized over-snow vehicle use, including late-season use (see figure B-12), as well as summer wheeled motorized use, consistent with the desired recreation opportunity spectrum."

In the beginning of each section of the final EIS, if there are notable changes between the draft and the final EIS for that resource, they are indicated.

2.4.4 Alternative C

Alternative C has more acres of recommended wilderness than the other alternatives and less acres where timber harvest is suitable or allowable. Primitive or semiprimitive nonmotorized recreational opportunities would be increased by identifying motorized and mechanized transport as not suitable in recommended wilderness areas. This alternative also adds several forest plan components (the same as those under alternative 3 for the amendment forests; see volume 3) that provide additional protections for grizzly bear habitat. Features of alternative C include:

- Areas that are within both the wilderness inventory area and inventoried roadless areas would be allocated to management area 1b (recommended wilderness). Additional areas within the wilderness inventory area would also be allocated to management area 1b, as guided by public comment and to improve manageability (i.e., to reduce extensions of nonwilderness roads and trails within recommended wilderness).
- Vegetation treatments would be allowed that use a variety of management tools (such as prescribed fire, timber harvest, and tree planting), with approximately 13 percent of the Forest suitable for timber production.
- Fourteen areas on the Forest are allocated as focused recreation management areas (management area 7). Krause Basin management area 7 would be changed to management area 6a, and summer motorized use would be suitable only on existing open roads and trails.[3]
- Forest plan component changes:
  - ♦ Management direction for management area 1b (recommended wilderness) would be changed so that motorized use and mechanized transport (i.e., mountain bikes,) would not be suitable.
  - ♦ Many of the grizzly bear plan components for vegetation, grazing, and minerals that apply to the grizzly bear primary conservation area for alternatives B and D would also apply to the Salish demographic connectivity area and/or zone 1 under alternative C. Any new oil and gas leases in the primary conservation area and zone 1 (including the demographic connectivity areas) would be required to include a no surface occupancy stipulation.
- In three of the areas currently suitable for late-season motorized over-snow motorized vehicle use (after March 31), late-season use would not be suitable. There would be no increase above the baseline acreage of areas and miles of routes that are open to motorized over-snow vehicle use in the den emergence time period.
- Some additional motorized trail access could occur in grizzly bear management zone 1, but only outside of the Salish demographic connectivity area.

[3] Note: In the draft EIS, the description of Krause Basin management area 7 mistakenly omitted the use of motorized trails.

- Roads located within grizzly bear secure core could not be opened for temporary use by the public.
- New or reauthorized permits for ski areas would have to include mitigation measures to reduce the risk of grizzly bear-human conflicts.

Alternative C relationship to significant issues

Vegetation management, timber production, and fire and fuels management

Similarly to alternative B modified, direction related to vegetation focuses on maintaining and developing resilient forest conditions. Under this alternative, greater reliance would be placed on natural disturbances such as fire (unplanned and planned ignitions) and less on mechanical management techniques (e.g., timber harvest, mechanical fuel treatments, thinning, planting) as tools to achieve desired vegetation conditions. Timber harvest would be conducted to move the vegetation towards desired conditions while providing societal goods. This alternative would have the lowest amount of acres (308,200 acres, or 13 percent of the Forest) suitable for timber production. The majority of the lands suitable for timber production would be allocated to a medium-intensity vegetation management (management area 6b). Under alternative C, the projected timber sale quantity for the first decade would be 18 million board feet/year and the projected wood sale quantity would be 4.5 million cubic feet/year.

Wildlife and fish habitat

Alternative C has forestwide desired conditions, objectives, standards, and/or guidelines to support the long-term persistence of species listed as threatened or endangered or identified as species of conservation concern and to provide for key ecosystem characteristics for species of interest for hunting, trapping, observing, and subsistence. Management direction is intended to address key aquatic and riparian ecosystem characteristics and their integrity to improve resilience in light of the changing climate and anticipated future environment. Because the Forest is required to continue to support the recovery of the NCDE grizzly bear population, roads open to public motorized vehicle use cannot exceed baseline levels. However, due to the indirect effect of increased wilderness acres and associated management direction, baseline levels of motorized road and trail access could actually decrease. Compared to the other alternatives, this alternative would provide the highest habitat security and connectivity for species that may be sensitive to higher levels of human disturbance. In response to public comment on wildlife habitat values (e.g., grizzly bear habitat, key big game winter habitat, high-value lynx habitat, habitat corridor/connectivity areas), and general forest management areas (6a, 6b, 6c) were reviewed; some areas were changed to management areas where less intensive vegetation management could be expected (e.g., changed from management area 6b to management area 6a).

Access and recreation

Alternative C would provide the opportunity for public motorized vehicle use (suitable on designated roads and trails) on approximately 1,577 miles of NFS lands on the Forest. Motorized over-snow vehicle use would be suitable on 25 percent and mechanized transport (e.g., mountain bikes) on 34 percent of the Forest (419 miles of NFS trails). Dispersed recreation opportunities would continue to be available. As a result of increased recommended wilderness and associated management direction, areas suitable for motorized over-snow vehicle use would be decreased by about 107,515 acres (open from December 1-March 31) and 252 acres yearlong for a total of 107,767 acres compared to the no-action alternative. To reduce the risk of grizzly bear-human conflicts on NFS lands in light of increasing human use of the national forests in the future, there are limits on the number and capacity of new developed recreation sites designed for overnight use in the primary conservation area for grizzly bears. Outside of the primary conservation area, the number of developed recreation sites designed for overnight use could be increased or their capacity could be expanded to meet increased use.

Recommended wilderness

Alternative C has 17 areas totaling about 506,919 acres of recommended wilderness. This change would result in a large reduction in areas suitable for public motorized vehicle use on a year-round basis. This alternative includes a plan component that says that mechanized transport and motorized travel and uses would not be suitable in recommended wilderness area. This plan component responds to the public concern that if existing mechanized transport and motorized travel and uses were allowed to continue, the social and ecological characteristics that provide the basis for the areas' suitability for inclusion in the National Wilderness Preservation System would not be protected or maintained, thereby reducing the potential of their being designated as wilderness.

- In the North Fork geographic area, three areas are recommended for wilderness: Tuchuck-Whale (90,638 acres), Coal (45,257 acres), and Canyon (7,939 acres).
- In the Salish Mountains geographic area, one area is recommended for wilderness: Le Beau (5,950 acres).
- In the Swan Valley geographic area, four areas are recommended for wilderness that would be added to the existing Mission Mountains Wilderness: Cold-Jim (317 acres), Elk Creek (2,964 acres), Fatty-Woodard Creek (2,133 acres), and Piper Creek (642 acres). Two areas are recommended for wilderness that would be added to the existing Bob Marshall Wilderness: Swan Front (48,151 acres) and a portion of Alcove-Bunker. A portion of the Jewel Basin-Swan Crest recommended wilderness area is in this geographic area.
- In the Middle Fork geographic area, four areas are recommended for wilderness: Essex (13,788 acres), Java-Bear Creek (3,725 acres), Sky West (5,193 acres), and Slippery Bill-Puzzle (20,703 acres).
- In the Hungry Horse geographic area, three areas are recommended for wilderness: Hungry Horse East (33,503 acres), Jewel Basin-Swan Crest (135,759 acres), and a portion of Alcove-Bunker.
- In the South Fork geographic area, two areas are recommended for wilderness that would be added to the existing Bob Marshall Wilderness: Limestone-Dean (26,294 acres) and Alcove-Bunker (63,962 acres). A portion of the Hungry Horse East recommended wilderness area is in this geographic area.

2.4.5 Alternative D

This alternative emphasizes active vegetation management, including timber harvest, to achieve desired conditions. As compared to alternative B in the draft EIS, more acres are allocated to management areas where high vegetation management intensity would be expected (i.e., management area 6c), although the difference is less pronounced when compared with alternative B modified in the final EIS. There is more emphasis on semiprimitive motorized and roaded recreation opportunities, and no recommended wilderness is included. Additional management area 7 areas (focused recreation areas) are allocated, including an area featuring off-highway, single-track motorized recreational opportunities and additional areas of nonmotorized emphasis. Features of alternative D include:

- A larger area would be allocated to management areas that are suitable for timber production, particularly management areas where a high-intensity vegetation management approach is expected (i.e., management area 6c). Approximately 20 percent of the Forest) would be suitable for timber production.
- No areas would be allocated to recommended wilderness.

- Motorized over-snow vehicle routes and area suitability would be mostly as described in the 1986 forest plan (amendment 24), except within the North Fork geographic area and in the Skyland/Challenge Creek area. In the North Fork, the Whitefish Range Partnership recommendations to increase the areas suitable to motorized over-snow vehicle use were followed, except in the Nasukoin Peak and Whale Lake areas. Motorized over-snow vehicle use suitability was expanded in these areas to reflect public comment. In the Skyland/Challenge Creek area, some of the management area 6a (general forest low-intensity vegetation management) areas that are outside wolverine maternal denning habitat are identified as suitable for motorized over-snow vehicle use, whereas an open area at the end of the Puzzle Creek Road in the Skyland drainage would become unsuitable. New areas would be suitable for motorized over-snow vehicle use only from December 1 to March 31.
- The Forest would have 21 focused recreation areas (management area 7), including areas to the east and west of Big Mountain. These areas near Big Mountain follow the Whitefish Range Partnership suggestions and concept of a frontcountry recreation area.
- A portion of backcountry management area 5a (nonmotorized year-round primitive) along the Whitefish Divide adjacent to the Stillwater State Forest would be management area 6a (general forest low-intensity vegetation management) to address comments by the Montana Department of Natural Resources and Conservation and the Forest Service desiring greater flexibility in accessing and managing this area.

Alternative D relationship to significant issues

Vegetation management, timber production, and fire and fuels management

Under alternative D, similar to alternative B modified, direction related to vegetation focuses on maintaining and developing resilient forest conditions. In response to public comment on economic and social sustainability, management areas 6a, 6b, and 6c (general forest) were adjusted to reflect the desire for a more intensive vegetation management approach. There would be greater emphasis on active vegetation management such as timber harvest, thinning, planting, mechanical fuel reduction, and prescribed fire. A higher proportion of the lands identified as suitable for timber production would be allocated to management areas where a high intensity of vegetation management could be expected (i.e., management area 6c), with most of the changes to management area 6c occurring within the wildland-urban interface. Natural disturbance processes would remain a primary source of vegetation change and movement towards desired conditions forestwide since most of the forest would remain within management areas unsuitable for timber production. Under alternative D, 482,600 acres (20 percent of the Forest) would be suitable for timber production. The potential timber sale quantity for the first decade would be 29.2 million board feet per year, and the projected wood sale quantity would be 6.8 million cubic feet per year.

Wildlife and fish habitat

Alternative D has forestwide desired conditions, objectives, standards, and/or guidelines to support the long-term persistence of species listed as threatened or endangered or identified as species of conservation concern and to support key ecosystem characteristics for species of interest for hunting, trapping, observing, and subsistence. The close interrelationship of vegetation conditions and wildlife habitat is emphasized, and forest plan components related to vegetation conditions provide key ecosystem characteristics to support wildlife habitat needs and diversity (e.g., big game species, species associated with old-growth forests, species associated with dead and defective tree habitat, and habitat connectivity), but this alternative would use more active management than alternative C. Management direction is provided to address key aquatic and riparian ecosystem characteristics and their integrity to improve

resilience in light of the changing climate and anticipated changes in the future environment. Along with fish habitat and water quality, wildlife habitat is emphasized in riparian management zones. Outside of riparian management zones, coniferous forests in management areas 6b and 6c, some management area 7 areas, and management area 4b (the Miller Creek Demonstration Forest) are suitable for timber production and would provide opportunities for the active management of vegetation for desired vegetation composition, structure, function, and distribution. Since management area 6b in some portions of the wildland-urban interface would be changed to management area 6c, this alternative provides the most opportunity for active management of vegetation to restore historic composition, structure, function, and distribution in the valley bottoms and areas of intermingled ownership in the warm-dry and warm-moist primary vegetation types.

Like alternative B modified, alternative D would adopt the habitat-related management direction of the draft Grizzly Bear Conservation Strategy, including limits on new grazing allotments, vegetation management guidelines, and mitigation for mineral development on some lands. It would maintain baseline conditions for motorized road access across the Forest that have supported the recovery of the grizzly bear but would not require additional closure of roads and trails open to public motorized vehicle use. Some additional motorized trail access could be suitable in zone 1, including the Salish demographic connectivity area. This alternative would retain the existing objectives, standards, and guidelines for lynx, with forest-specific modifications as described for alternative B modified.

Access and recreation

Motorized over-snow vehicle use would be suitable on about 1,964 miles of roads and trails, motorized over-snow vehicle use would be suitable on 770,969 acres (32 percent), and mechanized transport (e.g., mountain bikes) would be suitable on 836 miles of NFS trails over 52 percent of NFS lands. Dispersed recreation opportunities would continue to be available. Based upon public collaboration and comment, the areas suitable for motorized over-snow vehicle use would be added to in some parts of the Forest but would not be offset by making other areas unsuitable, resulting in a net increase of about 17,940 acres (open from December 1-March 31) compared to the no-action alternative. To reduce the risk of grizzly bear-human conflicts on NFS lands in light of increasing human use of the national forests, limits on the number and capacity of new developed recreation sites designed for overnight use would be established in the primary conservation area for grizzly bears. Outside of the primary conservation area, the number of developed recreation sites designed for overnight use could be increased or their capacity could be expanded to meet increased use.

There would be 21 focused recreation management areas under this alternative.

Recommended wilderness

Under alternative D, no areas would be managed as recommended wilderness. Most of the lands allocated to management area 1b in alternative B modified would be changed to a backcountry management area allocation (5a, 5b, 5c, or 5d).

2.4.6 Alternatives considered but eliminated from detailed study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR § 1502.14). Public comments received in response to the proposed action (“scoping comments”) provided suggestions for alternatives, a number of which were considered. The rationale for eliminating potential alternatives from detailed consideration is summarized below.

Add an alternative reflecting the 2006 proposed forest plan

The 2006 proposed forest plan was considered as a basis for developing the proposed action and was also used in the development of alternatives B, C, and D. The 2006 proposed forest plan is sufficiently reflected amongst the alternatives (e.g., the lands suitable for timber production in alternative C is similar to that in the 2006 proposed forest plan). An alternative that is identical to the 2006 proposed plan was not developed and was not carried forward as an independent alternative because it would not meet the purpose and need for action.

Add alternatives related to wilderness and inventoried roadless areas

Some commenters wanted to see inventoried roadless areas managed as recommended wilderness. This alternative is largely reflected in alternative C, which includes inventoried roadless areas that are within wilderness inventory areas. Under alternative C, those inventoried roadless areas outside the wilderness inventory area generally would be management area 5 (a backcountry management area) or management area 6a (general forest low-intensity vegetation management). The total acreage of inventoried roadless areas on the Forest is 478,757 acres; alternative C recommends 506,919 acres of wilderness, which is 27,946 acres above the total of inventoried roadless areas on the Forest, but the latter acreage does not include all inventoried roadless areas; for example, the Swan River Island inventoried roadless area was not included as a recommended wilderness area based on the wilderness inventory criteria.

Some commenters wanted all lands within the wilderness inventory areas to be recommended wilderness. The wilderness inventory was based on a very broad process that did not discuss the actual wilderness characteristics of the lands in the inventory but instead included areas based on criteria that included size as well as roads and other improvements. As this was a broad inventory, not all acres within this inventory were identified as having wilderness characteristics.

Add an alternative with no winter motorized recreation

Some commenters proposed not allowing any motorized over-snow vehicle use in order to eliminate any potential impacts on grizzly bears, Canada lynx, wolverines, and other wildlife, but others stated that the science showing motorized over-snow vehicle use is detrimental to wildlife is not defensible. As stated in the draft Grizzly Bear Conservation Strategy (USFWS, 2013a) and the five-year review of the status of the grizzly bear (USFWS, 2011b), there is no known or discernible impact from current levels of winter motorized recreation on the population of grizzly bears in the NCDE. The NCDE population has met the recovery goals stated in the grizzly bear recover plan with existing motorized over-snow vehicle use. For lynx, the USFWS stated that after evaluating the findings of Bunnell, Flinders, and Wolfe (2006) and Kolbe et al. (2007), they determined that the best information available did not indicate that compacted snow routes increase competition by other species to levels that adversely impact lynx populations (USFWS, 2014). John Squires also stated on a public field trip during the forest plan revision process that he agreed with the findings of other researchers regarding snow compaction (ISDA, 2013). Similarly, direct effects of current levels of motorized over-snow vehicle use on Forest roads do not appear to adversely affect lynx (Squires, Decesare, Kolbe, & Ruggiero, 2010). Heinemeyer and Squires are investigating winter recreational use in wolverine habitat in Idaho, and they state that wolverines, including denning females, appear to tolerate winter recreation in their home ranges. Based on their preliminary findings, potential wolverine habitats that have even high levels of winter recreation may support resident wolverines despite the potential human disturbance (Heinemeyer & Squires, 2013). However, the authors are still investigating variability of wolverine response to human disturbance and do not expect to have results until late 2017 or 2018. In summary, the science does not support the need for this kind of alternative.

Some commenters wanted to reduce motorized over-snow vehicle use opportunities on the Forest to make it more equitable for nonmotorized winter users and allow for solitude. Alternative C largely reflects this preference by having less acres suitable for motorized over-snow vehicle use.

Add more protection for the grizzly bear

Some commenters suggested plan components to provide a lower or higher level of protection of grizzly bear habitat or to better ensure the movement of bears between recovery areas. For various reasons explained in section 5.6.5, some of the specific suggestions by the public were not included in the alternatives because they were outside the scope of the action, did not meet the purpose and need for the forest plan, were conjectural and not supported by scientific or other evidence, or would be infeasible to implement.

Add more protection for the Canada lynx

Some commenters suggested that the Flathead National Forest retain existing objectives, standards, and guidelines from the Northern Rockies Lynx Management Direction (NRLMD) (USDA, 2007) or include plan components to provide a higher or lower level of protection for Canada lynx or its critical habitat. Alternative A, the no-action alternative, carries forward the existing management direction, with two modifications in the action alternatives B modified, C, and D. The following items suggested by the public were not included in alternatives considered for detailed analysis because they were outside the scope of the action, did not meet the purpose and need for the forest plan, were conjectural and not supported by scientific or other evidence, or would be infeasible to implement.

Apply information in Kosterman's 2014 thesis to Canada lynx management direction in the forest plan

Some commenters suggested that the forest plan should incorporate information from Megan Kosterman's 2014 thesis (Kosterman, 2014) into its management direction for Canada lynx. The thesis, Correlates of Canada Lynx Reproductive Success in Northwestern Montana, evaluates the effects of habitat and maternal covariates on the reproductive success of female lynx within a portion of the species' southern range in northwestern Montana.

Although Kosterman's thesis provides valuable new information with the potential to inform changes in Forest Service management of lynx and lynx habitat, the relationships between vegetation composition and lynx reproductive success described in the thesis are not well enough understood to determine whether specific changes in management direction are warranted and what they should be. By design, Kosterman classified vegetation in a way that was deliberately imprecise in order to allow her to correlate lynx demography to habitat in a simple and rough sense. For this purpose, the classification was a success. However, the parameters and metrics that Kosterman used do not directly correlate to Forest Service vegetation inventory data or the management direction established by the NRLMD. Two examples are summarized below.

VEG S1. The 30 percent threshold value for a lynx analysis unit in the early stand initiation structural stage under standard VEG S1 is not directly comparable to the 10-15 percent optimum level of young regenerating forest identified in Kosterman's thesis. Kosterman grouped vegetation into five categories, one of which was young regenerating forest. The VEG S1 standard threshold of 30 percent could include vegetation in at least three of the five vegetation categories described by Kosterman, including (1) open—trees not present, (2) thin forest, and (3) young regenerating forest. Thus, the optimum amount of 10-15 percent of young regenerating forest identified by Kosterman appears to be a subset of the early stand initiation structural stage used to calculate the 30 percent threshold under VEG S1.

VEG S6. The greater than 50 percent mature forest optimum vegetation class described by Kosterman is broadly defined as large trees with continuous canopy and no evidence of recent disturbance. This class could include a wide range of stand conditions, including mature stands of single-storied trees with little to no understory (stem exclusion structural stage) and mature stands of multistoried trees with dense understories. The latter category provides the snowshoe hare habitat addressed by standard VEG S6. The mature vegetation class in the thesis does not distinguish between single vs. multistoried mature forest structures and does not address understory horizontal cover metrics within lynx home ranges included in the study. Thus, the optimum 50 percent of mature forest identified by Kosterman appears to include a wider range of mature forest structural types than those addressed under standard VEG S6. Until the actual structural makeup of those mature forest stands within the lynx home ranges are better understood, it is not possible to identify whether or how the forest plan direction should be changed.

Kosterman and Rocky Mountain Research Station scientists are working to publish the results of her study in a peer-reviewed scientific journal. Some of the analyses or findings in the original thesis may change through that process.

For these reasons, the information in the thesis cannot be used to develop an alternative at this time. Forest Service staff will continue to work in partnership with the USFWS, the Rocky Mountain Research Station, and Kosterman to determine the appropriate application of her information to the management of Canada lynx habitat (Marten, 2016).

Do not allow any management in Canada lynx critical habitat

Some commenters suggested that there should be no management in lynx critical habitat. However, the Endangered Species Act does not automatically restrict all uses of critical habitat; it only imposes restrictions under section 7(a)(2) on Federal agency actions that may result in destruction or adverse modification of critical habitat. The USFWS stated that the scale of any activity should be examined to determine whether direct or indirect alteration of habitat would occur to the extent that the value of critical habitat for the survival and recovery of lynx would be appreciably diminished. In their designation of critical habitat for the northern Rocky Mountains, the USFWS stated, “Timber harvest and management are dominant land uses (68 FR 40075). Therefore, special management may be required depending on the silvicultural practices implemented. Timber management practices that provide for a dense understory are beneficial for lynx and snowshoe hares” (USFWS, 2009a). Therefore, all alternatives in the forest plan provide protections for lynx critical habitat and allow for vegetation treatments where consistent with those protections. Lands suitable for these vegetation treatments vary by alternative.

Reduce the level of protection for the Canada lynx

In response to the proposed action, some commenters suggested that the level of protection of Canada lynx habitat should be further reduced in order to allow more development and use of natural resources. The best available scientific information was used to inform the planning process, including plan components to support key ecosystem characteristics for the recovery of the northern Rocky Mountains Canada lynx population and to contribute to its long-term persistence. Relaxing or eliminating those forest plan components would not meet the purpose and need for the action.

Change the area of mapped Canada lynx habitat

Some commenters suggested that the Forest’s lynx habitat map is faulty because it includes too little or too much area and therefore should be revised. Some asserted that all critical habitat should be mapped as lynx habitat. Others asserted that lynx habitat should be mapped at the project level. Critical habitat on the Forest was mapped at a broad scale. Within the geographical area occupied by the lynx at the time of listing, the USFWS identified the physical and biological features that are essential to the conservation of

the species and that may require special management considerations or protections. The Forest used the best available scientific information and considered updated critical habitat mapped by the USFWS (2014) and published maps for northwest Montana covering the Forest (Squires et al., 2013). The estimate of the amount of lynx habitat on the Forest was developed using the procedures recommended in the Lynx Conservation Assessment and Strategy (ILBT, 2013) and was reviewed by the USFWS and by Forest Service regional office staff. Vegetation conditions in lynx habitat in the northern Rockies is ever-changing, but habitat maps are based upon biophysical characteristics such as habitat types capable of growing boreal forests and elevations associated with deep, fluffy snow. The current estimate, as well as data sources and methods used for the recent update, are summarized in section 3.7.5, subsection "Canada lynx critical habitat," and described in further detail in several planning record exhibits (Hanvey, 2016; Kuennen, 2017a; USDA, 2000, 2014c). Forestwide estimates are routinely field verified, and mapping is refined as part of project planning. The presence or absence of the physical and biological features essential to the conservation of the lynx (e.g., critical habitat primary constituent elements 1a-1d) are verified at the project level.

Provide for wildlife habitat connectivity

Some commenters suggested that the plan revision should include a connectivity management area (demographic or functional or structural) for habitat linkages with their own set of goals, objectives, standards, and guidelines focused on addressing habitat connectivity in the face of climate change. On Forests such as the Flathead, connectivity of forest cover is not static. It is constantly changing due to a variety of factors such as stand-replacing wildfire, forest succession, insects, and disease. As a result, the planning team considered this option but determined that connectivity is better addressed without having a specific management area. The plan components in the forest plan would be implemented under all action alternatives, which eliminates the need to have a separate wildlife habitat connectivity or linkage alternative. All action alternatives include forestwide and geographic area desired conditions for connectivity. Some commenters wanted an alternative that would allocate all existing unroaded areas, no matter how small, along the Salish Mountains divide as nonmotorized to protect the wildlife corridor. For some species, very small unroaded areas do not provide adequate security. In the Salish Mountains geographic area, plan components for maximum motorized route density as well as elk security habitat provide for the Salish Mountains divide travel corridor.

All alternatives include desired conditions, standards, and guidelines for streams and riparian management zones that would contribute to connectivity. Connectivity is a topic that is woven throughout the Forest's assessment, the plan components related to wildlife in the forest plan, and sections 3.2 and 3.7 of the final EIS. Additionally, connectivity of forest cover was analyzed in the Ecosystem Research Group report (appendix 3). All alternatives include a guideline for highway crossings. Connectivity with respect to forest roads is addressed by desired conditions, standards, and guidelines for grizzly bears, which will also meet the needs of many other wildlife species. Connectivity and habitat linkage is also addressed by the lynx standards. In addition, alternatives B modified, C, and D place different levels of emphasis on recommended wilderness, recreation, and timber production, but they all provide for connectivity.

Close National Forest System lands to trapping and/or hunting

Some commenters suggested that the plan revision should close NFS lands to trapping and/or hunting, based upon Forest Service Manual § 2643.1. Hunting, fishing, and trapping of fish and wildlife and associated practices on NFS lands are subject to State fish and wildlife laws and regulations unless they conflict with Federal laws or would permit activities that conflict with the land and resource management responsibilities of the Forest Service. Although the Forest has the authority to restrict hunting and trapping on NFS lands, the Forest knows of no scientific evidence indicating that impacts from hunting

and trapping would warrant this restriction. The range of alternatives considered is responsive to 2012 planning rule requirements for ecological, social, and economic sustainability and the multiple-use requirements of the Forest Service. As discussed in the alternatives analyzed in detail and in the final EIS sections on species such as the Canada lynx, wolverine, and gray wolf, the State of Montana monitors populations and has closed or limited hunting and trapping to meet population goals, including recovery goals or conservation recommendations for species at risk, and this is adequate at this time. If research or monitoring indicates that changes are needed in the future, the Forest will work with the State and/or USFWS to determine what is needed.

Add alternative prepared by Citizen reVision

The Forest considered the Citizen reVision proposal prepared by Friends of the Wild Swan and the Swan View Coalition. The issues, core components, and recommendations in this proposal are largely addressed by a combination of the no-action alternative (alternative A), alternative C, and various plan components under all action alternatives, so a specific alternative reflecting this proposal was not developed in detail (also see section 5.6.5, issues addressed in detail in the effects analysis sections of this final EIS, and appendix 8).

Revise plan components related to the Swan Valley geographic area

The Forest considered the proposal from Swan Valley residents for an “option E to maximize the area of land available for adaptive management and to maximize the amount of land available for multiple fuel mitigation strategies” and an option ER, with a similar approach to option E with but new management area direction for dispersed recreation. The issues identified in this comment are largely included in the design of alternative D, so a specific alternative reflecting this proposal was not developed in detail.

Map all existing and future old growth

Some commenters suggested an alternative that maps and designates all existing and future old growth as well as additional plan components for managing existing and potential old growth. The Forest considered this option but determined that an alternative that maps old-growth forest is not feasible and that old-growth forest and the habitat it provides to associated wildlife species is best addressed by forestwide plan components. Old-growth forest can be determined and locations can be known only through inventories that occur at the site-specific level. Old-growth forest is constantly changing location due to natural disturbances and ecological processes such as succession. All of the alternatives have plan components that provide for the protection of old-growth forest no matter where it may occur on the landscape. Forest plan desired conditions promote an increasing trend in the amount and patch size of old-growth forest as well as of very large tree size classes and individual very large trees, which are important features of old-growth forests. Standards and guidelines protect existing old growth, support the development of future old growth, and provide for components of forest structure associated with old growth (such as very large snags and downed wood and large live trees). See the analysis of old-growth forest in section 3.3.6 for details.

Identify additional airstrips

Some commenters wanted additional airstrips identified on the Forest. An alternative for additional airstrips was not developed in detail as this would require a site-specific decision at the project level, which is outside the scope of the forest plan. Suitability determinations for airstrips are included as plan components in alternatives B modified, C, and D

Add or delete miscellaneous standards and guidelines

Commenters requested additional guidelines or standards to those proposed in the plan or suggested increasing or decreasing the use of standards to minimize or increase flexibility and resource protection during plan implementation. The Forest carefully considered the suggested changes to standards and guidelines and modified the forest plan where appropriate. Increased and decreased flexibility and resource protection are largely reflected in the four alternatives being analyzed in detail. The four alternatives reflect varying levels of standards and guidelines; the action alternatives (B, C, and D) varied the standards and guidelines for grizzly bear and recommended wilderness, which were the main issues brought up in the scoping of the proposed action.

Identify additional eligible rivers

Some commenters suggested particular river segments that might be eligible for inclusion in the National Wild and Scenic River System. The Montanans for Healthy Rivers 2014 report to the Northern Region determined that 46 rivers on the Flathead National Forest should be eligible for inclusion in the National Wild and Scenic River System. Out of those 46 rivers, 10 had already been identified as eligible by the Forest during the 2004 planning process. The Forest went through an additional eligible wild and scenic rivers process on the remaining 36 rivers, and as a result 10 additional rivers were determined by the Forest to have outstandingly remarkable values and were determined to be eligible in the proposed action. In addition, scoping comments indicated that other rivers should be eligible; the Forest revisited the upper Swan River and determined it to be an eligible river, bringing the total number of eligible rivers to 21. Some comments to the proposed action wanted all rivers that were ranked a 3 (one of a few this significant in the region) for outstandingly remarkable values to be considered eligible, as well as those ranked a 4 (most significant in the region); this alternative was not included in the analysis.

In addition, scoping comments requested that all rivers that support bull trout and westslope cutthroat trout populations should be eligible wild and scenic rivers. To evaluate the fish outstandingly remarkable value, the merits of the fish population and/or habitat were reviewed. The Forest looked at the presence of bull trout, a federally listed threatened species, as well of westslope cutthroat trout. In addition, habitat measures such as the watershed conservation framework, connectivity, crucial habitat, and habitat conditions were also considered. Three rivers were ranked as 4 for fish; when the region of comparison was considered, the rest did not meet the criteria for 4 and were not included as eligible wild and scenic rivers. See appendix 5 for more information on the eligibility study process.

Modify plan components related to aquatic habitat

Some commenters suggested that the Forest retain the Inland Native Fish Strategy (INFISH) in its entirety and expand riparian habitat conservation area widths, hereinafter “riparian management zones,” to 300 feet for all perennial streams to protect native fish. Other commenters, however requested smaller riparian management zone widths. There is some debate within the scientific community as to the size of riparian management zone widths that is necessary to accomplish resource objectives, but the Forest did not evaluate in detail any proposals to reduce riparian management zone widths. Monitoring on the Forest has shown that INFISH has been effective in improving aquatic habitat conditions with riparian management zone widths of 300 feet for fish-bearing streams, 150 feet for perennial streams, 100 feet for intermittent streams in bull trout watersheds, and 50 feet for all other intermittent streams (see section 1.4.3). INFISH is fully maintained without modification in alternative A, the no-action alternative. The forest plan increases riparian management zone widths compared to INFISH along mapped wetlands, ponds, and lakes to 300 feet (regardless of size), and all intermittent streams would have a 100-foot riparian management zone width rather than 50 feet as allowed in some locations under INFISH. This change would enable the Forest to ensure consistency with the Montana streamside management zone law on intermittent streams with slopes that are greater than 35 percent that, under the law, are required to have a

100-foot-wide streamside management zone. It would also enable the Forest to protect the multiple ecological functions contributed by riparian areas. These functions include providing wildlife habitat and connectivity of habitat as well as providing for stream habitat conditions such as pools and large wood. Reducing the widths of riparian management zones has the potential to reduce the ability to protect and restore riparian and aquatic resources and provide wildlife habitat connectivity; therefore, reducing riparian management zone widths was not evaluated in detail.

Do not constrain desired future conditions and objectives based on budget considerations

Several commenters requested that the plan components not be constrained by budget considerations. Forest Service Handbook 1909.12 chapter 21.12 specifically states that the responsible official shall base forest plan components on likely budgets and other assumptions that are realistic, as required by 36 CFR § 219.1(g). This final EIS includes discussions of effects when evaluating progress in meeting desired conditions. Appendix 2 of the final EIS (timber analysis) displays vegetation treatments and timber outputs that are achieved under constrained and unconstrained budgets in moving towards desired vegetation conditions while complying with identified management objectives and limitations (constraints). Therefore, an alternative based on these comments was not developed and was not analyzed in detail.

Add an alternative reflecting an indigenous view of the natural world

Some commenters requested that the plan include an alternative that reflects a more indigenous view of the natural world. The Flathead National Forest has consulted with the Confederated Salish and Kootenai Tribes since the beginning of the planning process. The tribes did not submit an alternative proposal similar to that suggested, but they were involved in discussion surrounding the development of the plan components of the forest plan, and their native knowledge contributed to the best available scientific information. Part of preserving the Forest’s historic and cultural heritage is recognizing differing human views and the fact that humans have utilized the physical and cultural resources offered by the Flathead National Forest for thousands of years. Based upon the collaborative public efforts, tribal consultation, and the effects of each alternative displayed in the final EIS, an alternative based on these comments was not developed and was not analyzed in detail.

2.4.7 Comparison of alternatives

The following tables compare alternatives by summarizing management area allocations and effects, focusing on selected indicators for the issues used for alternative development. Refer to table 3 for a cross-reference that correlates the management areas in the existing 1986 forest plan (alternative A) to those in the forest plan. Chapter 3 presents a detailed description of the affected environment and the environmental consequences of the alternatives on Forest resources.

Table 4 compares alternatives by management area allocation, indicating only one management area allocation for each acre based upon an established hierarchy. Lands with dual (overlapping) or multiple management area allocations are managed in accordance with all management area plan direction and must comply with the most restrictive plan direction. Table 5 compares alternatives by key topic where levels of outputs can be distinguished quantitatively.

In instances where management area allocations overlap (e.g., an area that is management area 1b, recommended wilderness, may also be management area 4a, a research natural area), the acres were calculated based upon the following hierarchy: 1) designated wilderness (management area 1a); 2) designated wild and scenic rivers (management area 2a); 3) recommended wilderness (management area 1b); 4) research natural areas (management area 4a); 5) eligible wild and scenic rivers (management area

2b); 6) experimental and demonstration forests (management area 4b); and 7) special areas (management area 3)

Table 4. Comparison of alternatives by management area acres[a] and percent allocation (single allocation based upon established hierarchy)

Management Area	Alternative A acres[b] (percent)	Alternative B modified acres (percent)	Alternative C acres (percent)	Alternative D acres (percent)
1a Designated wilderness	1,072,040 (45%)	1,072,040 (45%)	1,072,040 (45%)	1,072,040 (45%)
1b Recommended wilderness	98,388 (4%)	190,403 (8%)	506,905 (21%)	0
2a Designated wild and scenic rivers	17,605 (1%)	17,592 (1%)	17,605 (1%)	17,605 (1%)
2b Eligible wild and scenic rivers	0[c]	20,473 (1%)	15,725 (1%)	30,867 (1%)
3a Administrative areas	1,918 (< 1%)	435 (< 1%)	435 (< 1%)	435 (< 1%)
3b Special areas	226 (< 1%)	1,579 (< 1%)	1,579 (< 1%)	14,787 (1%)
4a Research natural areas	9,870 (< 1%)	7,820 (< 1%)	2,423 (< 1%)	9,870 (< 1%)
4b Experimental and demonstration forests	6,602 (< 1%)[d]	11,544 (< 1%)	11,544 (< 1%)	11,544 (< 1%)
5a Backcountry nonmotorized year-round primitive	--	149.258 (6%)	61,052 (3%)	290,262 (12%)
5b Backcountry motorized year-round (motorized vehicle use only on designated roads, trails, and areas)	--	50,002 (2%)	441 (< 1%)	50,365 (2%)
5c Backcountry motorized over-snow vehicle opportunities (on designated routes and areas)	--	107,656 (4%)	73,426 (3%)	117,650 (5%)
5d Backcountry motorized wheeled vehicle use on designated roads, trails, and areas from April 1 to November 30	--	9,854 (< 1%)	0	9,855 (< 1%)
5a-5d Backcountry **total**	381,685 (16%)[e]	316,770 (13%)	134,919 (6%)	468,132 (20%)
6a General forest low-intensity vegetation management	93,714 (4%)	123,693 (5%)	214,595 (9%)	116,659 (5%)
6b General forest medium-intensity vegetation management	--	298,770 (12%)	258,056 (11%)	292,872 (12%)
6c General forest high-intensity vegetation management	--	270,799 (11%)	125,946 (5%)	297,095 (12%)
6b-6c General forest **total**	703,454 (29%)[e]	569,569 (24%)	384,002 (16%)	589,967 (25%)
6a-6c General forest **total**	797,168 (33%)	693,262 (29%)	598,597 (25%)	706,626 (30%)
7 Focused recreation areas	7,305 (< 1%)[f]	60,888 (3%)	31,035 (1%)	60,901 (3%)
Total Forest acres	2,392,807	2,392,807	2,392,807	2,392,807

a. Acres and percentages are from GIS data set. The official acres for NFS lands and wilderness areas can be found in the land area report, http://www.fs.fed.us/land/staff/lar-index.shtml.

b. Alternative A, the no-action alternative, is included even though it does not use the same management areas as the forest plan. See table 3 for a cross-reference of the 1986 forest plan management areas with those used in the forest plan and the action alternatives.

c. The acres of eligible wild and scenic rivers in the existing 1986 forest plan are the same as in the action alternatives (see table 5). However, they were not assigned a management area in the 1986 forest plan and were not mapped for the final EIS.

d. Miller Creek Demonstration Forest (4,942 acres) was not assigned a management area in the 1986 forest plan.

e. The 1986 forest plan does not differentiate backcountry areas or general forest medium- and high-intensity areas, as is done under the action alternatives; thus, acres for these areas are combined for alternative A.

f. There is no management area in the 1986 forest plan equivalent to management area 7, focused recreation areas. These acres represent the Round Meadow and Essex cross-country ski areas and the mapped developed recreation sites.

Table 5 compares the alternatives by acres in each management area. In some instances, management area allocations overlap, e.g., an area that is management area 1b (recommended wilderness) may also be 4a (a research natural area). In this table, the allocations of acres are listed under all assigned management areas even if an overlap occurs.

Table 5. Comparison of alternatives by actual acres of management area allocation (includes multiple management area acres for an area) [a]

Management Area	Alternative A acres	Alternative B modified acres	Alternative C acres	Alternative D acres
1a Designated wilderness	1,072,040	1,072,040	1,072,040	1,072,040
1b Recommended wilderness	98,388	190,403	506,905	0
2a Designated wild and scenic rivers[b]	42,174	42,161	42,175	42,174
2b Eligible wild and scenic rivers[b]	0	79,873	79,872	79,872
3a Administrative areas	2.116	489	489	489
3b Special areas	15,510[c]	2,508	2,508	17,792[d]
4a Research natural areas	9,870	9,870	9,870	9,870
4b Experimental and demonstration forests	7,478[e]	12,420	12,420	12,420
5a Backcountry nonmotorized year-round primitive	--	149,263	61,052	290,262
5b Backcountry motorized year-round (motorized vehicle use only on designated roads, trails, and areas)	--	50,002	441	50,365
5c Backcountry motorized over-snow vehicle opportunities (on designated routes and areas)	--	107,656	73,426	117,650
5d Backcountry motorized wheeled vehicle use on designated roads, trails, and areas from April 1 to November 30	--	9,854	0	9,855
5a-5d Backcountry **total**	460,185[f]	316,755	134,919	468,132
6a General forest low-intensity vegetation management	96,833	123,693	214,595	116,659
6b General forest medium-intensity vegetation management	--	298,770	258,056	292,872
6c General forest high-intensity vegetation management	--	270,799	125,946	297,095
6b-6c General forest **total**	706,153[f]	569,569	384,002	589,967
6a-6c General forest **total**	802,986[f]	693,262	598,597	706,626
7 Focused recreation areas	7,404[g]	61,047	31,194	61,060

a. Acres and percentages are from GIS data set. The official acres for NFS lands and wilderness areas can be found in the land area report, http://www.fs.fed.us/land/staff/lar-index.shtml.

b. The minor differences in acres by alternative for management area 2a designated wild and scenic rivers is the result of mapping (geographic information system analysis); actual acres are the same for all alternatives.

c. These acres include the Jewel Basin Hiking Area.

d. The additional acres compared to the action alternatives are due to the management area 3b (special area) designation of the Jewel Basin Hiking Area, which is recommended wilderness under alternatives B and C.

e. Miller Creek Demonstration Forest was not assigned a management area in the 1986 forest plan.

f. The 1986 forest plan does not differentiate backcountry areas or general forest medium- and high-intensity areas, as is done under the action alternatives; thus, acres for these areas are combined for alternative A.

g. There is no management area in the 1986 forest plan equivalent to management area 7, focused recreation areas. These acres represent the Round Meadow and Essex cross-country ski areas and the mapped developed recreation sites. Information in table 6 is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively between alternatives.

Chapter 3 of this final EIS presents a detailed description of the effects of the alternatives. The following table provides a comparison of some key topics by alternative.

Table 6. Comparison of key differences among alternatives

Topic[a]	Alternative A-Current/No Action	Alternative B-Modified (Preferred)	Alternative C	Alternative D
Jobs	1,490	1,582	1,490	1,607
Income	$50,692 million	$54,952 million	$50,712 million	$56,130 million
Projected Timber Sale Quantities (average annual volume over next 10 years)	28.2 million board feet	27.3 million board feet	18 million board feet	29.2 million board feet
Commercial Timber Harvest (even-aged and uneven-aged)	1,700 acres	3,140 acres	2,580 acres	1,830 acres
Prescribed Fire (approximate annual acres)	2,500 acres	4,900 acres	4,900 acres	4,100 acres
Recommended Wilderness	98,388 acres	190,403 acres	506,919 acres	0 acres
Inventoried Roadless Areas[b]	478,754 acres	478,754 acres	478,754 acres	478,754 acres
Access	518 miles of road/trails estimated to be reclaimed	30-60 miles estimated to be decommissioned or placed into intermittent stored service over life of the plan	30-60 miles estimated to be decommissioned or placed into intermittent stored service over life of the plan	30-60 miles estimated to be decommissioned or placed into intermittent stored service over life of the plan

a. Jobs, income, and timber sale (volume and acres) and access are estimates derived from analysis models.

b. The 17 inventoried roadless areas totaling 478,754 acres or 20% of forest remain the same for all alternatives.

Chapter 3. Affected Environment and Environmental Consequences

3.1 Introduction

This chapter presents the existing environment of the areas used for analysis and the potential consequences to that environment that may be caused by implementing the alternatives described in chapter 2. Each resource section discloses the boundaries of the area used for the resource analysis. The discussions of resources and potential effects draw on existing information included in the assessment, other planning documents, resource reports and related information, and other sources as indicated. The planning record contains additional references not listed in the references sections of the final EIS and appendices.

This final EIS is a programmatic document. It discloses the environmental consequences on a large scale, at the planning level. This is in contrast to analyses conducted for site-specific projects. The final EIS presents a programmatic action at the Forest level of analysis but does not predict what will happen each time the standards and guidelines are implemented. Environmental consequences of individual, site-specific projects on the Forest are not described. The environmental effects of individual projects will depend on the implementation of each project, the environmental conditions at each project location, and the application of the standards and guidelines in each case.

The discussions of the affected environment and environmental consequences in this chapter allow a reasonable prediction of consequences on the Forest. However, this document does not describe every environmental process or condition.

3.1.1 Use of best available scientific information

The 2012 planning rule requires the responsible official to use the best available scientific information to inform the development of a forest plan, including plan components, the monitoring program, and plan decisions. The plan components developed for the Flathead forest plan were based on the assessment of the Flathead National Forest (USDA, 2014a) and the best available scientific information and analyses therein. New best available science published since the 2014 assessment has been used by resource specialists to develop the plan components and inform the final EIS. This information includes material that was readily available from public sources (libraries, research institutions, scientific journals, and online literature). It also includes information obtained from other sources, such as participation and attendance at scientific conferences, scientific knowledge from local experts, findings from ongoing research projects, workshops and collaborations, professional knowledge and experience, and information received during public participation periods. Resource specialists considered what is most accurate, reliable, and relevant in their use of the best available scientific information. The best available scientific information includes the publications and other sources listed in the references sections of the Flathead's assessment and EIS and the documentation in the planning record.

Cooperation between State and Federal agencies and tribes contributed to the best available scientific information. The Forest coordinated with other national forest and regional specialists, Montana Fish, Wildlife and Parks (MFWP), the Montana Natural Heritage Program, and the U.S. Fish and Wildlife Service (USFWS) to develop lists of species known to occur on NFS lands managed by the Flathead National Forest, species habitat associations, and components the forest plan. Examples of other plans that were considered during the development of the forest plan include Montana's Statewide Wildlife Action Plan (MTFWP, 2015) as well as other state management plans. For example, see MFWP's

management plans for elk, wolf, bald eagle, common loon, and grizzly bear (http://fwp.mt.gov/doingBusiness/reference/managementPlans/wildlifeMgmt.html); the Montana Department of Natural Resources and Conservation Habitat Conservation Plan for grizzly bear, Canada lynx, and riparian management areas (MTDNRC, 2010); and tribal plans related to wildlife management and climate change (CSKT, 2013).

The planning principles and guidance presented in this plan for the aquatic resources are based on the Integrated Scientific Assessment for Ecosystem Management (Quigley, Haynes, & Graham, 1996). The analyses developed as part of the Interior Columbia Basin Ecosystem Management Project and current best available science were used. The recovery plan for the coterminous U.S. population of bull trout (USFWS, 2015b), the Columbia Headwaters Recovery Unit Implementation Plan for bull trout (USFWS, 2015a), and the Region 1 Bull Trout Conservation Strategy (USDA-USFWS, 2013) were instrumental in developing plan components and the conservation watershed network for native fish. Research conducted by scientists at the USDA Forest Service (USFS) Rocky Mountain and Pacific Northwest Research Stations on climate change and native fish provided the impetus to be forward thinking.

Unpublished information provided by cooperative USFS monitoring efforts (e.g., forest carnivore monitoring by the Swan Ecosystem Center) was reviewed, as was information provided by interest groups with local wildlife expertise (e.g., Flathead Audubon, American Bird Conservatory). Some members of the public (including wildlife interest groups from across the nation) submitted scientific information during the comment period for the proposed action, and this information was also reviewed. The two wildlife biologists, the aquatics specialist, and the vegetation specialist on the planning team each have more than 20 years of experience working with the vegetation, wildlife, and aquatic species and habitats of the northern Rocky Mountains, including the Flathead National Forest. Their local knowledge and experience of the ecosystems in the planning area contributed to the best available scientific information.

Much of the recreation and roads plan direction is derived from information from the Forest Service infrastructure database, which is called INFRA, as well as the national visitor use monitoring surveys. The INFRA database is a collection of web-based data entry forms, reporting tools, and mapping tools that enable Forests to manage and report the best available information about its inventory of constructed features (e.g., roads, trails). The national visitor use monitoring data is an NFS-wide monitoring survey that collects Forest-specific recreation use surveys every five years through visitor exit surveys.

Much of the information with respect to social and economic conditions and trends contained in the assessment was taken from the Economic Profile System-Human Dimension Toolkit developed by Headwaters Economics in partnership with the Bureau of Land Management and the USFS (Headwaters Economics). This database uses published statistics from Federal data sources, including but not limited to the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, and the U.S. Census Bureau. Other significant sources of information used in developing plan direction were publications on Montana's forest products industry developed by the University of Montana Bureau of Business and Economic Research; Northwest Economic Development District publications; data on Forest Service programs, salary and non-salary expenditures, and employment from Forest Service databases; and the results of an analysis of the contribution of Forest programs and expenditures to jobs and labor income using Forest Service data and data from IMPLAN (an economic impact model) for the year 2015.

3.1.2 Forest plan and future climate

Climate has a major influence on the Forest's ecosystems. Climate is described by the long-term characteristics of precipitation, temperature, wind, snowfall, and other measures of weather that occur over a long period in a particular place. Global research indicates that the world's climate is warming and that this has been ongoing for many decades. This trend is expected to continue into the future, which will

influence the world's and this nation's forests (Barton, 2002; Boisvenue & Running, 2010; Breshears & Allen, 2002; Dale et al., 2001; Hicke et al., 2012; IPCC, 2007a; Littell, McKenzie, Peterson, & Westerling, 2009; Running, 2006; Westerling & Bryant, 2008). For this final EIS, the Forest used a recent compilation of information on climate change and potential effects published for the Northern Region Adaptation Partnership and authored by Halofsky et al. (in press), which is incorporated by reference and is the source for most of the information in this section. These predictions represent the current state of knowledge.

Global climate models have been used to understand the nature of climate and to project potential future climate. Different climate models project different rates of change in temperature and precipitation because they operate at different scales, have different climate sensitivities, and incorporate feedbacks differently. Projections from global models have been downscaled to represent climate dynamics for smaller areas, such as the subregions encompassing the USDA Forest Service Northern Region (see figure 1-05). As stated in the synthesis report based upon summaries from working groups of the Intergovernmental Panel on Climate Change (IPCC, 2014), it is clear that atmospheric carbon dioxide is increasing and that this increase is causing and will continue to cause major changes in climate). Although climate changes are expected, there is a great deal of uncertainty about the magnitude and rate of climate change (Roe & Baker, 2007; Stainforth et al., 2005), especially as projections are made at finer resolutions or for longer time periods (Knutti & Sedlacek, 2013). Nevertheless, model projections at smaller scales are able to provide information useful to resource managers.

The forest plan and final EIS incorporate models, plan components, and resource management strategies that were developed using the latest understanding of climate and potential changes into the future. Climate predictions at the national, regional (USDA Forest Service Northern Region), and Flathead National Forest level were accessed through the web-based TACCIMO (Template for Assessing Climate Change Impacts and Management Options) tool (https://www.fs.usda.gov/ccrc/tools/taccimo). TACCIMO was used to prepare a climate report for the Flathead National Forest (USDA, 2013c). Climate trends and projections from this report and from summaries in the Northern Region Adaptation Project that are important to the ecosystems of the Forest are listed below (Joyce, Talbert, Sharp, Morissette, & Stevenson, in press). Also refer to Milner (2013) for a summary of expected climate-related changes in the northern U.S. Rockies.

- Climatologically, the Forest sits at the boundary between warm, wet, maritime airflows from the Pacific Ocean and cooler, drier airflows from Canada. The western side of the Forest (Salish Mountains geographic area) is within the Western subregion as summarized by the Northern Region Adaptation Project, and the rest of the Forest is within the Central subregion. In mountainous regions such as the Flathead, climatic variability is strongly influenced by interactions with topography, elevation, and aspect.
- Temperatures have increased across the region over the past century. In the Western and Central subregions, the annual mean monthly minimum temperature increased by about 3.0 °F and 2.6 °F, respectively, and the annual mean monthly maximum by about 0.6 °F and 1.3 °F, respectively. During this same period, annual mean monthly precipitation increased slightly.
- By the 2040s, mean annual monthly temperatures are projected to increase in the Western and Central subregions. By the year 2100, annual mean monthly minimum and maximum temperature is projected to increase up to 10 °F in the Western subregion and up to 12 °F in the Central subregion. These increases exceed observed 20th-century year-to-year variability.
- Cold extremes will decrease and heat extremes will increase, meaning there will be fewer below-freezing days and a longer frost-free season.

- Models have much higher uncertainty about future precipitation than temperature, but projections for precipitation suggest a slight increase in the future. Variation in precipitation between years may increase. Seasonal precipitation is projected to be slightly higher in winter and spring and at high elevations but slightly lower in summer and at low elevations.
- Changes in climate affecting mountain snowpack will have important hydrological implications. Most of the streams in the Western and Central subregions depend on snowmelt for runoff, and snowpack changes strongly dictate streamflow responses.

Effects associated with climate change for specific key ecosystem characteristics and for wildlife and aquatic species are discussed in their respective sections throughout this EIS.

3.1.3 Regulatory framework

The Forest will follow all laws, regulations, and policies that relate to managing NFS land. The forest plan is designed to supplement, not replace, direction from these sources. Other Forest Service direction, including laws, regulations, policies, executive orders, and Forest Service directives (manual and handbook), are not repeated in the forest plan. The regulatory framework applicable to each resource is included by section, with some of the overarching framework listed below.

Federal law

Organic Administration Act of 1897: Provides the main statutory basis for the management of forest reserves. States that the intention of the forest reserves (which later were called national forests) was to “improve and protect the forest” and to secure “favorable conditions of water flows” and provide a “continuous supply of timber for the use and necessities of citizens of the United States.”

Endangered Species Act of 1973, as amended: Directs Federal agencies to conserve threatened and endangered species and to ensure that actions authorized, funded, or carried out by agencies are not likely to jeopardize the continued existence of these species or result in the destruction or adverse modification of their critical habitats.

Multiple-Use Sustained-Yield Act of 1960: Congress has affirmed the application of sustainability to the broad range of resources over which the Forest Service has responsibility. The Multiple-Use Sustained-Yield Act confirms the Forest Service’s authority to manage the national forests and grasslands “for outdoor recreation, range, timber, watershed, and wildlife and fish purposes” (16 U.S.C. § 528) and does so without limiting the Forest Service’s broad discretion in determining the appropriate resource emphasis or levels of use of the lands of each national forest and grassland.

National Environmental Policy Act (NEPA) of 1969: Requires analysis of projects to ensure the anticipated effects upon all resources within the project area are considered prior to project implementation (40 CFR § 1502.16).

National Forest Management Act of 1976: Directs the Forest Service to manage for a diversity of habitats to support viable populations (36 CFR § 219.19). Regulations further state that the effects on these species and the reasons for their choice as management indicator species need to be documented (36 CFR § 219.19(a)(1)).

2012 planning rule (36 CFR § 219): Sets out the planning requirements for developing, amending, and revising land management plans for units of the National Forest System (NFS), as required by the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976 (16 U.S.C. 1600 et seq.) (NFMA). This subpart also sets out the requirements

for plan components and other content in land management plans. This part is applicable to all units of the NFS as defined by 16 U.S.C. 1609 or subsequent statute.

Regulation and policy

Forest Service Manual and Handbook direction (USDA, n.d.):

- Forest Service manuals and handbooks within the 2500 file code designation contain direction for soil and watershed management.
- Forest Service manuals and handbooks within the 2600 file code designation contain direction on species and habitat management that supports the recovery of listed species and the maintenance of viable populations on NFS lands.

3.1.4 Budget levels

The Forest's budget directly affects the level of activities and outputs that may occur when a forest plan is implemented. Budgets are expected to remain flat or decrease in the future. Objectives in the forest plan are based on the assumption that there will not be a significant increase to current budget levels. To analyze effects without consideration of expected budgets would be a misrepresentation of expected outcomes. The exceptions are the vegetation and timber resource sections. To display movement towards vegetation desired conditions and to develop the sustained yield limit, an unconstrained budget level was analyzed along with the current constrained budget level.

3.1.5 Chapter 3 organization

Chapter 3 is divided into four major sections:

1. Physical and biological
2. Human uses, benefits, and designations of the Forest
3. Production of natural resources
4. Economic, social, and cultural environment

Physical and biological

This section addresses the following resources:

- Soils, Watersheds, Aquatic Species, Riparian Areas, and Wetlands
- Vegetation—Terrestrial Ecosystems
- Carbon Sequestration
- Plant Species
- Non-Native Invasive Plants

Refer to volume 2 for a continuation of this section, including:

- Wildlife
- Fire and Fuels Management
- Air Quality

3.2 Soils, Watersheds, Aquatic Species, Riparian Areas, and Wetlands

Introduction

This section considers numerous physical and biological resources, such as soil productivity, water quality, native and non-native desirable species, and aquatic habitats. Managing for high-quality soils, water, and soil hydrologic function is fundamental in maintaining and restoring watershed health. Soil is the primary medium for regulating the movement and storage of energy and water and for regulating the cycles and availability of plant nutrients (ICBEMP, 1997). The physical, chemical, and biological properties of soils determine biological productivity, hydrologic response, site stability, and ecosystem resilience.

The Forest Service commonly evaluates how proposed management activities meet the requirements of the Clean Water Act from a holistic perspective that considers land management activities occurring throughout the watershed and their effects on water quality and aquatic habitat integrity. The goal of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the nation's water." Listings of waterbodies and development of total maximum daily loads (TMDLs) of pollutants under Section 303(d) of the Act reflect the effects of historical and some ongoing management activities. Maintaining healthy watersheds and restoring degraded watersheds will contribute to the delisting of impaired waterbodies and to the survival and recovery of aquatic species.

Productivity of soil and vegetation, proximity to water, and the general attractiveness of riparian and aquatic systems continue to make these areas ideal for many land uses managed by the Forest Service. Conflicts between some human uses and the resources dependent on resilient riparian conditions may continue unless management provides for sufficient land use limitations and resource protection to maintain the disturbance processes and pathways associated with resilient riparian conditions (Lake, 2000; D. C. Lee, Sedell, Rieman, Thurow, & Williams, 1997; B. Poff, Koestner, Neary, & Henderson, 2011; Reeves, Benda, Burnett, Bisson, & Sedell, 1995). The forest plan is designed to provide management direction that addresses, if not resolves, these conflicts.

The variety of landscapes and associated aquatic ecosystems on the Forest supports an array of different aquatic, terrestrial, and botanical species. Population sizes and the distribution of some species, such as bull trout, have declined in some locations across their range in recent decades, despite special protection granted under the Endangered Species Act. Across the range of bull trout, reasons for the decline of some populations are many (Allendorf, Leary, Spruell, & Wenburg, 2001; D. C. Lee et al., 1997; Martinez et al., 2009), yet some populations of bull trout are increasing (High, Meyer, Schill, & Mamer, 2008). Aquatic species viability is dependent upon maintaining an array of desirable, well-connected habitat conditions. Humans have caused changes in habitat conditions through such activities as timber management, road and facility construction, dam construction, recreation, and the introduction of non-native species. Future management activities have the potential to adversely impact or restore habitat for species associated with aquatic and riparian ecosystems. For aquatic species, this analysis looks at how the management alternatives proposed in the forest plan either contribute to or mitigate common threats to aquatics within Forest Service authority and the capability of the lands to sustain native species.

Regulatory framework

Federal law

Organic Administration Act of 1897: This act states that one aspect of the mission of the national forests is to "provide favorable conditions of water flow."

Clean Water Act of 1948, as amended: This act is the principal law concerned with polluting activity in the nation's streams, lakes, and estuaries. Originally enacted in 1948, it has been revised by amendments in 1972 (Pub. L. 92-500) that gave the act its current form and spelled out ambitious programs for water quality improvements that are now being put in place by industries and cities. Congress refined these amendments in 1977 (Pub. L. 95-217) and 1981 (Pub. L. 97-117). The 1987 amendments added:

> **Section 319**, under which States are required to develop and implement programs to control non-point sources of pollution, or rainfall runoff from farm and urban areas as well as construction, forestry, and mining sites.
>
> **Section 303(d)**, which requires states to identify pollutant-impaired water segments and develop TMDLs that set the maximum amount of pollution that a waterbody can receive without violating water quality standards; develop a water-quality classification of streams and lakes to show support of beneficial uses; and establish anti-degradation policies that protect water quality and stream conditions in systems where existing conditions exceed standards.
>
> **Federal Water Pollution Control Act, as amended**, provides direction intended to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Sections 303, 319, and 404 apply to forest management activities. Section 208 of the 1972 amendments specifically mandates identification and control of non-point source pollution resulting from silvicultural activities. There are five required elements:

- Compliance with state and other federal pollution control rules.
- No degradation of instream water quality needed to support designated uses.
- Control of non-point source water pollution using conservation or "best management practices."
- Federal agency leadership in controlling non-point source pollution from managed lands.
- Rigorous criteria for controlling the discharge of pollutants into the nation's waters.

Multiple-Use Sustained-Yield Act of 1960: Congress has affirmed the application of sustainability to the broad range of resources over which the Forest Service has responsibility. The Multiple-Use Sustained-Yield Act confirms the Forest Service's authority to manage the national forests and grasslands "for outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (16 U.S.C. § 528) and does so without limiting the Forest Service's broad discretion in determining the appropriate resource emphasis or levels of use of the lands of each national forest and grassland.

Sikes Act of 1960 (16 U.S.C. 670a): This act provides for carrying out wildlife and fish conservation programs on Federal lands, including authority for cooperative State-Federal plans and authority to enter into agreements with States to collect fees to fund the programs identified in those plans.

National Environmental Policy Act (NEPA) of 1969: This act requires the analysis of projects to ensure that the anticipated effects upon all resources within the project area are considered prior to project implementation (40 CFR § 1502.16).

Endangered Species Act of 1973, as amended: Section 7(a)(1) supports biotic sustainability by requiring that "all . . . federal agencies shall . . . utilize their authorities in furtherance of the purposes of this act by carrying out programs for the conservation of endangered species and threatened species." Section 7(a)(2) of the Endangered Species Act includes direction that federal agencies, in consultation with the USFWS, will not authorize, fund, or conduct actions that are likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitat.

National Forest Management Act of 1976: This act directs the Forest Service to manage for a diversity of habitat to support viable populations (36 CFR § 219.19). Regulations further state that the effects on these species and the reason for their choice as management indicator species need to be documented (36 CFR § 219.19(a)(1)).

Safe Drinking Water Act Amendments of 1996: This act provides states with additional resources and authority to enact the Safe Drinking Water Act of 1977. This amendment directs states to identify source areas for public water supplies that serve at least 25 people or 15 connections at least 60 days a year.

Regulation and policy

Forest Service Manual and Handbook direction (USDA, n.d.):

- Forest Service manuals and handbooks within the 2500 file code designation contain direction for soil and watershed management.
- Forest Service manuals and handbooks within the 2600 file code designation contain direction on species and habitat management that supports recovery of listed species and maintenance of viable populations on NFS lands.

Northern Region direction:

- Forest Service Handbook 2509.22—Soil and Water Conservation Practices contains direction on developing site-specific soil and water conservation practices for use on NFS lands in the Northern Region and Intermountain Region to comply with direction in the Clean Water Act.

Executive orders

Executive Order 11988 (May 24, 1977): This order directs Federal agencies take action on Federal lands to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains. Agencies are required to avoid the direct or indirect support of development on floodplains whenever there are reasonable alternatives and to evaluate the potential effects of any proposed action on floodplains.

Executive Order 11990 (May 24, 1977), as amended: This order requires Federal agencies exercising statutory authority and leadership over Federal lands to avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands. Where practicable, direct or indirect support of new construction in wetlands must be avoided. Federal agencies are required to preserve and enhance the natural and beneficial values of wetlands.

Executive Order 12962 (June 7, 1995): This order acknowledges the recreational value of aquatic biota by stating the objectives "to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities" by "(h) evaluating the effects of federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries and document those effects relative to the purpose of this order."

Executive Order 13112 (Feb. 3, 1999): Directs Federal agencies whose actions may affect the status of invasive species to (1) prevent the introduction of invasive species and (2) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner, as appropriations allow.

Other

Administrative Rules of the State of Montana 16.20.603: This states that best management practices are the foundation of water-quality standards for the State of Montana. The Forest Service has agreed to follow best management practices in a memorandum of understanding with the State. Many best management practices are applied directly as mitigation at the project level. Implementation and effectiveness monitoring of best management practices are routinely conducted by contract administrators and during other implementation and annual monitoring events.

Administrative Rules of the State of Montana 17.30, subchapter 6: Details water-quality standards for the State of Montana. The Forest Service has primary responsibility to maintain these standards on lands under their jurisdiction in the State.

Montana Natural Streambed and Land Preservation Act of 1975, also known as the 310 law: Requires any person planning on working in or near a perennial stream on public or private lands to first obtain a permit from the State.

Methodology

This analysis takes a programmatic look at the outcomes that might result from implementing the proposed management direction in each alternative over the life of the forest plan. The three watershed scales most relevant to the implementation of the forest plan are subbasin (8-digit hydrologic unit), watershed (10-digit hydrologic unit), and subwatershed (12-digit hydrologic unit). A subwatershed may range from 10,000 to 40,000 acres in size. For estimating the effects at the programmatic forest plan level, the assumption has been made that the kinds of resource management activities allowed under the alternatives are reasonably foreseeable future actions to achieve the goals and objectives. However, the specific location, design, and extent of such activities are generally not known because these activities are made at the project level based on a site-specific analysis. Therefore, the discussions here refer to the potential for the effects to occur and are in many cases only estimates. The effects analyses are useful when comparing and evaluating alternatives but are not intended to be applied directly to specific locations on the Forest.

Since the site specificity of future activities is not known at the programmatic forest plan level, the potential spatial and temporal effects to water quality cannot be attributed to any specific watershed, nor can quantitative estimates of potential effects to aquatic resources be determined (such as changes in water quantity). Broad-scale estimated effects and trends related to hydrologic function and watershed processes for NFS lands within the project area have been qualitatively estimated. Cumulative effects to water quality are described in terms of their potential to generally affect trends on the subwatershed to basin scale. The temporal scale for this analysis is limited to the life of this plan, generally 15 to 20 years.

Analysis area

The analysis area for the watersheds, soils, and aquatic species includes all lands within the outside boundary of the Forest and the connected waterways to Flathead Lake (figure 1-06). Flathead Lake and the connected river system is included because migratory bull trout and westslope cutthroat trout that emerge from Forest streams move downstream to reach sexual maturity and then return to their natal

streams to complete the spawning cycle. The river system and the lake are connected, and native fish within the Middle and North Forks of the Flathead River depend on both for their survival.

The affected area for effects to soils, watersheds, aquatic species and riparian areas is the lands administered by the Forest. This area represents the NFS lands where changes may occur as a direct result of management activities or natural events.

The affected area for cumulative effects to soils and aquatic resources includes the lands administered by the Forest as well as the lands under other ownership, both within the boundary of the Flathead and in the connected waterways to Flathead Lake (figure 1-06). Flathead Lake and the connected river system is included because migratory bull trout and westslope cutthroat trout that emerge from Forest streams move downstream to reach sexual maturity and then return to their natal streams to complete the spawning cycle. The river system and the lake are connected, and native fish within the Middle and North Forks of the Flathead River depend on both for their survival.

The headwaters of the North Fork of the Flathead River are in British Columbia, where the river flows 31 miles through the province to the United States-Canada border. In the United States, the North Fork continues south, bounded on the east side by Glacier National Park and on the west by the Forest. The Middle Fork of the Flathead River has its headwaters in the Bob Marshall and Great Bear Wildernesses. From its confluence with Bear Creek to where it joins with the North Fork of the Flathead River, the Middle Fork is bordered on the north by Glacier National Park and on the south by the Forest. Just 10 miles south of the confluence of the North and Middle Forks, the South Fork of the Flathead River enters after leaving Hungry Horse Dam. The headwaters of the South Fork are in the Bob Marshall Wilderness. The North, Middle, and South Forks of the Flathead River have a combined drainage area of 4,464 square miles and an average annual discharge of 9,699 cubic feet per second, as measured at Columbia Falls (USGS, 2016).

Between Columbia Falls and Kalispell, Montana, the main stem of the Flathead River flows through the Flathead Valley on its way to Flathead Lake. Two major tributaries—the Stillwater and Whitefish Rivers—enter it here. They drain the valley floor and low-elevation mountain ranges of the northwestern part of the subbasin, where ownership is mostly private but includes both Forest and State lands. The Whitefish River joins the Stillwater River about 3 miles before its confluence with the Flathead River, roughly 22 miles upstream of Flathead Lake.

Flathead Lake is the largest lake, in terms of surface area, of any natural freshwater lake in the western United States, and it is one of the 300 largest lakes in the world. It covers 126,000 acres and has a mean depth of 165 feet and a maximum depth of 370 feet. The Flathead Indian Reservation, where the Confederated Salish and Kootenai Tribes are the primary landowner, encompasses the south half of the lake. The Swan River enters the lake just north of the reservation boundary at the town of Bigfork. The Swan River flows generally north for 66 miles from its headwaters in the Swan and Mission Mountain Ranges. The drainage includes private, State, and Forest lands.

INFISH background

By the beginning of the 1990s, there was great concern about stream habitat degradation as well as the potential loss of salmon, trout, and char populations in the western United States (Nehlsen, Williams, & Lichatowich, 1991; B. Rieman & McIntyre, 1993). By the mid-1990s, the Forest Service and Bureau of Land Management had completed three broad-reaching documents that amended forest plans across much of the public lands in the West to improve their conservation function. Two of those documents were the Record of Decision for Amendments to Forest Service and Bureau of Land Management Land Planning Documents Within the Range of the Northern Spotted Owl (often referred to as the 1994 Northwest Forest

Plan Record of Decision) (USDA, 1994) and the Decision Notice/Decision Record for Interim Strategies for Managing Anadromous Fish-Producing Watersheds on Federal Lands in Eastern Oregon and Washington, Idaho and Portions of California (USDA, 1995a). Both of these documents greatly improved the protection of migratory salmon and steelhead. Although these documents influenced the development of the Inland Native Fish Strategy (INFISH), they do not apply to the Flathead National Forest.

The last of the three broad strategies developed was the Inland Native Fish Strategy: Interim Strategies for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (USDA, 1995b). INFISH was designed to maintain options for inland native fish by reducing negative impacts to aquatic habitat. Riparian management objectives, standards, and guides and monitoring requirements were implemented beginning in 1995 to avoid causing further damage and begin recovery of aquatic habitats. The Flathead's 1986 forest plan was amended by INFISH in 1995, and this strategy is still in effect on the Flathead National Forest.

INFISH was originally expected to last 18 months to three years while an effort similar to the Northwest Forest Plan, the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 1996, 2014), was completed for the Interior Columbia River Basin. That strategy was never completed, but science from that effort has been retained in the form of guidance for plan revisions occurring in areas covered by INFISH and the Pacific Fish Strategy (PACFISH). Interior Columbia Basin Ecosystem Management Project science and guidance is followed in this forest plan revision. In addition, this plan also follows direction in the 2012 planning rule. Specifically, greater emphasis is placed on meeting improved and more refined desired conditions, and "Standards and Guidelines" that were not differentiated in PACFISH/INFISH are separated into standards or guidelines in this plan.

Since INFISH was implemented in 1995, there have also been numerous changes to policy, best available scientific information, and the condition of listed species. There have been tremendous advances in knowledge regarding physical habitat and ecological interactions at many scales and across scientific disciplines, as well as advances in spatial database management. Scientists' findings disclosed in best available scientific information urge managers and biologists working to maintain and improve aquatic habitat to look beyond the stream reach when considering how best to plan and implement project activities. Climate change science has also emerged as an important aspect of forest and river management since INFISH was adopted. These topics are further discussed in appendices C and E of the forest plan. Information on best available science with regards to riparian management and aquatic issues can be found in Thomas (2017).

Best available science indicates that the ways in which riparian management objectives are used need to be changed. When instituted, riparian management objectives were an important component of INFISH. Riparian management objectives (also known as RMOs) were developed from PACFISH objectives measured in habitats across the range of anadromous fish in Washington, Oregon, and Idaho. The objectives selected were considered good indicators of ecosystem health and were thought to be "a good *starting point* to describe the desired condition for fish habitat" (USDA, 1995b, p. E-3, emphasis added). INFISH guidance recommended that riparian management objectives values should "be refined to better represent conditions that are attainable in a specific watershed or stream reach based upon local geology, topography, climate and potential vegetation" (USDA, 1995b, p. A-2). Since INFISH was adopted on the Flathead National Forest, effectiveness monitoring has occurred on the Forest as required by the PACFISH/INFISH biological opinion (PIBO). The PIBO monitoring program collects data systematically across NFS and Bureau of Land Management lands in Washington, Oregon, Idaho, and Montana that are subject to either the PACFISH or the INFISH decision. PIBO monitoring was developed to determine whether components in PACFISH and INFISH were effective at preventing further habitat degradation at the scale of the entire Columbia River Basin as well as on a watershed-by-watershed basis (mostly at the

level of the subbasin, hydrological unit code 8 [HUC8]. This monitoring program collects reach-level stream habitat, temperature, macroinvertebrate, and riparian data to evaluate whether key biological and physical components of aquatic and riparian communities are being degraded, maintained, or restored. Data has also been collected locally by Forest personnel on the Flathead that has been used for comparison purposes in project design, consultation, and monitoring. Forest staff have found that only four of the six categories of riparian management objectives listed in INFISH are highly applicable to the Forest—pool frequency, water temperature, large woody debris, and width/depth ratio—because they apply to forested systems. Two other indicators, bank stability and lower bank angle, are less applicable to the Flathead because they are most appropriate for non-forested systems and the Forest has limited amounts of that habitat.

Riparian management objectives from PACFISH and INFISH have also become a part of Endangered Species Act section 7 consultation. Regulatory frameworks in use today (NMFS, 1996; USFWS, 1998) include a matrix of pathway indicators with numerical ranges that describe targets of healthy habitat; the portions of the numerical ranges that correspond with professional opinion of high-quality habitat is called "proper functioning condition." Over time, an expectation has been created that all watersheds can be managed to achieve a rating of proper functioning condition at the same point in time (Reeves & Duncan, 2009). In addition, a review by Kershner and Roper (2010) disclosed that the eight riparian management objectives monitored in 726 reference and managed subwatersheds had never all been properly functioning in one watershed at the same time. Because of these findings, riparian management objectives need to be used differently. This Flathead National Forest plan revision retains the riparian management objectives concept but moves this component to the monitoring section so that managers have a statistically robust method to judge how riparian conditions are trending across the Forest.

Upon review of best available science, PIBO monitoring best meets the original intent of INFISH riparian management objectives by providing rigorously collected local data that can be statistically compared to reference conditions in the same geophysical province. In addition to collecting data on many of the INFISH riparian management objectives, the PIBO monitoring program also collects sediment data, which was not included in the INFISH riparian management objectives. With more than a decade of consistently collected data and improvements in data analysis, comparisons between managed and reference watersheds can now be scaled down to conditions on individual national forests. PIBO data collection will replace riparian management objectives under the orest plan.

The forest plan proposes the use of PIBO monitoring data in the monitoring section of the plan to determine whether aquatic conditions on the forest are improving. Because the concept of riparian management objectives has been moved to the monitoring section to be addressed with PIBO data, descriptive desired conditions contained in the forest plan will be used to guide project location and development. Because of the lag time between projects and effects, as well as the tremendous variability that can result from localized weather events, analyzing PIBO data at the scale of the Forest is actually a more rigorous method to ascertain whether plan components designed to protect and restore the aquatic environment are effective. As funding allows, the Forest expects to continue to collaborate with MFWP and USFWS on completing bull trout redd counts. Electrofishing and genetic status monitoring of westslope cutthroat trout are also expected to continue in cooperation with MFWP. All of this information will enable the Forest to adapt its management strategies and to adjust decisions in the future, if needed, based upon what has been learned.

Besides adjusting the use of riparian management objectives, the forest plan will reflect more recent conservation strategies for listed fish. One of the original goals of INFISH was to develop a conservation plan for sensitive species. Bull trout became a listed species under the Endangered Species Act in 1998, three years after the INFISH decision. The USFWS designated critical habitat for bull trout in 2010; the

Northern Region developed a Bull Trout Conservation Strategy for Forests in western Montana in 2013, partly in response to guidance in INFISH to develop a long-term conservation strategy; and the USFWS released its Bull Trout Recovery Plan (USFWS, 2015b) and its Recovery Unit Implementation Plan for the Columbia Headwaters (USFWS, 2015a). The forest plan will reflect the latest direction regarding bull trout.

All of the above changes have created a need to update original INFISH plan components for the forest plan to improve the management of aquatic habitat and to remain consistent with strategies in place across public lands in the western United States. Comments received since the draft EIS was published have been used where appropriate to improve the proposed action and have helped inform this final EIS. In the forest plan and action alternatives, additional management direction has been included to address aquatic and riparian ecosystem integrity and connectivity. Components have been added to the proposed action that increase attention for watersheds identified for conservation (see appendix E.) In addition, the Flathead’s forest plan is being completed under the 2012 planning rule, so the text and style of the original INFISH components have been adjusted to comply with the current planning rule.

More specifically, the Forest has identified a conservation watershed network (see appendix E of the forest plan) and added a restoration objective under the Conservation Watershed Network section of the forest plan to help conservation watersheds be more resilient to climate change, i.e., less prone to damage caused by interaction between a warming climate and fish transportation corridors. The proposed conservation watershed network in the forest plan is designed to provide a long-term conservation strategy to conserve native fish in watersheds that are expected to be long-term cold-water refugia in the face of climate change (Isaak, Young, Nagel, Horan, & Groce, 2015). Conservation watersheds are intended to maintain multiscale connectivity for at-risk fish and aquatic species by identifying important areas needed for conservation and/or restoration, thus ensuring ecosystem components needed to sustain long-term persistence of species will remain functioning on the landscape. In addition, conservation watersheds will include areas important for other water uses, specifically municipal watersheds designated in accordance with 36 § CFR 251.9 in the forest plan. Although all water that originates on the Forest could be used for human consumption at some point downstream, Forest Service Manual 2542.03 states that Forest Service policy is to “identify watersheds providing the principal source of community water during land management planning.” Watershed protection is provided for municipal supply watersheds through Forest Service Handbook 2509.22 and through including these watersheds within the proposed conservation watershed network.

The final EIS uses a multiscale analysis strategy, as described in appendix C. Multiscale analysis, a refinement of watershed analysis, has been a widely applied methodology that the Forest Service was first required to use in the Pacific Northwest region (USDA, 1994). It was also described and recommended for use in key and priority watersheds in the Interior Columbia Basin by the PACFISH and INFISH strategies (USDA, 1995a, 1995b) and is recommended for inclusion in plan revisions by the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 2014) strategy. The multiscale analysis strategy included in appendix C has been simplified and clarified to sharpen the focus on necessary integration.

Changes in the name, some of the widths, and the management objectives of riparian habitat conservation areas were included in the final EIS because of comments received and additional analysis. Riparian management has been controversial for over 20 years. Everest and Reeves (2007) reviewed literature and data associated with riparian reserve widths in the Northwest Forest Plan (same total widths as in INFISH) and concluded that the interim widths were not excessive. However, they did acknowledge that changes in widths were not often made and that “additional alternative riparian management strategies could be implemented and evaluated in concert to shorten the time needed to realize effective strategies

that fully meet riparian management goals" (p. 98). Subsequent literature supports vegetation management within 100 feet of perennial streams and 50 feet of intermittent streams as having a low probability of affecting riparian processes. No clear distance emerges from the literature of a width that would support most or all terrestrial species because distances studied range from several feet to over a thousand feet. Therefore, in the forest plan the Forest maintained or increased the overall widths of riparian habitat conservation areas to provide for terrestrial wildlife protection. Additional rationale is provided in Kuennen (2017b).

Based on the best available scientific information reviewed, riparian management zones were split into inner and outer zones in the draft EIS, and these two zones have been retained in the final EIS. Activities will have stronger restrictions in the inner riparian management zone, but more active management is allowed in the outer riparian management zone. This was always the intent of INFISH, but confusion has occurred both internally and among the public because some have considered riparian habitat conservation areas to be "buffers" where no management was to occur. The inner and outer zones in the forest plan are consistent with current "buffering" methods employed around water resources in that they allow for the attainment of aquatic and riparian desired conditions while restricting ground-disturbing activities in close proximity to water in order to control and prevent the degradation of aquatic conditions. The inner and outer riparian reserve strategy is designed to provide assurances to regulatory agencies that desired conditions will be maintained and improved, to give simple and clear guidance at the project level that can be effectively implemented, and to include the best available scientific information that allows for appropriate management. This strategy is expected to increase the quality of management for multiple resources and to ensure that values desired by society will be considered and protected.

Under INFISH, riparian habitat conservation areas were designated around all bodies of water. These areas have now been renamed riparian management zones to indicate that active management of these areas can and should be considered, rather than leaving them as "no-touch buffers." Compared to INFISH, riparian management zone overall widths in the forest plan are increased along mapped wetlands, ponds, and lakes to 300 feet (regardless of wetland size), and intermittent streams will have a 100-foot riparian management zone width on all streams rather than 50 feet on some streams as allowed under INFISH. This change will help ensure the Forest is consistent with Montana streamside management zone law for slopes that are greater than 35 percent which requires a 100-foot-wide streamside management zone and provides for the ecological functions of wetland plants and wildlife that were not covered under INFISH. The 2012 planning rule emphasizes the integration of management direction in recognition of the interdependence of ecological resources and the need for ecological sustainability. Expanding the riparian management zone in these critical areas will contribute to wildlife habitat connectivity and the protection of plant species and animal communities associated with wetlands.

Climate change and aquatic ecosystems

Over the last 50 years, average spring snowpack (the April 1 snow water equivalent) has declined, and average snowmelt runoff is occurring earlier in the spring. These trends are observed in northwestern Montana, the entire Pacific Northwest, and much of the western United States. Since the available data is limited to the last 50 years, it is not clear whether these trends are persistent long-term trends or reflect short-term decade-to-decade variability that may reverse in coming years. Several recent studies of the same trends across the entire western United States have concluded that natural variability explains some, but not all, of the trend through the western United States of decreasing spring snowpack and earlier snowmelt runoff.

Potential changes in streamflow and rising stream temperatures are likely to increase risks to maintaining existing populations of native, cold-water aquatic species. Over the last century, most native fish and amphibians have declined in abundance and distribution throughout the western United States, including

northwest Montana. It is unknown whether, or to what degree, these changes are attributable to climate trends. Potential climate-induced trends of altered streamflow timing, lower summer flows, and increased water temperature will likely reduce the amount, quality, and distribution of habitat suitable for native trout and contribute to fragmentation of existing populations. Climate-related impacts are likely to add cumulatively to other stressors on native fish and amphibian species. Non-native trout and other aquatic species better adapted to warm water temperatures may increase in abundance and expand their existing ranges.

These climatic and hydrologic trends, combined with climate-related trends in wildfires and forest mortality from insects and diseases, can significantly affect aquatic ecosystems and species (Dunham, Rosenberger, Luce, & Rieman, 2007; Dunham, Young, Gresswell, & Rieman, 2003; Isaak et al., 2010). A growing body of literature has linked these hydrologic trends with impacts to aquatic ecosystems and species in western North America, often as a result of climate-related factors affecting stream temperatures and the distribution of thermally suitable habitat (Bartholow, 2005; Isaak et al., 2010; Kaushal et al., 2010; Morrison, Quick, & Foreman, 2002; Petersen & Kitchell, 2001). Lower summer streamflows and higher air temperatures, as observed over recent decades in northwestern Montana, are generally expected to result in increased stream temperatures. However, stream temperatures are controlled by a complex set of site-specific variables, including shading from riparian vegetation, wind velocity, relative humidity, geomorphic factors, groundwater inflow, and hyporheic flow (Caissie, 2006).

Warming climate and fire

Fire and changing conditions on the landscape that result from a warming climate must be kept in mind when considering riparian management needs (Joyce et al., in press; Robert E. Keane et al., in press; Charles H. Luce, in press; Reeves et al., in press). When considered by subregion, model runs in the Northern Region show that average temperatures will continue to become warmer during the first half of the 21st century (Joyce et al., in press). Some locations in the region are expected to become drier and have more periods of drought, but overall, precipitation is expected to range from 5 percent less to an increase of up to 25 percent, with the mean increase expected to be 6 to 8 percent (Joyce et al., in press). The changing climate is expected to reduce streamflows (Charles H. Luce & Holden, 2009), reduce the storage capacity associated with snowpack (C. H. Luce, Lopez-Burgos, & Holden, 2014), and shift the timing of runoff in some locations (C. Luce et al., 2012; Charles H. Luce, in press).

Climactic changes are expected to differentially affect tree species and their distribution on the landscape, as well as some of the pathogens that act upon them (Robert E. Keane et al., in press). There is also significant concern that climate change effects combined with altered disturbance regimes caused by fire suppression will change ecosystems (Hessburg, Agee, & Franklin, 2005). Finally, climate change may create conditions heretofore not observed and cause ecosystems to shift in novel ways (Reeves et al., in press; Reeves, Pickard, & Johnson, 2016). These changes include how riparian areas respond to potentially novel disturbance regimes (Dwire, Meyer, Riegel, & Burton, 2016; Hessburg et al., 2015; Reeves et al., in press). How land managers prepare for climate change and respond to it is crucial.

The relation of fire behavior between riparian areas and adjacent uplands is influenced by a variety of factors that contribute to high spatial variation of fire effects on riparian areas. Landform features, including broad valley bottoms and headwalls, appear to act as fire refugia (Camp, Oliver, Hessburg, & Everett, 1997). Biophysical processes within a riparian area, such as climate regime, vegetation composition, and fuel accumulation, are often distinct from upland conditions (Dwire & Kauffman, 2003; Reeves et al., 2016). This can be especially true for understory conditions (Halofsky & Hibbs, 2008). Riparian areas experiencing moderate annual climate conditions can have higher humidity and can act as a buffer against fire and therefore as a refuge for fire-sensitive species (Halofsky & Hibbs, 2008). Some

studies have found that fire typically occurs less frequently in riparian areas (Dwire et al., 2016; Russell & McBride, 2001).

Depending on geologic and topographic features, riparian conditions and response to fire vary (Halofsky & Hibbs, 2008). A study in mixed-severity fire regime conifer stands found that riparian and upland conditions are similar and consequently fire effects are similar (Van de Water & North, 2010). Under severe fire weather conditions and high fuel accumulation, riparian zones may become corridors for fire movement (Pettit & Naiman, 2007). Fire effects occurring upstream will likely influence downstream conditions (Wipfli, Richardson, & Naiman, 2007) as well as future fire behavior (Pettit & Naiman, 2007). High-severity fire will likely have short-term negative effects on aquatic systems at the reach scale but beneficial effects over time at that same scale as recolonization naturally occurs (Gresswell, 1999). At the watershed scale, fire effects for one life history phase can be negative and beneficial for another life history phase (Flitcroft et al., 2016). Considering these varied conditions that occur from the stream edge to upslope and from river mouth to mountaintop, the riparian response to fire is complex and heterogeneous and therefore requires considerable effort to design treatment plans that maximize benefits for both terrestrial and aquatic-dependent species.

In the face of larger fires and disease outbreaks, the challenge of how to integrate management of aquatic and terrestrial resources has confronted the agency for over a generation, including national forests in the Northern Region. Rieman et al. (2000) spoke directly to this and identified opportunities for convergence, as have many others since (Reeves et al., in press; Reeves et al., 2016; B. E. Rieman, Hessburg, Luce, & Dare, 2010). Current habitat has been degraded in many dry and mesic forests, and treatments (such as road improvement or relocation, culvert replacement, thinning, prescribed fire, and wildfire use to restore old forest structure) could create more suitable aquatic habitat in the long term. Rieman et al. (2000) stated, “By working strategically it may be possible to establish mosaics of fuel and forest conditions that reduce the landscape risk of extremely large or simultaneous fires without intensive treatment of every subwatershed.” Further, they suggested that the recovery of function in some watersheds may not be possible without human intervention. Treatments in dry forest types, although still controversial (Williams & Baker, 2012), are broadly supported by the current scientific literature (Hessburg et al., 2016) and have continued to gain acceptance by the public and greater use by managers.

In the Northern Region, restoring mixed-severity fire regimes remains controversial and complicated for numerous reasons, such as the habitat needs of the endangered bull trout, lynx, and grizzly bear. Therefore, treating riparian areas in mixed-severity fire regime forests can be especially controversial and complicated. In locations where upslopes and riparian forests have qualitatively similar fire effects, treatments guided by scientific findings are likely to restore the ecological function of fire regimes at the landscape level (Finney et al., 2007). The position in the landscape relative to elevation, location within the stream network, and climate regime should be carefully considered to ensure understanding of riparian function (Reeves et al., in press; Reeves et al., 2016). Because the effects of restoration treatments on impaired riparian habitats are poorly understood, focused research within an adaptive management framework is necessary.

In addition to vegetation treatments in riparian areas, stream channel restoration treatments will likely be considered to help aquatic ecosystems adapt to climate change. In a paper titled “Restoring Salmon Habitat for a Changing Climate” by Beechie et al. (2013), the authors recommend actions that connect streams to floodplains, restore flow, and help degraded channels aggrade as most likely to improve water temperatures. They also indicate that instream channel actions are unlikely to ameliorate the effects of climate change.

Potential impacts to fish of a warming climate include the following:

- Egg incubation and fry emergence may be adversely affected due to flood flows, dewatering, and/or water temperatures. Shifts in the timing and magnitude of natural runoff will likely introduce new selection pressures that may cause changes in the most productive timing or areas for spawning.
- Spring and summer rearing may be adversely affected due to reduction in stream flow and higher water temperatures.
- Overwinter survival may be positively affected by higher winter water temperatures enabling fish to feed more actively, potentially increasing growth rates if sufficient food is available. If food is limited, the elevated metabolic demands could reduce winter growth and survival.

Bull trout is the native trout species most vulnerable to potential increases in stream temperatures because it has the coldest range of thermally suitable habitat among native salmonids in the northern Rockies. For this species, increasing stream temperatures may cause a net loss of habitat because areas are not available farther upstream to replace those that become unsuitably warm. For rainbow trout, which tolerates warmer stream temperatures better than bull trout and is often limited by upstream temperatures that are too cold, warming may only shift suitable habitats towards higher-elevation stream reaches with little or no net change in total amount of thermally suitable habitat (Bruce E. Rieman & Isaak, 2010). Cutthroat trout in high-elevation streams currently are commonly limited by low water temperatures and short growing seasons (Coleman & Fausch, 2007; Harig & Fausch, 2002). These populations may benefit from climate-induced increases in thermally suitable habitat in higher-elevation stream reaches (Bruce E. Rieman & Isaak, 2010). However, warmer stream temperatures may also lead to non-native fish and other aquatic species moving into previously unsuitable upstream areas where they will compete with native species (Fausch, Rieman, Dunham, Young, & Peterson, 2009; Haak et al., 2010; Rahel & Olden, 2008; Bruce E. Rieman et al., 2007).

Projected increases in air temperatures, along with projected decreases in summer stream flows, will likely lead to warmer stream temperatures in the Columbia River Basin, particularly during summer low-flow periods (Casola et al., 2009). Recent scientific publications suggest that projected air temperature changes are likely to reduce the distribution of thermally suitable natal habitat for bull trout, fragment existing populations, and increase the risk of local extirpation (Isaak et al., 2010; Bruce E. Rieman et al., 2007). However, the risk of climate-induced extirpation in subbasins of northwestern Montana may be less than other, relatively drier and warmer in the Columbia River basin (Bruce E. Rieman et al., 2007).

Other recent publications conclude that westslope cutthroat trout, which can generally tolerate warmer stream temperatures than bull trout, is at a low risk for increasing summer stream temperatures in most basins within its range, including the Clark Fork Basin of northwestern Montana (which includes all Flathead River drainages) (Haak et al., 2010). These studies also conclude that stream temperature increases resulting from projected climate-change-induced increases in wildfire extent and severity posed a moderate or high risk of cutthroat trout extirpation in 46 percent of occupied subwatersheds throughout the species' occupied range and in 45 percent of the subwatersheds in the Clark Fork Basin (Haak et al., 2010).

Haak et al. (2010) conclude that risks to native trout resulting from projected increases in winter flood risk in northwestern Montana are greater than risks associated with climate-induced changes in wildfire, drought, or stream temperatures. They estimate that cutthroat trout in most subwatersheds in the Clark Fork Basin face high to moderate risk of increased winter flooding (Haak et al., 2010).

Notable changes between draft and final EIS

Changes that occurred between the draft and final EIS related to aquatics include adding responses to comments, updating the best available science, making organizational changes within sections, and making changes for clarity. Meltwater stonefly changed to a proposed species rather than a candidate species, and westslope cutthroat trout is no longer considered a species of conservation concern.

Changes were made to update and clarify plan components in the final EIS because the language of riparian management plan components was modified. The categories of riparian management zones were changed so that ponds, lakes, reservoirs, and wetlands is now category 4 rather than category 3 and has a minimum size criterion of 0.5 acre. Plan components were changed related to management within both the inner and the outer riparian management zones, and management was grouped for streams vs. lakes, reservoirs, ponds, and wetlands.

3.2.1 Affected environment—Introduction

The aquatic systems in the Inland Northwest evolved over millions of years under the influence of many geologic forces and processes. The present character and resilience of the systems, climate, and geological processes have evolved following the last ice age, approximately 10,000 years ago. Since then, the aquatic systems have been subject to a wide array of disturbances and events. These disturbances have often been intense and cyclic in nature. The watersheds and their dependent resources have evolved under this "pulse" disturbance regime so that they can effectively respond to natural disturbances while sustaining their long-term functions, processes, and conditions.

Around the beginning of the 20th century, the expansion of human populations began in the Inland Northwest, along with the development of the land and resources to support those populations. This has resulted in many new human-caused disturbances to the watershed systems, and the pattern of many of those disturbances has tended to be a more sustained or "press" disturbance regime. A press disturbance forces an ecosystem to a different domain or set of conditions (Lake, 2000; Reeves et al., 1995; Stanley, Powers, & Lottig, 2010; Yount & Niemi, 1990). Many of those disturbances tend to mimic historic "natural" processes, but the frequency increases and intensity decreases, creating a constant press condition. In some cases, the watershed systems that have been continually pressed have undergone regime changes (Stanley et al., 2010), creating stressors to aquatics-dependent resources.

Human activities have altered stream channels by direct modification such as channelization, removal of large woody debris, dams and diversions, historical log drives, and the building of infrastructure such as roads, railways, bridges, and culverts that have encroached on riparian areas and stream channels. Humans have also indirectly affected the incidence, frequency, and magnitude of disturbance events. This has affected the inputs and outputs of sediment, water, and vegetation. These factors have combined to cause changes in channel conditions throughout many parts of the Forest, resulting in aquatic and riparian habitat conditions different from those that existed prior to human development. Natural disturbances (primarily wildfire, floods, and landslides) combined with human-caused disturbances (timber harvest, fire suppression, road construction, mining, dams, introduction of non-native species, recreation, grazing, altered food web) over the last century have led to changes in the physical watersheds and in the fish and amphibians dependent on them (ISAB, 2011a, 2011b; D. C. Lee et al., 1997; R. J. Naiman, 2013; R. J. Naiman et al., 2012; B. Poff et al., 2011; Bruce E. Rieman et al., 2015).

Roads can have some of the greatest effects on watersheds and aquatic biota. Roads can change the runoff characteristics of watersheds, increase erosion, alter sediment composition and delivery to streams, and alter channel morphology (Furniss, Roelofs, & Yee, 1991; Grace III & Clinton, 2007; Gucinski, Furniss, Ziemer, & Brookes, 2001; Trombulak & Frissell, 2000). These direct effects lead to changes in the habitats of fish and amphibians. Although current best management practices for road construction are

designed to minimize the effects to watersheds, many miles of roads existing on the landscape were not built to these standards (Swift Jr. & Burns, 1999) or have been placed in stored service. As a result, these roads either continue to affect watersheds through chronic erosion or are at risk of mass failure from undersized stream crossings or locations on sensitive land types. Due to the glaciated nature of the Forest, many of the Forest's valleys are U-shaped, which allows for road locations on old floodplain terraces rather than along streams, which is often the case in southwest Montana. Locating roads away from streams undoubtedly reduces sediment delivery into streams.

3.2.2 Soils affected environment

The diverse lithology, structure, and climate of the northern Rockies over time have resulted in a spatially complex pattern of landforms and soils across the Forest that respond differently to management activities. Most management activities and natural processes, such as recent wildfires, affect soil resources to varied extents. Impacts or indicators of stress include surface erosion, compaction, and nutrient loss through removal of coarse woody debris, high-severity burns, flooding, and landslides. These effects may be in the uplands or within streams. Soil effects or stresses are not always detrimental or long lasting. In order to maintain and, where necessary, restore the long-term quality and productivity of the soil, detrimental impacts to the soil resource must be kept within tolerable limits.

The Forest has a wide diversity of soil types, from the minimally developed, nutrient-poor soil and rock outcrop complexes of the steep mountain slopes and ridges to the deep, fertile soils of the lower valleys. Steep terrain prone to intermittent surface movement, combined with the recent ablation of glaciers, has limited soil development. Cool temperatures shorten the growing season to 140 days in the high country. A growing season as long as 210 days and gentle topography provide favorable conditions for soil development and forest production in the lower elevations of the Forest.

Soils in the area developed on the Mesoproterozoic Belt Supergroup, a sequence of sedimentary and metasedimentary rocks, primarily mudstones, or Belt-derived material deposited by glaciers, streams, and wind. Soils tend to be skeletal and have varying degrees of ash/loess surface soil that increases the soil's ability to hold water. Soil depth follows geomorphology closely; deep soils form on concave slopes and valleys whereas shallow soils form on ridges.

Valley soils developed on material deposited by glaciers, glacial streams, and modern streams and rivers. They vary therein by more subtle geomorphic form, including outwash fans, moraines, lacustrine and stream-laid terraces, and contemporary river floodplains. The outwash fans and moraines promote very rocky soils with a thick root-tight layer of mixed ash/loess material. The lacustrine terraces have much finer textures that can shift vegetation habitat type. An ash/loess topsoil heightens productivity since glacial deposits have inherent excessive drainage.

3.2.3 Watersheds affected environment

Watershed condition framework

Watersheds and their ecological condition have been an increasingly important focus of public land managers in the last two decades (Esselman et al., 2011; Reeves, Williams, Burnett, & Gallo, 2006; J. W. Thomas, Franklin, Gordon, & Johnson, 2006; USDA, 1994, 1995a, 1995b). Congress has also had increasing interest in watershed condition, especially when it comes to investment in watershed restoration. Nationally, in 2011 the Forest Service introduced two general technical reports responding to congressional interest. These reports are the Watershed Condition Framework (FS-977) (USDA, 2011b) and the Watershed Condition Classification Technical Guide (FS-978) (Potyondy & Geier, 2011). These reports were developed in tandem to provide a consistent method for categorizing how the Forest Service

identifies the condition of subwatersheds as well as to provide guidance to help national forests select priority watersheds.

The watershed condition framework establishes a nationally consistent reconnaissance-level approach for classifying watershed condition, using a comprehensive set of 12 indicators that are surrogate variables representing the underlying ecological, hydrological, and geomorphic functions and processes that affect watershed condition. The primary emphasis is on aquatic and terrestrial processes and conditions that Forest Service management activities can influence. The indicators use data when available and professional opinion when data is not available. The approach is designed to foster integrated ecosystem-based watershed assessments, provide guidance to programs of work in watersheds that have been identified for restoration, enhance communication and coordination with external agencies and partners, and improve national-scale reporting and monitoring of program accomplishments. The watershed condition framework provides the Forest Service with an outcome-based performance measure for documenting improvements to watershed condition at Forest, regional, and national scales (USDA, 2011b).

Watershed condition classification ultimately ranks watersheds in one of three discrete categories (or classes) that reflect the level of watershed health or integrity. Watershed health and integrity are considered conceptually the same (Regier, 1993). Watersheds with high integrity are in an unimpaired condition in which the ecosystems show little or no influence from human actions (Lackey, 2001).

The Forest Service Manual defines watershed condition in terms of "geomorphic, hydrologic and biotic integrity" relative to "potential natural condition." In this context, integrity relates directly to functionality. In this final EIS, geomorphic functionality or integrity is defined in terms of attributes such as slope stability, soil erosion, channel morphology, and other upslope, riparian, and aquatic habitat characteristics. Hydrologic functionality or integrity relates primarily to flow, sediment, and water quality attributes. Biological functionality or integrity is defined by the characteristics that influence the diversity and abundance of aquatic species, terrestrial vegetation, and soil productivity. In each case, integrity is evaluated in the context of the natural disturbance regime, geoclimatic setting, and other important factors within the context of a watershed. The definition encompasses both aquatic and terrestrial components because water quality and aquatic habitat are inseparably related to the integrity and, therefore, the functionality of upland and riparian areas within a watershed.

Within this context, the three watershed condition classes are directly related to the degree or level of watershed functionality or integrity:

Class 1 = functioning properly

Class 2 = functioning at risk

Class 3 = impaired function

The watershed condition framework (USDA, 2011b) characterizes a watershed in good condition as one that is functioning in a manner similar to natural wildland conditions (Karr & Chu, 1999; Lackey, 2001). A watershed is considered to be functioning properly if the physical attributes are adequate to maintain or improve biological integrity. This consideration implies that a Class 1 watershed that is functioning properly has minimal undesirable human impact on its natural, physical, or biological processes and that it is resilient and able to recover to the desired condition when disturbed by large natural disturbances or land management activities (Yount & Niemi, 1990). In contrast, a Class 3 watershed has impaired function because a physical, hydrological, or biological threshold has been exceeded. Substantial changes

to the factors that caused the degraded state are commonly needed to return the watershed to a properly functioning condition.

See appendix E for more detailed information on the watershed condition framework.

Watershed conditions on the Flathead National Forest

The primary hydrologic unit upon which watershed condition has been assessed is the 6th-level hydrologic unit, or subwatershed, which is a watershed of about 10,000-40,000 acres. To evaluate baseline watershed conditions across the analysis area, a watershed condition rating was determined for each subwatershed. This characterization estimated the existing condition based on physical characteristics (e.g., hydrologic, geomorphic, landscape, topographic, vegetative cover, and aquatic habitat) and human-caused disturbances (e.g., road construction and vegetative treatments).

The Forest completed its classification of watershed conditions in 2011 following the guidelines set forth in the Watershed Condition Classification Technical Guide (Potyondy & Geier, 2011). Specialists used GIS-derived data such as road and trail density within riparian management zones, barrier locations, insects and disease, etc., to classify conditions, using the guide as a template. Best professional judgment was also used, as suggested in the guide. The watershed condition classification for the Forest summarizes in a spreadsheet the information used for determining the watershed condition classifications for the Forest (USDA, 2015g).

The Forest completed the first round of watershed condition classification in summer 2011 and identified five Class 2 watersheds (Middle Logan Creek, Meadow Creek, Beaver Creek, Jim Creek, and Cold Creek) and 176 Class 1 watersheds. Although many of the subwatersheds have had extensive human use, there are some important geophysical characteristics that help to explain why so many watersheds are considered Class 1 and no watersheds were ranked as Class 3 on the Forest. Parent geology in the project area is mostly composed of the relatively hard Belt Supergroup that does not erode as easily as other kinds of rock (Brian D Sugden & Woods, 2007). Further, Sugden and Woods (2007) note that geology in the plan areas has low erodibility and low rainfall. These characteristics reduce the amount of human-caused sedimentation occurring in streams, which, if present and widespread, would more negatively influence some of the components that help make up the watershed condition classification scores.

When compared to watersheds on other national forests across the country, the Flathead National Forest also does not face the level of urbanization pressure faced by Forests with large urban centers bordering and sometimes intermixed with Federal lands. Urbanization brings increasing levels of nutrient contamination and increasing percentages of hardened surfaces, both of which negatively affect watersheds in myriad ways (Meyer, Paul, & Taulbee, 2005; Wang & Kanehl, 2003).

Watersheds that support bull trout are a priority for restoration, using the priority watershed designation under the watershed condition framework and the conservation watershed network. Bull trout are a listed species, and one goal of the Bull Trout Conservation Strategy and the Recovery Unit Implementation Plan is to improve habitat conditions. Of the Forest’s five Class 2 watersheds, bull trout are found only in Jim and Cold Creeks. These two creeks are rated as the highest priority for restoration of the class 2 watersheds. Bull trout were never present historically in Logan, Meadow, or Beaver Creeks.

Stream channels

Streams carry water, sediment, dissolved minerals, and organic material derived from hillsides and their vegetation cover. The shape and character of stream channels constantly and sensitively adjust to the flow of this material by adopting distinctive patterns such as pools and riffles, meanders, and step pools. The

vast array of physical channel characteristics combined with energy and material flow provide diverse habitats for a wide array of aquatic organisms.

Varied topography coupled with irregular occurrences of channel-affecting processes and disturbance events such as fire, debris flows, landslides, drought, and floods result in a mosaic of river and stream conditions that are dynamic in space and time under natural conditions. The primary consequence of most disturbances is to directly or indirectly provide large pulses of sediment and wood into stream systems. As a result, most streams and rivers undergo cycles of channel change on timescales ranging from years to hundreds of years in response to episodic inputs of wood and sediment. The types of disturbances that affect the morphology of a particular channel depend on watershed characteristics, size, and position of the stream within the watershed. Many aquatic and riparian plant and animal species have evolved in concert with stream channels. They develop traits, life-history adaptations, and propagation strategies that allow persistence and success within dynamic landscapes.

Human uses have altered some stream channels in the last century. Stream channels have changed as a result of channelization, wood removal, road building, logging, and splash dams and have changed indirectly due to alterations to the natural incidence, frequency, and magnitude of disturbance events such as wildfire. Some characteristics of channels commonly measured to help identify changes caused by management include the frequency and depth of large pools, the width-depth ratio of stream channels, and the percentage of fine sediment contained in the substrate (Robert Al-Chokhachy, Roper, & Archer, 2010). Low-gradient stream channels show the most response to land management activities. Lower pool frequencies and higher fine sediment concentrations are most obvious in watersheds with higher road densities such as the Swan Island Unit and Tally Lake Ranger District. These findings are consistent with observations that indicate that past road construction and maintenance, grazing, and timber harvest practices altered sediment delivery and routing, and potentially other habitat components, which in turn led to fewer pools, higher fine sediment content, and stream aggradation.

Consequently, watersheds, stream channels, and aquatic habitats in some locations on the Forest are now subject to continued compounding effects of watershed disturbance. This contrasts with the more pulse-like pattern of disturbance under which most streams and associated species evolved. Consequently, some stream channels are less than optimal for aquatic and riparian-dependent species, which evolved in environments that had many more high-quality habitat areas spread across the landscape. These conditions are more prevalent in the Salish Mountains geographic area.

The most comprehensive and consistent data set on stream channel conditions is provided by the PIBO monitoring program, which is a highly organized monitoring effort that collects data systematically across NFS and Bureau of Land Management lands across the Interior Columbia River Basin (see section 1.4.3). Monitoring began on the Forest in 2001 and includes 70 sites in reference and managed watersheds. This program allows the evaluation of status and trends and comparison of reference and managed conditions. A draft analysis of stream habitat conditions on the Forest using the PIBO data was completed in 2014 (USDA, 2014b).

Another good metric to describe channel conditions is percent fine sediment (material < 6.35 millimeters) measured by McNeil core samples. MFWP has been monitoring percent fine sediment on Forest streams since 1980, and that data can be found in the assessment of the Forest.

Forest-scale analysis of PIBO data has determined that habitat attributes in reference and managed streams in the Swan and Stillwater River drainages are significantly different for median particle size, percent fines, and bank angle. Median particle sizes and percent fines data indicate that fine sediment levels in managed streams are statistically different and slightly higher than reference streams on average when considered for the entire Forest. The most degraded sediment conditions occur on the Swan and

Tally Lake Ranger Districts. Bank angles are actually smaller in managed streams compared to reference streams (C. N. Kendall, 2014). In non-forested ecosystems, smaller bank angles indicate more favorable habitat conditions. Smaller bank angles may create more favorable habitat on forested streams on the Flathead as well, but there is some uncertainty regarding this assumption. The data reveals that percent fines are highest in streams that primarily support brook trout.

Water quality

The State of Montana's non-degradation policy (Montana Code Annotated 75-5-303 and Administrative Rules of the State of Montana 17.30.701) states that existing and anticipated uses and the water quality necessary to protect those uses must be maintained and protected. Many, but not all, land management activities on NFS lands are considered nonsignificant activities under State law as long as reasonable land, soil, and water conservation practices are applied and existing and anticipated beneficial uses will be fully protected. State-defined nonsignificant activities are identified in Montana Code Annotated 75-5-317.

Water quality is regulated under the authority of the Clean Water Act, and the State of Montana assesses the waters within its jurisdiction and identifies stream segments and other waterbodies whose water quality is "impaired" or generally not meeting water quality standards for beneficial uses.

Individual stream segments, lakes, and other waterbodies have been listed as "water quality limited segments" (i.e., "impaired") by the state of Montana (MTDEQ, 2014) and are described in subsection 303(d) of the Clean Water Act as waters that do not meet State standards. This is a broad term that includes water quality criteria, designated uses, and anti-degradation policies. The dominant pollutant currently affecting "impaired" waterbodies on the Forest is sediment.

The Montana Department of Environmental Quality develops TMDLs and submits them to the U.S. Environmental Protection Agency for approval. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. The Montana Water Quality Act requires the Montana Department of Environmental Quality to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. TMDLs provide an approach to improving water quality so that streams and lakes can support and maintain their State-designated beneficial uses. Montana Department of Environmental Quality has a Web site (http://svc.mt.gov/deq/wmadst/) that displays water quality information across the state.

An excellent example of the TMDL process is Big Creek, which was previously listed as impaired for sediment in 1996 because historic road building and timber harvesting activities in the Big Creek watershed had led to accelerated soil erosion and a substantial increase in the amount of fine sediment delivered to Big Creek. Frequent monitoring by MFWP revealed degraded fish habitat in Big Creek due to increases in the amount of sand and silt in bull trout spawning habitat. Spurred by this listing, the Flathead National Forest collaborated with the Montana Department of Environmental Quality to complete the Watershed Restoration Plan for Big Creek, North Fork of the Flathead River (Sirucek, 2003), which established a TMDL for sediment that was approved by the Environmental Protection Agency on May 9, 2003. The State concluded during subsequent evaluations that subsurface fine sediment is no longer limiting the fishery and aquatic life beneficial uses. As a result, the Montana Department of Environmental Quality removed Big Creek from the state's 2012 list of impaired waters for sediment. Big Creek was the first waterbody in Montana to have undergone the full water quality restoration process and be removed from the Montana Department of Environmental Quality's list of sediment-impaired waters.

An indication of the improving stream habitat and water quality trend can be intuited and partially explained by the TMDL and 303(d) listing process. In 1996, the year after the implementation of INFISH, there were 22 streams on the Forest that were listed as impaired due to siltation. During the TMDL development for streams on the Forest from 2004 to 2014, no TMDL was required for 17 of those streams because data collected to support TMDL development indicated that they were no longer impaired for sediment; they were removed from the 303(d) list without a required TMDL (MTDEQ, 2014). In other words, sediment, which was a leading factor in impairment, was no longer negatively impacting beneficial uses. The implementation of INFISH direction along with best management practices, reduction of road construction, and a reduction of timber harvest along streams likely helped reduce sediment delivery.

There are approximately 8,177 miles of streams within the Forest's administrative boundary. The Montana Department of Environmental Quality has assessed about 5.2 percent (422 miles) of those streams (MTDEQ, 2016). The breakdown of the categories of the assessed streams on the Forest is as follows:

- Category 1: 42 percent of the streams assessed were found to be fully supportive of all beneficial uses.
- Category 2: 32 percent of the streams assessed had information that showed some, but not all, of the beneficial uses are supported.
- Category 3: 0 percent (there are no category 3 streams on the Forest).
- Category 4A: 18 percent of the streams assessed were required to have TMDLs, and these TMDLs have subsequently been prepared and approved by the Environmental Protection Agency.
- Category 4C: 8 percent of the streams assessed are impaired in pollution categories such as dewatering or habitat modifications, and thus a TMDL is not required.

The results are not indicative of actual water quality, as the Montana Department of Environmental Quality focuses its assessment on impaired water. Most of the healthy stream miles have not been assessed and entered into Montana's Waterbody System (MTDEQ, 1998).

On the Forest, the Montana Department of Environmental Quality determined that sediment continues to impair aquatic life in Logan, Sheppard, Coal, Goat, and Jim Creeks. The Montana Department of Environmental Quality provided sediment TMDLs for those waterbody segments. Therefore, TMDLs have been developed for all streams on the Forest where required. Fish Creek is a recent example of a stream that was previously on the 303(d) list for sediment impairment from 1996 through 2014, but data collected by the Montana Department of Environmental Quality to support TMDL development in 2014 indicated that Fish Creek is no longer impaired for sediment, so it was removed from the 303(d) list in 2016 (MTDEQ, 2014).

For the five streams with sediment TMDLs, excess sediment may be limiting their ability to support aquatic life. Water quality restoration goals for sediment were established on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available in-stream habitat as it relates to the effects of sediment, and the stability of streambanks. The Montana Department of Environmental Quality believes that once these water quality goals are met, all water uses currently affected by sediment will be restored. The Montana Department of Environmental Quality's water quality assessment methods for sediment impairment are designed to evaluate the most sensitive use, thus ensuring protection of all designated uses. For streams in western Montana, the most sensitive use assessed for sediment is aquatic life. Table 7 lists the impaired waterbodies on the Forest and the cause and source of impairment based on the 2014 303(d) list.

Table 7. Impaired waterbodies on Forest and cause and source of impairment based on the 2014 303(d) list

Waterbody	Cause of impairment	Sources of impairment
Big Creek*	Alteration in streamside or littoral vegetative covers	Forest roads (road construction and use) Streambank modifications/destablization
Coal Creek	Alteration in streamside or littoral vegetative covers Sedimentation/siltation	Forest roads (road construction and use) Timber harvesting
South Fork of the Flathead River (Hungry Horse Dam to mouth)	Other flow-regime alterations	Hungry Horse Dam
Logan Creek	Other flow-regime alterations Physical substrate habitat alterations Sedimentation/siltation	Forest roads (road construction and use) Silvicultural activities Streambank modifications/destablization
Sinclair Creek	Low flow alterations	Agriculture Streambank modifications/destablization
Sheppard Creek	Alteration in streamside or littoral vegetative covers Sedimentation/siltation	Crop production (crop land or dry land) Forest roads (road construction and use) Grazing in riparian or shoreline zones Timber harvesting
Jim Creek	Sedimentation/siltation	Timber Harvesting
Goat Creek	Total suspended solids	Highways, roads, bridges, infrastructure (new construction) Timber harvesting

* Big Creek was removed from the list for “alteration in streamside or littoral vegetative covers” in April 2016.

Flathead Lake lies downstream about 25 miles from the Forest boundary on the Flathead River and about 8 miles downstream from the Forest boundary on the Swan River. Aquatic life was first listed as being impaired in Flathead Lake because of sediment in 1996, and the lake was still identified as impaired for sedimentation/siltation in 2014 (MTDEQ, 2014). The last formal assessment by the Montana Department of Environmental Quality was completed in 2000. Along with sediment, the lake is also listed as impaired by polychlorinated biphenyls, mercury, total nitrogen, and total phosphorus. To address some of these listings, nutrient TMDLs for both total nitrogen and total phosphorus were completed and approved for Flathead Lake in 2001 (MTDEQ, 2001). In the summer of 2014, the Water Quality Planning Bureau of the Planning, Prevention and Assistance Division of the Montana Department of Environmental Quality reassessed the existing Flathead Lake sediment impairment listing and used a weight of evidence reassessment to determine that Flathead Lake is not impaired for sediment and that beneficial uses in Flathead Lake are not currently threatened or impaired by sediment (MTDEQ, 2014).

Holland, Lindbergh, and Ashley Lakes are within the Forest administrative boundary and have been classified as category 3 (insufficient or no data available to determine whether or not any designated use is attained). Four waterbodies that are below the Forest boundary—Whitefish Lake (2004), Swan Lake (2004), Haskill Creek (2014), and the Stillwater River (2014)—also have sediment TMDLs that have been developed (the years that the plans were completed are given in parentheses).

Municipal watersheds and source water protection areas

Public water systems are defined under the Safe Drinking Water Act as entities that provide “water for human consumption through pipes or other constructed conveyances to at least 15 service connections or

serves an average of at least 25 people for at least 60 days a year" (EPA, 2017). The term "public" in "public water system" refers to the people drinking the water, not to the ownership of the system.

Source water protection areas are established to protect public water systems from contamination in accordance with the 1996 amendments to the Safe Drinking Water Act. Montana Department of Environmental Quality's source water protection program provides guidance and approval of source water protection areas within the State of Montana. Source water protection areas in Montana are divided into distinct regions according to the time water takes to reach a public water system intake. The purpose of subdividing source water protection areas in this way is to prioritize source water protection efforts. Montana Department of Environmental Quality has identified management goals within each of these regions, and these management goals are discussed in the context of the water systems located within, adjacent to, or downstream of the Flathead National Forest. Public water supplies and source water assessments can be found on the Montana Department of Environmental Quality's Web site: http://svc.mt.gov/deq/wmadst/default.aspx?requestor=DST&type=SWP.

Public water system intakes on surface water, i.e., streams, are the most susceptible to contamination from land management activities within the Flathead National Forest. Two public water systems divert surface water from streams within the Forest. The City of Whitefish diverts water out of several streams in Haskill Basin, and Glacier Haven Inn in Essex uses water out of Pinnacle Creek. The source water protection areas of these surface water intakes includes a smaller "spill response" area that is a buffer along each source stream measuring a maximum of 10 miles in length, 0.5 mile from both streambanks and 0.5 mile downstream from the surface water intake, confined to the extent within the contributing watershed. These spill response areas are to be managed to prevent releases of contaminants that could be drawn directly into a water intake with little lag time. In addition, the rest of the contributing watershed upstream of the intake is the "watershed region" part of the source water protection area, in which management is to maintain and improve the long-term quality of surface water used by the public water system. In addition to these two surface water users located within the Forest, four other surface water users are located downstream of the Flathead National Forest, and the "watershed region" of their source water protection area extends up into the Forest. These six surface water public water systems serve approximately 10,000 people (table 8 and table 9).

Table 8. Public water systems (PWS) that use surface water with intakes and source water protection areas located within the Flathead National Forest

PWS number	PWS Primary Name	Water Source	Class of PWS per the Safe Drinking Water Act	Population served by PWS
MT0000357	City of Whitefish	Haskill Basin	Community	9,671
MT0000947	Glacier Haven Inn	Pinnacle Creek	Transient, Non-Community	31

Table 9. Public water systems (PWS) that use surface water with intakes located downstream of NFS lands with source water protection areas whose watershed region overlaps NFS lands within the Flathead National Forest

PWS Number	PWS Primary Name	Water Source	Class of PWS per the Safe Drinking Water Act	Population served by PWS
MT0001020	Camp Tuffit, LLC	Lake Mary Ronan	Transient, Non-Community	151
MT0001027	Big Sky RV Resort	Flathead Lake	Transient, Non-Community	97
MT0003175	Ridgewood Estates	Flathead Lake	Community	250
MT0003204	Many Springs Flathead Lake Resort	Flathead Lake	Transient, Non-Community	27

Groundwater sources also supply drinking water in and around the Flathead National Forest. There are 20 public water systems withdrawing groundwater at 22 locations within or near NFS lands on the Forest, which includes 21 wells and 1 infiltration gallery. All of these groundwater users are classified as transient, non-community systems under the Safe Drinking Water Act. Ten of these locations are on NFS lands, with eight sites at Forest Service-managed campgrounds or work centers. The remaining two are wells for Blacktail Mountain Ski area and Whitefish Mountain Resort Summit House. These public water systems are listed in table 10.

Table 10. Groundwater wells/spring water sources located within or near (100 feet) NFS lands on the Flathead National Forest (FNF) by public water system number.

Location of water intake in or near the FNF)	Public Water System Number	Public Water System Primary Name	Place Name	Population served by Primary Water System
In the FNF	MT0000841	Holland Lake Lodge	Condon	200
In the FNF	MT0000885	Glacier Campground	West Glacier	102
In the FNF	MT0001033	Laughing Horse Lodge	Swan Lake	53
In the FNF	MT0003190	B and W Association	Essex	29
In the FNF	MT0003235	Summit House Restaurant	Whitefish	175
In the FNF	MT0003279	Paola Water Commission	Essex	25
In the FNF	MT0004103	Blacktail Mountain Ski Area	Lakeside	285
In the FNF	MT0004326	Glacier Raft Company	West Glacier	515
In the FNF	MT0062279	Condon Work Center	Condon	60
In the FNF	MT0062280	Owl Creek, Holland Lake	Condon	167
In the FNF	MT0062281	Swan Lake Annex Campground	Swan Lake	150
In the FNF	MT0062282	Spotted Bear Resort and Campground	Hungry Horse	42
In the FNF	MT0062286	Lost Johnny Point Campground	Hungry Horse	42
In the FNF	MT0062290	Big Creek Outdoor Education Center	Columbia Falls	31
In the FNF	MT0062291	Tally Lake Campground	Whitefish	117
In the FNF	MT0063608	Big Creek Campground	Columbia Falls	42
near the FNF	MT0000209	Essex Water and Sewer District	Essex	59
near the FNF	MT0000879	San-Suz-Ed RV Park	West Glacier	86
near the FNF	MT0003066	Glacier Wilderness Resort	West Glacier	34
near the FNF	MT0003134	Summit Station Lodge	East Glacier Park	42

Montana’s source water protection program states that areas located within 100 feet of these groundwater sources is the control zone for each intake, and this area is to be managed to protect sources from damage and to prevent direct introduction of contaminants into sources or the immediate surrounding areas. In addition, the area within 1 mile of each groundwater public water system sources are typically designated as inventory regions by Montana Department of Environmental Quality, which are managed to minimize susceptibility to contamination. The inventory region encompasses the area expected to contribute water to a public water system within a fixed distance or a specified groundwater travel time. The recharge region is generally the entire area contributing recharge to groundwater that may flow to a drinking water supply over long time periods or under higher rates of usage. The delineation of these inventory regions can be defined using other methodologies than a simple 1-mile buffer, depending on the information available and the circumstances. Management in these inventory regions will be focused on pollution prevention activities where water is likely to flow to a public water system well intake within a specified

time period. These inventory regions have various degrees of delineation on the Forest, and management in these inventory regions will be considered at the site-specific project level. Best management practices can be implemented to control non-point sources of contamination in these areas (MTDEQ, 1999). Table 11, table 12, and table 13 list the community public water systems that are not on the Flathead National Forest but whose inventory region overlaps the Forest.

Table 11. Community public water systems (PWS) that use groundwater and whose well/spring intake is outside the Flathead National Forest but whose source water protection area's inventory region (MTDEQ, 2016) overlaps the Flathead National Forest.

PWS number	PWS Primary Name	Place Name	Population served by PWS
MT0000060	Big Mountain Water Company	Whitefish	2,435
MT0000108	Riverside Mobile Home Park	Columbia Falls	100
MT0000253	Hungry Horse Co Water and Sewer District	Coram	950
MT0000259	Kalispell Public Works	Kalispell	20,008
MT0000262	Bigfork County Water and Sewer District	Bigfork	2,900
MT0000286	Martin City Water and Sewer District	Martin City	305
MT0002997	Kokanee Bend Homeowners Association	Columbia Falls	230
MT0003176	Glacier National Park Headquarters	West Glacier	500

Table 12. Non-transient, non-community public water systems (PWS) that use groundwater and whose well/spring intake is outside the Flathead National Forest and whose source water protection area inventory region (MTDEQ, 2016) overlaps the Flathead National Forest.

PWS number	PWS Primary Name	Place Name	Population served by PWS
MT0000923	Bissell School District #58	Kalispell	97
MT0002491	Swan Valley Elementary School District #33	Condon	36
MT0001040	Point Service Corporation	Bigfork	45
MT0003724	Flathead Lake Biological Station	Polson	66
MT0004698	Woods Bay Sheaver Creek Water & Sewer District	Bigfork	685

Table 13. Transient, non-community public water systems (PWS) that use groundwater and whose well/spring intake is outside the Flathead National Forest but whose source water protection area inventory region (MTDEQ, 2016) overlaps the Flathead National Forest.

PWS number	PWS Primary Name	Place Name	Population served by PWS
MT0000850	Liquid Louie's Bar	Condon	102
MT0000873	Hungry Bear Steakhouse	Condon	104
MT0000878	Vista Motel	West Glacier	61
MT0000880	West Glacier Motel	West Glacier	30
MT0000881	Lake Five Resort	West Glacier	152
MT0000882	West Glacier KOA Campground	West Glacier	303
MT0000883	Glacier View Golf Club	West Glacier	319
MT0000884	Glacier Ridge	West Glacier	282
MT0000898	Snow Slip Inn	Essex	104
MT0000920	Dew Drop Inn	Coram	51
MT0000941	Middle Fork Motel and Trailer Court	Martin City	29

PWS number	PWS Primary Name	Place Name	Population served by PWS
MT0000946	Glacier Bible Camp	Hungry Horse	903
MT0000951	Stanton Creek Lodge	Essex	52
MT0001031	Birch Glen Resort	Bigfork	23
MT0001998	Crooked Tree Motel and RV Park	Hungry Horse	103
MT0002502	Halfway House Bar Restaurant	Essex	62
MT0002724	Polebridge Ranger Station	Polebridge	62
MT0002811	Polebridge Mercantile	Polebridge	72
MT0002812	Rocky Mountain Hi Campground	Kalispell	275
MT0002891	Glacier Meadow RV Park	East Glacier Park	105
MT0003029	Sundance Campground	Coram	62
MT0003243	MP Water	West Glacier	29
MT0003696	Canyon RV and Campground	Hungry Horse	82
MT0003817	North American RV Park and Campground	Coram	257
MT0004008	Belton Chalet	West Glacier	66
MT0004071	Home Ranch Bottoms	Polebridge	27
MT0004196	Bielenberg Landing Homeowners Association	Bigfork	25
MT0004297	Belton Mercantile	West Glacier	70
MT0004341	Amazing Ventures	Coram	130
MT0004343	Great Northern Whitewater Resort	West Glacier	176
MT0004410	Northern Lights Saloon	Polebridge	50
MT0004435	Flathead Lake Brewing Company	Bigfork	107
MT0004498	Glacier Guides	West Glacier	80
MT0004704	North American Wildlife Museum	Coram	27
MT0004758	Swan Bar & Grill	Swan Lake	32

Per 36 CFR § 251.9, "The Forest Service shall manage National Forest watersheds that supply municipal water under multiple use prescriptions in Forest Plans." Although all water that originates on the Forest could be used for municipal supply at some point downstream, Forest Service Manual 2542.03 states that the Forest's policy is to "identify watersheds providing the principal source of community water during land management planning." Watershed protection is provided for municipal supply watersheds in Forest Service Handbook 2509.22. Additional direction is provided under 36 § CFR 251.9(a), which states that in order for a municipal water supply to receive additional protection measures beyond those already specified in the forest plan, agreements, and/or special-use authorizations, a "municipality must apply to the Forest Service for consideration of these needs."

The Forest has one municipal supply watershed recognized in accordance with 36 CFR § 251.9. Haskill Creek originates northeast of the City of Whitefish at the east end of Whitefish Mountain Resort, and it flows approximately 11 miles to its confluence with the Whitefish River. Haskill Creek has three main tributaries, First Creek, Second Creek, and Third Creek, all of which comprise Haskill Basin. Second and Third Creeks are the primary source of the municipal water supply for the City of Whitefish. First Creek is no longer used as an intake. The entire Haskill Basin watershed covers approximately 8,200 acres, of which 53 percent is privately owned, 41 percent is owned by the Forest Service, and 6 percent is owned by the State of Montana. In recent years, sediment production from point and non-point sources has increased throughout the Haskill Basin due to a variety of human-caused modifications, including land cover disturbance, physical stream straightening, and floodplain encroachment as well as residential and commercial developments.

The proposed protection of land and water in Whitefish's Haskill Basin was ranked as the top priority nationwide for the Forest Service's Forest Legacy Program in 2015 (USDA, 2015d), and the related conservation easement was granted in May 2016. The easement is primarily on F. H. Stoltze Land & Lumber Company lands and will enable the City of Whitefish to better manage its water supply, in coordination with the Forest and Stoltze.

Groundwater

Groundwater-dependent ecosystems are communities of plants, animals, and other organisms that depend on access to or discharge of groundwater such as springs, fens, seeps, areas of shallow groundwater, cave and karst systems, hyporheic and hypolentic zones, and groundwater-fed lakes, streams, and wetlands.

Groundwater is an important resource in Montana, and it will likely become more important in the future as the State's population and industries grow. More than half of Montanans depend on groundwater for their primary water supply. According to the Montana Natural Resource Information Service, groundwater provides 94 percent of Montana's rural domestic water supply and 39 percent of the public water supply. Montana uses over 188 million gallons of groundwater per day for domestic use, public water supplies, irrigation, livestock, and industry (Hutson et al., 2005). Water generated in the mountains of the Forest is an important source of recharge for valley aquifers and is therefore an important Forest product.

Because of limited supply and lack of development opportunities, beneficial use of Forest groundwater is generally low. Consumption is limited to special-use permits and Forest Service campgrounds or administrative sites with domestic wells. Off-Forest, groundwater is used extensively for pump irrigation and drinking water wells in the valley. There are very few natural sources of groundwater contamination. Most threats to groundwater quality are linked directly or indirectly to a variety of human activities. Groundwater can be contaminated by leaks from underground fuel storage tanks and pipes, leaks from cemeteries, leaks from waste disposal sites such as landfills, seepage from septic systems and cesspools, accidental spills from truck and train mishaps, saline runoff from roads and highways, seepage from animal feedlots, irrigation return flow, leaching and seepage from mine spoils and tailings, and improper operation of injection wells. None of these activities occur on the Forest, although hauling of coal from North Dakota on railcars along the Middle Fork of the Flathead River remains a concern.

Bull trout are highly dependent on hyporheic exchange and groundwater areas that influence spawning and winter habitat conditions. Weekes et al. (2012) outlines how such areas of strong groundwater influence are determined by long-term geologic features, including moraines left by retreating glaciers earlier in the Quaternary Period, more recent or contemporary rock glaciers, rock talus, and ancient landslides and debris flow events. The unifying feature of these geomorphic controls on groundwater is that they are permanent landforms with high permeability and water storage capacity whose effects on hydrology last far beyond their initial creation by glacial or colluvial deposition. Bull trout can be seen as ecological specialists whose spawning and early rearing is highly dependent on the stream habitats these geologic features create, where flow and thermal conditions are relatively invariant in the face of weather events and climate shifts. The direct reliance of bull trout on groundwater-influenced waters where temperature changes are not accurately predicted by presently available climate hydrology change models such as the Climate Shield model (Isaak et al., 2015) may bring into question the utility of these models in the area of the Flathead National Forest.

Four major sources of groundwater influence and buffering of streams support bull trout spawning and early rearing:

1) deep, long-residence groundwater associated with bedrock fracturing and other geologic structures;

2) shallow-slope aquifers, commonly associated with ancient Quaternary Period glacial or periglacial deposits of sediment and soil that are recharged by wetland complexes and associated upland processes, or in some cases by lakes deep enough to retain cold water at depth, with water stored over time frames of months to a few years percolating subsurface to recharge adjacent or connected streams;

3) delayed ice melt, storage, and percolation of runoff through coarse-textured colluvial (periglacial and landslide) deposits in mountain tributaries; and

4) shallow aquifers associated with hyporheic entrainment of stream and riverine surface waters in alluvial deposits and discharge back into those surface waters. Recharge of alluvial aquifers by winter and spring snowmelt, rain-on-snow, or rainfall results in storage of cold water for periods ranging from weeks to months and lagged discharge of stored cold water back into surface waters during the hottest summer and early fall months (Weekes et al., 2012).

3.2.4 Aquatic species affected environment

This analysis considers bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) because these two species require colder and cleaner water and thus have stricter habitat requirements than other native fish in the plan area. Because of these two species' strict habitat requirements, plan components developed for bull trout and westslope cutthroat trout will provide high-quality stream habitat conditions for other native aquatic organisms such as sculpins and tailed frogs. Other native species known to be present in riverine environments in the project area are mountain whitefish (*Prosopium williamsoni*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), and sculpin (*Cottus* spp.). Native species found in lakes include pygmy whitefish (*Prosopium coulterii*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), and redside shiner (*Richardsonius balteatus*). Tailed frog (*Ascaphus montanus*), long-toed salamander (*Ambystoma macrodactylum*), Columbia spotted frog (*Rana luteiventris*), Pacific treefrog (*Pseudacris regilla*), and western toad (*Bufo boreas*) are also present in the watersheds. Non-native brook trout (*Salmonidae fontinalis*), lake trout, (*Salmonidae namaycush*), rainbow trout (*Oncorhynchus mykiss*), and grayling (*Thymallus arcticus*) are present within the project area. Warm-water species such as northern pike (*Esox lucius*), perch (*Perca flavescens*), and, most recently, walleye (*Sander vitreus*) can be found in some lower-elevation lakes and river sloughs on the valley floor, primarily off-Forest. These non-native fish are desired by anglers and provide recreational angling opportunities both on and off the Forest; however, no plan components are being specifically developed for these species since the plan components for bull trout and westslope cutthroat trout will provide stream habitat conditions for trout species. Riparian management zones will provide for protection of lakeshore habitat and water quality (figure 1-07).

This analysis also considers the meltwater stonefly (*Lednia tumana*), which the USFWS has proposed for listing under the Endangered Species Act. The meltwater stonefly has been found in glacier meltwater in Glacier National Park, in upper Tunnel Creek below Mount Grant, and above Sunburst Lake on the Forest. This species likely occurs elsewhere on the Forest in glacial meltwaters above treeline.

Bull trout (threatened species)

In November 1999, USFWS listed all populations of bull trout within the coterminous United States as a threatened species pursuant to the Endangered Species Act of 1973, as amended (64 Federal Register 58910). The 1999 listing applied to one distinct population segment of bull trout within the coterminous

United States. The Forest is in the Columbia Headwaters recovery unit. Recovery actions for bull trout (USFWS, 2015a), developed in cooperation with Federal, State, tribal, local, and other partners, fall generally into four categories:

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of non-native fishes and other non-native taxa on bull trout.
4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks and considering the effects of climate change.

Two basic life history forms of bull trout are known to occur: resident and migratory. Resident bull trout spend their entire lives in their natal streams, whereas migratory bull trout travel downstream as juveniles to rear in larger rivers (fluvial types) or lakes (adfluvial types). The populations in the Flathead are an adfluvial migratory group, with juveniles moving downstream to rivers or lakes at age 2-3 and then returning around age 6 to spawn. Bull trout spawning occurs in the fall, and the eggs incubate in the stream gravel until hatching in January (Fraley & Shepard, 1989). The alevins remain in the gravel for several more months and emerge as fry in early spring. Unlike many anadromous salmonids, which spawn once and die, bull trout are capable of multi-year spawning (Fraley & Shepard, 1989). The historic range of bull trout stretched from California, where the species is now extinct, to the Yukon Territory of Canada (G. R. Haas & McPhail, 1991).

Several factors have contributed to the decline of bull trout. Habitat degradation, interaction with exotic species, overharvesting, and fragmentation of habitat by dams and diversions are all factors contributing to the decline (Bruce E. Rieman & McIntyre, 1995). A change in the species composition of Flathead Lake is perhaps the most important factor in the decline of the upper Flathead bull trout subpopulation (McIntyre, 1998). Between 1968 and 1975, opossum shrimp (*Mysis relicta*) were stocked in three lakes with tributaries feeding into Flathead Lake; the shrimp were then able to migrate downstream, and they became established in Flathead Lake. The shrimp were documented in Flathead Lake in 1981, and populations peaked in 1986. Two non-native species, lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*), expanded as juvenile fish benefited from the addition of shrimp to the prey base.

It is believed that the expansion of the lake trout and lake whitefish contributed to the decline of bull trout (McIntyre, 1998). The mechanisms of the decline are not well understood, but it is assumed that the loss of kokanee as a food source for bull trout and competition with and predation by lake trout was a major contributor to the decline in bull trout. Bull trout populations remain healthy in Hungry Horse Reservoir. Lake trout are absent from Hungry Horse but have recently been documented in Swan Lake, which has raised concern among land and fishery managers, and efforts are underway to reduce lake trout (see below).

Westslope cutthroat trout

The USFWS was petitioned by environmental groups to include the westslope cutthroat trout under the protection of the Endangered Species Act. In 2003, the USFWS determined that the listing was not warranted due to wide species distribution, available habitat on public lands, and conservation efforts underway by State and Federal agencies. The South Fork of the Flathead River drainage is considered a stronghold for westslope cutthroat trout throughout its range (Bradley B. Shepard, May, & Urie, 2005).

Westslope cutthroat trout have two possible life forms, resident and migratory. Migratory forms are further divided into adfluvial (migrates to lakes) or fluvial (migrates to rivers). All life forms spawn in tributary streams in the springtime when water temperature is about 10 °C and flows are high (Liknes & Graham, 1988). Cutthroat trout spawn when they are about four or five years old, and only a few survive to spawn again (Bruce E. Rieman & McIntyre, 1995). Fry emerge in late June to mid-July and spend one to four years in their natal streams. Resident fish spend their entire lives in tributary streams, whereas migratory forms may travel miles as they move between waterbodies and spawning habitat.

The primary reasons for this species' decline are similar to those discussed above for the bull trout. Habitat loss is considered a widespread problem. Cutthroat trout have declined across their range due to poor grazing practices, historic logging practices, mining, agriculture, residential development, and the lingering impact of forest roads. Locally, on the Forest, logging and associated road building have had the greatest impact upon populations. Fish have been unable to use spawning habitat due to barriers created by dams and road culverts. Genetic introgression with rainbow trout threatens the long-term persistence of westslope cutthroat trout and is most likely the greatest threat (Hitt, Frissell, Muhlfeld, & Allendorf, 2003). Climate change may likely exacerbate the rate of introgression (Muhlfeld et al., 2014). Efforts in the South Fork have been underway since 2006 to chemically remove hybrids from high mountain lakes in order to protect and restore westslope cutthroat trout genetic integrity, and were completed in 2017 to protect this important stronghold (BPA, 2005). Other efforts have included the construction of barriers in the Swan to prevent the upstream invasion of brook trout and electrofishing removal in Sheppard Creek since 1998, also to remove brook trout.

Meltwater stonefly (proposed species)

The meltwater lednian stonefly (*Lednia tumana*) is a small, dark-colored species that inhabits extremely cold glacier-fed streams, primarily at high elevations in Glacier National Park. The USFWS published a rule on October 4, 2016, proposing to list this species as threatened (81 FR 68379). Little else is known about its habits or ecology except that the adults hatch by mid-summer (July-August) and are presumably mating during this time. The meltwater stonefly was found on the Forest in the headwaters of Tunnel Creek below Grant Glacier in 2010 and above Sunburst Lake in 2015. This species could possibly be found in other glacier meltwater areas on the Forest, although this habitat type is rare on the Forest.

Meltwater lednian stonefly larvae are found in small, alpine, mountain streams (Newell & Minshall, 1976), but only those closely linked to glacial runoff (Treanor, Giersch, Kappenman, Muhlfeld, & Webb, 2013). Ecologically, this species is a cold-water stenotherm that is unable to tolerate warm water temperatures (greater than 10 °C) and is generally collected within a few hundred meters of the base of glaciers or snow melt derived streams.

The greatest concern with this species is climate change, which will continue to shrink glaciers that this species is dependent on for survival. Estimates are that glaciers will be gone from Glacier National Park by 2030, essentially the life of this forest plan. The Forest does not conduct activities, such as trail construction, in this species habitat and thus will have no effect on the meltwater stonefly.

Western pearlshell mussel (sensitive species under alternative A only)

The western pearlshell mussel (*Margaritifera falcata*) is a State species of special concern in Montana (S2) and is a species previously identified as sensitive on the Northern Region's sensitive species list (USDA, 2011a). Montana's populations of western pearlshell may be significantly contracting and becoming less viable with decreased streamflows, warming, and degradation of habitat. Previously reported mussel beds in the larger rivers (Blackfoot, Big Hole, Bitterroot, Clark Fork) are extirpated from the drainage or are at such low densities that long-term viability is unlikely. This mussel species appears

to have crossed the Continental Divide in Montana from west to east with its salmonid host, the westslope cutthroat trout.

Western pearlshell occurs in sand, gravel, and even among cobbles and boulders in low- to moderate-gradient streams up to larger rivers. This species prefers stable gravel and pebble substrates in low-gradient trout streams and intermountain rivers. Western pearlshell is found in runs and riffles in stable main-current channel areas. This mussel is intolerant of silt and warm-water temperatures (D. M. Stagliano, Stephens, & Bosworth, 2007).

In large river systems, the western pearlshell attains maximum density and age in river reaches where large boulders structurally stabilize cobbles and interstitial gravels. Boulders tend to prevent significant bed scour during major floods. Boulder-sheltered mussel beds, although rare, may be critical for population recruitment elsewhere within a river, especially after periodic flood scour of less protected mussel habitat. In localized areas where canyon reaches are aggrading with sand and gravel, the western pearlshell mussel is often replaced by the Rocky Mountain ridged mussel (*Gonidea angulata*).

Nearly all mussels require a host or hosts during the parasitic larval portion of their life cycle. Hosts are usually fish species, and hosts for the western pearlshell mussel in Montana are typically and have historically been *Oncorhynchus* spp. (e.g., westslope cutthroat trout).

Western pearlshell mussels have been found in Ashley Creek about 2 miles below the Forest boundary (D. M. Stagliano et al., 2007). Stagliano (2010) modeled likely mussel habitat on the Forest, and the Forest has surveyed many of the likeliest sites and but has not found mussels on the Forest. In addition, the site on Ashley Creek is about 7 miles below Ashley Lake. The Forest's ownership is primarily above Ashley Lake, and any sediment generated from Forest activities would settle in the lake. Therefore, the forest plan will not have an impact on western pearlshell mussels and they will not be discussed further.

Bull trout and westslope cutthroat status by subbasin (8-digit hydrological unit code)

The status of bull trout and westslope cutthroat trout in four main subbasins on the Flathead National Forest are discussed in this section. Bull trout monitoring has been done in these subbasins for the past 15 to 30 or more years. figure 3 through figure 7 display the bull trout redd counts on the Forest. Redd counts from 1993 to 2014 in the South Fork indicate that the bull trout population is stable (figure 6).

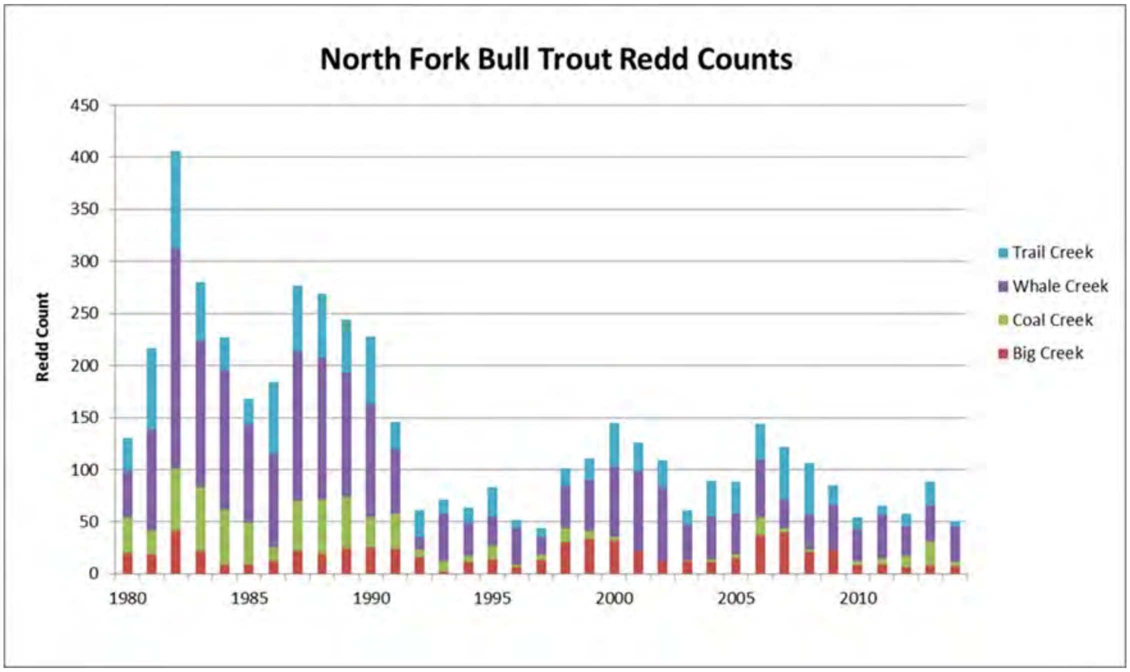

Figure 3. Bull trout redd counts in the North Fork of the Flathead River, 1980-2015

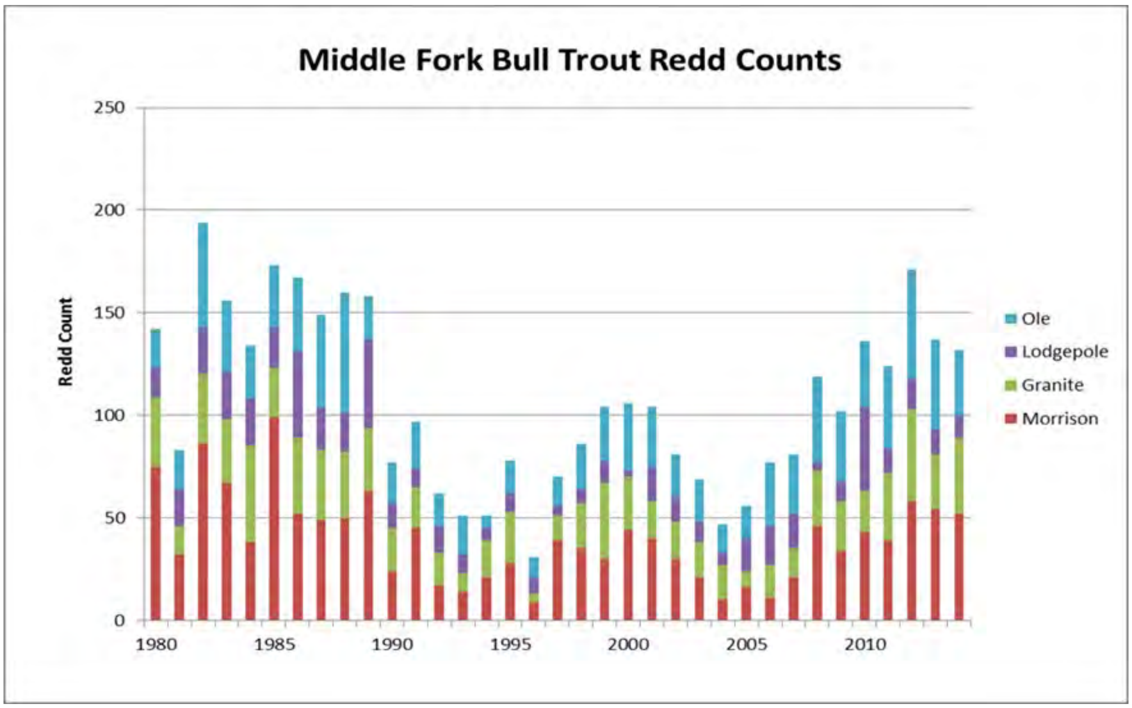

Figure 4. Bull trout redd counts in the Middle Fork of the Flathead River, 1980-2015.

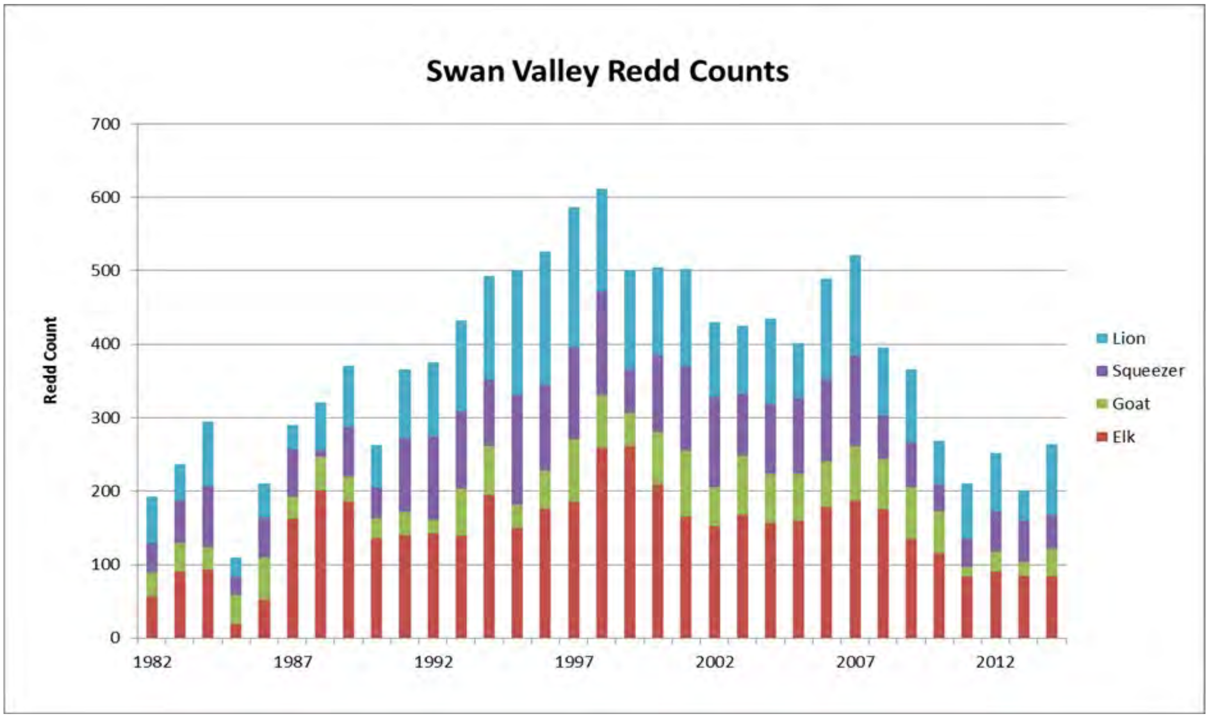

Figure 5. Bull trout redd counts in the Swan River, 1982-2015.

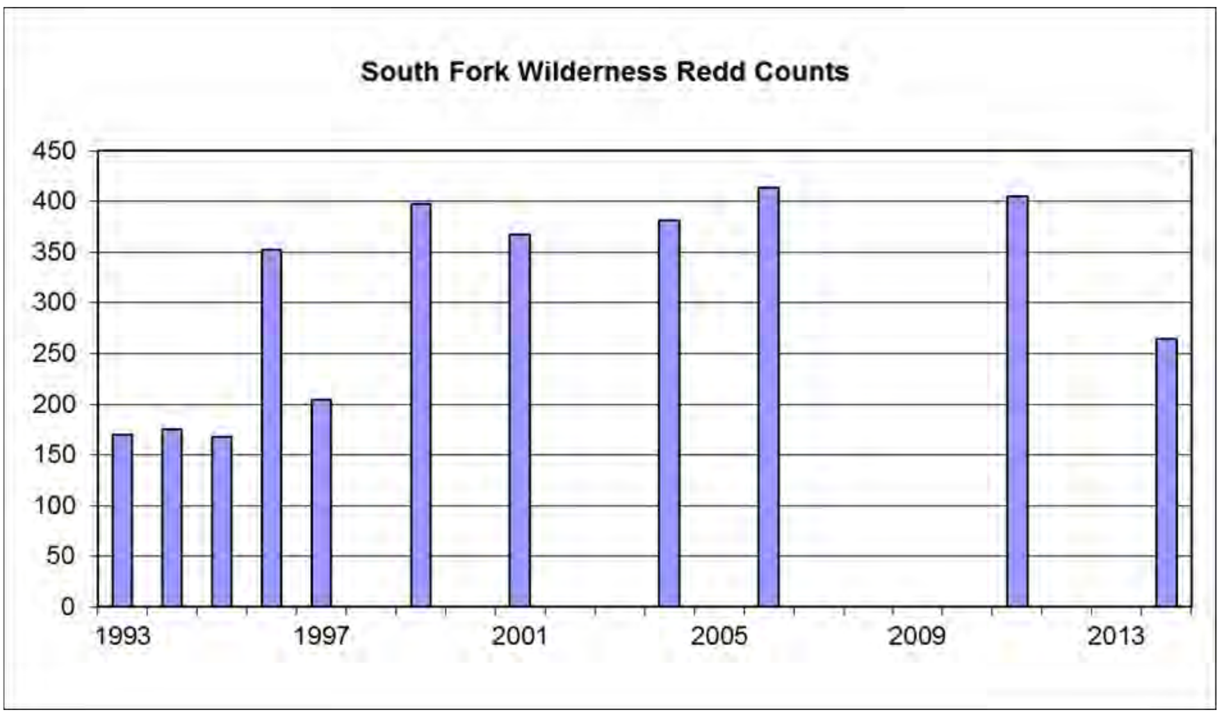

Figure 6. Bull trout redd counts in the South Fork of the Flathead River within the Bob Marshall Wilderness, 1993-2014.

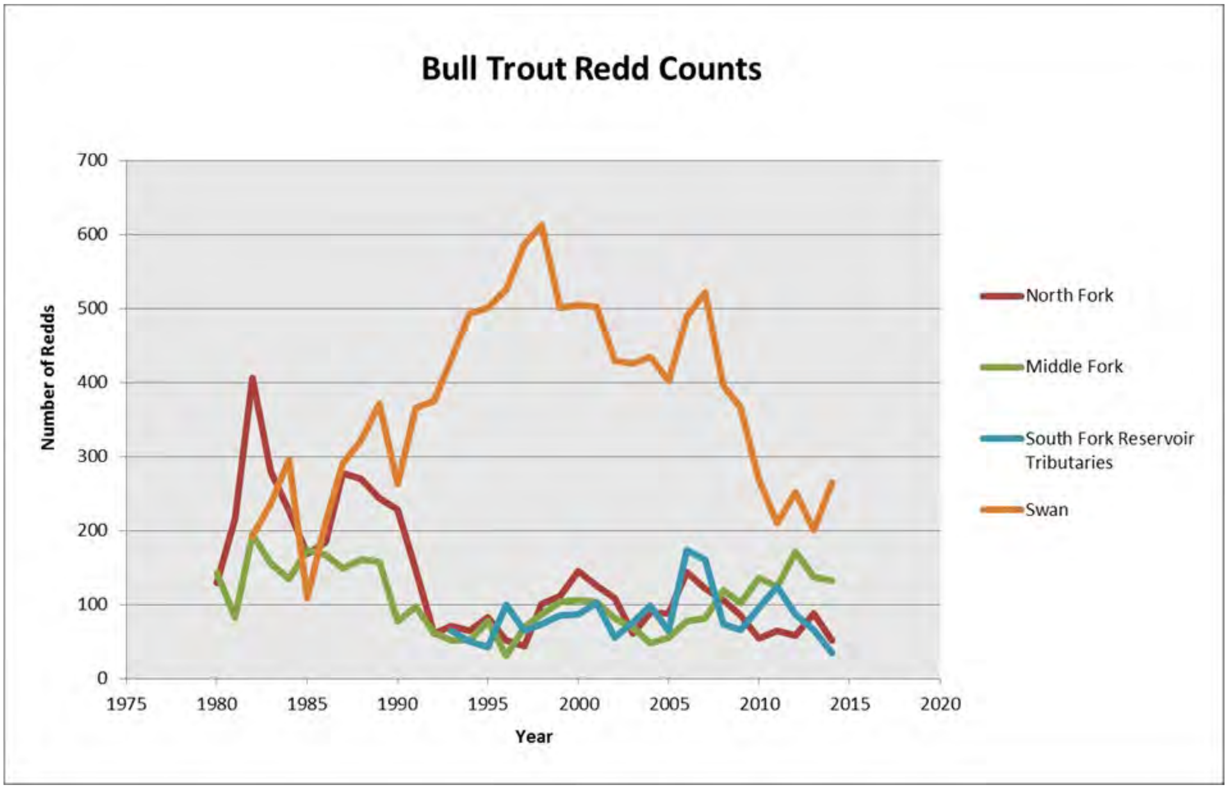

Figure 7. Bull trout redd counts within four main river basins on the Flathead, 1980-2015.

Middle and North Forks of the Flathead River

The Flathead River drainage supports one of the largest migratory bull trout populations in the United States. This population spawns in the tributaries of the North Fork and the Middle Fork of the Flathead River. Historically, prior to the construction of Hungry Horse Dam and Reservoir, Flathead Lake bull trout had access to all three forks of the Flathead River (North, South, and Middle), and bull trout were widely distributed throughout the drainage. The South Fork population is disconnected from the Flathead Lake population of bull trout and has been since the construction of Hungry Horse Dam over 60 years ago. The Middle and North Fork populations are considered one metapopulation since these fish depend on Flathead Lake for a major part of their life cycle. Juvenile fish rear in the tributaries of the Middle and North Fork for one to three years before migrating back to Flathead Lake (Fraley & Shepard, 1989).

The Middle Fork of the Flathead River originates in the Great Bear Wilderness at the confluence of Bowl and Strawberry Creeks. It flows for 47 miles to Bear Creek along U.S. Highway 2, where it forms the southern boundary of Glacier National Park. It then flows for 54 miles to its confluence with the North Fork. Nineteen streams in the Middle Fork subbasin are known to support bull trout, including five in Glacier National Park.

At present, the predominant life history form of bull trout in the Middle Fork system is the lacustrine-adfluvial. No resident populations are known to exist, and there are no indications that fluvial populations are present. Adfluvial fish reach sexual maturity in Flathead Lake at about age 6 and migrate upriver beginning in April. They reach the North and Middle Forks in June and July and enter tributaries in August, with spawning commencing in late September and October when water temperatures drop to 9-10 °C (Fraley & Shepard, 1989). Incubation of eggs to emergence of swim-up fry lasts about 200 days with emergence occurring in April. Juvenile bull trout rear for two to three years in the streams until they migrate downstream to Flathead Lake.

Unlike the South Fork bull trout population, recent monitoring data indicates declining numbers of spawning bull trout in the Middle Fork and North Fork river systems, with bull trout numbers down significantly. Redd counts in the Middle and North Forks of the Flathead River from 1980 to 2015 are displayed in figure 3, Figure 4, and figure 7. They indicate substantial declines during the past 30 years. This has caused concern about the status of these Flathead Lake migratory bull trout. The mechanisms for the decline in the Flathead Lake migratory population are not completely understood. However, the decline coincided with the introduction and subsequent population increase in mysis shrimp in Flathead Lake, which is in turn related to the recent change in the composition of the fish community in Flathead Lake. Lake trout and lake whitefish now dominate the fish community and may be responsible for the decline in bull trout as well as other species. These changes in the Flathead Lake and Flathead River system are considered the primary threat to bull trout in the entire drainage system (USFWS, 2015a). Lake trout and bull trout competition has been documented elsewhere. Donald and Alger (1993) looked at 34 lakes in the distributional overlap of the species and found that in 28 cases, only one species was present. In the lakes where they were sympatric, lake trout were the dominant species, and three case histories were documented where lake trout completely displaced bull trout.

A secondary threat is the high incidental catch of bull trout and the strong fisheries management emphasis on introduced species as well as the catch from gillnetting of lake trout (MBTSG, 1995a; USFWS, 2015a). Forestry issues are also considered important in the managed portions of the Middle and North subbasins.

A panel of fishery experts concluded that if bull trout are to return to the levels of the 1980s, then lake trout have to be reduced by 70 to 90 percent from current levels (McIntyre, 1998). Ten of the 12 panel members gave a 60 to 80 percent probability that lake trout can be reduced to achieve bull trout recovery goals. The panel further concluded that introduced species are causing a decline of bull trout and cutthroat trout in Flathead Lake. This conclusion is bolstered by the fact that bull trout populations remain healthy in Hungry Horse Reservoir, which has no lake trout. It should also be noted that outside of the isolated South Fork subbasin, bull trout in the Flathead system have declined equally in wilderness and managed streams. These declining trends in both managed and wilderness streams may indicate that habitat degradation may not be the primary factor in bull trout population declines in the Middle and North Fork subbasins.

Bull trout numbers in Flathead Lake have been estimated based upon redd counts. In 1982, the highest bull trout redd count year, the population of adult bull trout in Flathead Lake was estimated at about 13,000. The lowest redd count year was 1996, when adult bull trout were estimated at 916 fish (T. Weaver, 1998). It is important to note that these are gross estimates based on complex assumptions, but these numbers do provide an indication of how much has been lost.

Core areas in the Middle Fork include the Nyack, Park, Ole, Bear, Long, Granite, Morrison, Schafer, Clack, Strawberry, and Bowl Creek drainages. Nyack, Park, and Ole Creeks are within Glacier National Park. Core areas in the North Fork include the Trail, Whale, Red Meadow, Coal, and Big Creek drainages. These core areas are identical to bull trout critical habitat as designated by the USFWS. Climate change models (Isaak et al., 2015) may be a useful tool to determine where cold water might persist into the future, thus identifying important watersheds to protect as part of a conservation watershed network.

Flathead bull trout spawning site inventories from 1980-2015 in index stream sections are monitored annually. Identical sections of these eight index streams are counted annually and represent a known portion (about 45 percent) of the total bull trout spawning in the drainage. This indicates that index counts capture basinwide trends, although there is some shifting between individual streams.

Westslope cutthroat trout that are migratory have also been affected by lake trout predation in Flathead Lake, but resident populations remain strong.

Swan subpopulation

Until the last decade, the Swan River drainage provided habitat for one of the strongest collections of local migratory bull trout populations remaining in the State of Montana (MBTSG, 1996). At least 23 tributaries support some level of juvenile bull trout rearing (Leathe & Enk, 1985). Bull trout spawning occurs in at least 10 tributary drainages. Critical habitat and core areas include Elk Creek, Cold Creek, Jim Creek, Piper Creek, Lion Creek, Goat Creek, Woodward Creek, Soup Creek, and Lost Creek as well as Swan Lake, Holland Lake, and Lindbergh Lake. Major spawning and rearing areas in the Swan River drainage are highly groundwater influenced, which reduces the risk of impact from drought conditions. The Swan subpopulation of bull trout is thought to consist of primarily adfluvial fish that mature in Swan Lake, located at the northern end of the Swan Valley. The recent invasion of lake trout into Swan Lake threatens the long-term viability of this population. Efforts are underway to remove lake trout from Swan Lake (this is discussed below).

Swan Valley has historically been home to one of Montana's strongest bull trout populations. However, in 1998 anglers began to occasionally catch adult-sized (20-30-inch) lake trout from Swan Lake and the Swan River. In 2003, the level of concern was compounded when biologists gillnetted juvenile lake trout from Swan Lake, indicating that wild reproduction was occurring. Since 2003, the lake trout catch by anglers as well as during MFWP biological sampling continued to increase, another indication that the population was expanding. Research efforts between 2006 and 2008 focused on lake trout population demographics and the exploration of potential techniques to reduce lake trout numbers while minimizing bull trout bycatch. Based on case histories from nearby waters, managers determined that developing long-term management actions to control this increasing lake trout population was necessary in order to maintain the popular bull trout and kokanee fisheries.

In 2009, MFWP released an environmental assessment for a three-year experimental removal of lake trout in Swan Lake. In 2009-2011, over 20,000 lake trout were removed from Swan Lake. Modeled total annual mortality rates for lake trout year classes vulnerable to the nets (age classes 3, 4, and 5) were higher than literature suggests are sustainable (50 percent). Montana Fish, Wildlife and Parks released another environmental assessment in May 2012 for a five-year extension of the project to further evaluate the long-term effectiveness of the current lake trout suppression effort relative to measurable goals and specific success criteria outlined in the original 2009 environmental assessment. From 2012 to 2014, about 25,000 lake trout were removed under the suppression program (Rosenthal, Fredenberg, & Steed, 2015). The Forest has been supportive of the netting effort.

Bull trout redd counts in the Swan River drainage over about the past 30 years are displayed in figure 5 and figure 7 and indicate a steep decline starting about 10 years ago. However, bull trout redd counts (i.e., spawning beds) in the Swan River drainage in 2014 were higher than in 2013, and juvenile abundance surveys conducted in select streams indicated that the juvenile numbers were remaining at least stable.

Westslope cutthroat trout populations remain strong in some tributary streams but have been replaced by brook trout and have hybridized with rainbow trout in other streams.

South Fork of the Flathead River

The South Fork of the Flathead River originates at the confluence of Danaher and Youngs Creeks in the Bob Marshall Wilderness area and flows north 57 miles into Hungry Horse Reservoir. The South Fork drains a 1,663-square-mile area with an average annual discharge of 3,522 cubic feet per second. Bull trout are native to the South Fork of the Flathead River drainage and are distributed throughout the

Flathead River Basin. Prior to human intervention, migratory bull trout that spawned and reared in the South Fork occupied Flathead Lake as adults. Anecdotal information indicates that large adult bull trout were seasonally common in the South Fork and several of its tributaries (MBTSG, 1995b). Construction of Hungry Horse Dam in 1952-1953 blocked access to the entire South Fork drainage. This cut off about 38 percent of the spawning and rearing area once available to the Flathead bull trout population (Zubik & Fraley, 1987). Water stored in Hungry Horse Reservoir is used for power production, irrigation, recreation, flood control, and augmentation of downstream flows for salmon passage on the Columbia River.

The construction of Hungry Horse Dam in 1952 isolated the South Fork population of bull trout from the rest of the Flathead River system. The Montana Bull Trout Scientific Group (MBTSG, 1995b) reported that the South Fork of the Flathead drainage upstream from Hungry Horse Dam is the “most intact native fish ecosystem remaining in western Montana.” Currently, subadult bull trout in Hungry Horse Reservoir or in the main stem of the South Fork above the reservoir reside there for several years prior to maturity and then migrate into tributaries to spawn. The majority of the spawning and rearing habitats of the South Fork bull trout population are located in the backcountry areas, most of which is in the Bob Marshall Wilderness. Juvenile bull trout rear from one to four years before moving downstream to the main stem or to the reservoir. In 1993, MFWP surveyed tributaries suspected of bull trout spawning and found a total of 366 redds in the South Fork drainage (MBTSG, 1995b). Of these redds, 64 were in non-wilderness areas and 302 in wilderness areas. No spawning was observed in 21 of the 36 streams surveyed (T. M. Weaver & Fraley, 1993).

Eight of the streams that were surveyed in 1993 were selected as index streams for monitoring adult bull trout abundance. According to the 1993 and 1994 spawning site inventories, the total population of bull trout in Hungry Horse Reservoir was estimated at 2,932 and 3,194 respectively (T. Weaver, 1998; T. M. Weaver & Fraley, 1993). The Montana Bull Trout Scientific Group (1995b) reported that the South Fork bull trout population trend is stable based on available data. However, they cautioned that data are limited and more long-term information is needed for a full assessment. Monitoring redd counts over the last 20 years supports the premise that the bull trout population is stable (figure 6 and figure 7). Additionally, Weaver (1998) reported that sinking gill net sets in the fall in Hungry Horse Reservoir indicated that catches appeared to be some of the highest on record during the 38-year period since gill netting began. This data also suggests a relatively stable population. This is significantly different than for the rest of the Flathead River Basin subpopulations. For example, the current status of Flathead River subpopulations of migratory bull trout in the Middle Fork and North Fork of the Flathead River is depressed, and the trend is declining.

Two known disjunct populations of bull trout occur in the South Fork of the Flathead River drainage. Big Salmon Lake supports a migratory bull trout population that uses 5.5 miles of Big Salmon Creek upstream of the lake to a barrier falls for spawning and rearing. Doctor Lake also supports a bull trout population. Little is known about this population, but it is suspected to spawn and rear in a short reach of Doctor Creek upstream of Doctor Lake (MBTSG, 1995b).

Core areas are drainages that currently contain the strongest remaining populations of bull trout and are recommended as highest priority for conservation and protection because they will be the primary source of fish for recolonization (B. Rieman & McIntyre, 1993). They are usually relatively undisturbed (MBTSG, 1995b). Core areas and critical habitat in the South Fork include some of the tributaries flowing directly into Hungry Horse Reservoir. These include the entire drainages of Wounded Buck, Wheeler, and Sullivan Creeks. Also included as core areas are tributaries to the South Fork upstream of the reservoir (Spotted Bear River, Bunker Creek, Little Salmon Creek, White River, Gordon Creek, Youngs Creek, and Danaher Creek) and the South Fork itself above Gordon Creek. Foraging, migration,

and overwintering habitats are waters that provide migratory corridors, overwintering areas, or other areas that are otherwise essential to bull trout at some point in their life history. Foraging, migration, and overwintering habitat for the South Fork population is provided by the main stem South Fork of the Flathead River downstream from Gordon Creek, including Hungry Horse Reservoir (MBTSG, 1995b). The Montana Bull Trout Scientific Group (1995b) reported that the main single threat to the long-term survival of bull trout inhabiting the South Fork of the Flathead River is illegal introductions, and the level of threat varies depending on the species introduced. Other threats are tied largely to forestry practices in the non-wilderness portion of the watershed and the manipulations of the water level of Hungry Horse Reservoir. Illegal harvest during fall spawning in the backcountry areas (e.g., fall hunting in the Bob Marshall) was also identified as a problem in the drainage.

The South Fork of the Flathead River drainage upstream of Hungry Horse Dam is considered the most intact native fish ecosystem remaining in western Montana (MBTSG, 1995b). The 52 years of isolation of the South Fork of the Flathead River bull trout population and the wilderness habitat component has contributed to its relatively healthy population. There still remains uncertainty as to what factors will be needed to maintain a healthy population in the future, however.

The Montana Bull Trout Scientific Group (1995b) has suggested that an appropriate conservation goal is to maintain the status quo. It is believed that by protecting and maintaining the existing native species complex through natural production, maintaining the current genetic structure and diversity, and ensuring operation of Hungry Horse Dam does not exceed the desired minimum pool level, the conservation goal to meet bull trout life history requirements in the South Fork of the Flathead River will be met.

Westslope cutthroat populations in the South Fork of the Flathead River are arguably the strongest within their range (Bradley B. Shepard et al., 2005), given that there are no non-native fish except for grayling in Handkerchief Lake and that the area is primarily wilderness.

Non-native fish

The Draft Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (USFWS, 2015a) documents primary threats to bull trout. The greatest threats throughout the Flathead are non-native species interactions, primarily lake trout. It is important to note that habitat condition is not listed as a primary threat in any of the Flathead core areas except for Upper Whitefish Lake, which is primarily within the Stillwater State Forest managed by Montana Department of Natural Resources and Conservation. PIBO monitoring data for bull trout watersheds indicates that habitat conditions are closer to expected in unmanaged sites than in other parts of the Forest where bull trout do not occur. Overall ranking averages are good, but bank angle balances the average and is suspect. Sediment indicators have some degradation but are trending in a positive direction. Declines in bull trout populations are largely associated with non-native species interactions.

The primary threats in the Swan and Flathead Lake core areas, as identified in the Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (USFWS, 2015a), are as follows:

> **Nonnative fishes:** Lake trout represent the single largest primary threat to bull trout, overwhelming the FMO [foraging, migrating, and overwintering habitat] habitat in Swan Lake. Lake trout invasion and expansion in the past 20 years, coupled with a robust *Mysis* population from a 1970s introduction, has compromised bull trout survival (predation) and introduced competition for a limited prey base (primarily kokanee) available to piscivores.
>
> Brook trout have been present in most SR [spawning and rearing habitat] tributaries for a half century or longer, with no documented recent change in status, but in some important SR tributaries (e.g., Lion, Goat) resulting in high documented rates of hybridization. Hybrids are

> abundant throughout SR and FMO (observed hybrids to 8-10 lbs in Swan Lake), further reducing potential bull trout recruitment. (pp. D-22-D-23)
>
> In the 1980's, the nonnative lake trout expanded in the Flathead Lake and mainstem Flathead River FMO habitat, triggered by the accidental Mysis introduction (now estimated 1+ million lake trout population). Concurrently, the complete collapse of the formerly abundant kokanee forage base for lake trout likely lead to substantial increase in predation of bull trout and competition for other foods. This combination of effects likely caused the subsequent rapid decline in bull trout, demonstrated by a 75 percent decline in redd counts from the 1980s levels. Partial recovery of bull trout occurred in the 2000's (to approx. one-half 1980's levels) but gains have stagnated and are fluctuating below conservation objectives. Nonnative lake trout predation and competition remains a substantial threat to bull trout in this system.
>
> Predation from nonnative northern pike populations in the mainstem Flathead River is a documented threat.
>
> **Fisheries Management:** Loss of bull trout from angling bycatch mortality (combined Flathead Lake and River system) and occasional poaching contributes to the low populations in this system. Low population size (single digit redd counts) are a concern in some SR tributaries, especially in recent years in the North Fork of the Flathead SR streams.
>
> Sampling mortality of bull trout due to aggressive monitoring in SR habitat (e.g., North Fork of the Flathead) and gillnetting for lake trout suppression in Flathead Lake may directly impact potential recruitment and reduce local populations. (pp. D-18-D-19)

Flathead Lake bull trout have also declined due to negative interactions with lake trout. The Confederated Salish and Kootenai Tribes began a netting program in 2014 to reduce lake trout with the long-term goal of reducing the population of age eight and older lake trout by 75 percent. Modeling results show that suppressing lake trout can result in an increase in bull trout (CSKT & Hansen, 2015). In 2014, about 8,000 lake trout were netted and another 68,000 were harvested through general angling and the Mack Days tournament (CSKT & Hansen, 2015).

Hybridization of westslope cutthroat trout with non-native rainbow trout is increasing in the Flathead River drainage (Boyer, Muhlfeld, & Allendorf, 2008; Muhlfeld et al., 2014). Hybridization reduces reproductive success of westslope cutthroat trout and can lead to a loss of the species and genetic material (Muhlfeld, Kalinowski, et al., 2009; Young et al., 2016). Several efforts are ongoing to reduce hybridization. Trapping on the Forest of rainbow trout in select Flathead tributary streams, i.e., Abbott Creek and Rabe Creek, is designed to prevent the spread of hybridization up the river into the North and Middle Forks of the Flathead. The project to remove hybrids from high mountain lakes within the South Fork since 2006 is nearing completion, which will secure a large stronghold for the species without threats from non-native brook trout and rainbow trout (BPA, 2005). Kovach et al. (2015) demonstrated that dispersal of hybrid individuals from downstream source populations is a significant factor and probably the primary mechanism contributing to the spread of hybridization between cutthroat and rainbow trout. Temperature may play a key role in reducing hybridization between the two species, with westslope cutthroat trout favoring colder water, and thus climate change is a concern for the long term. The distribution and colonizing success of rainbow trout is positively correlated with temperature in areas where westslope cutthroat trout are native (Muhlfeld, Kalinowski, et al., 2009; Muhlfeld, McMahon, Boyer, & Gresswell, 2009). Brook trout tolerate increased sediment levels (Bradley B. Shepard et al., 2005; Bruce B. Shepard, Taper, White, & Ireland, 1998) better than cutthroat trout. Thus, the negative effects of non-native fish on native species can be expected to amplify with increases in other system stressors.

Aquatic invasive species

Non-native invasive species are a serious threat to all aquatic habitats in the United States. The severity of this threat is difficult to assess or predict in this plan area or in any other specific locality. Zebra and quagga mussels are a serious threat to water quality and aquatic life forms. Fortunately, these mussels have not been found in the Flathead Valley, but Eurasian milfoil has been documented just off the Forest in Beaver Lake outside of Whitefish. Mandatory check stations for all watercraft have been established throughout Montana to prevent the spread of invasive species. Since dreissenid mussels were discovered in the upper Missouri River Basin in the fall of 2016, the State of Montana has increased the number of mandatory check stations during high-use months to deter the spread of these species.

When a new aquatic invasive species occurs in a locality, research and observations are necessary before reliable inferences can be made regarding spread patterns, specific effects, and potential containment strategies. A baseline often is lacking to predict how an invasive species from another region or continent will respond when introduced into a new environment. Since a local environment contains a unique assemblage of thousands of interconnected components and processes, the results in one area can vary slightly or significantly from previously infected areas.

If an aquatic invasive species becomes established, elimination may be nearly impossible and efforts to contain it can be very difficult, time consuming, and expensive. Thus, prevention of invasions is of paramount importance in land and natural resource management. This involves recognizing the vectors for infection and spread and implementing safeguards, or resource protection measures, to minimize and prevent the transmission of invasive organisms through these pathways. An example of a transmission vector would be pumps and other fire equipment that come into contact with water. This equipment is increasingly used and transported globally between projects. Microbes, spores, planktonic larval and adult stages of species, and plant materials can easily be spread on this and other equipment. Requiring effective sanitation and inspection measures would be appropriate resource protection measures.

3.2.5 Riparian areas and wetlands affected environment

In general terms, riparian areas are lands at the interface between land and a river or stream and wetlands are lands that are saturated with water all year or for varying periods of time during the year. Both encompass unique and diverse vegetation types that are closely associated with lakes, streams, ponds, marshes, swamps, bogs, fens, and other areas of high or fluctuating water tables. Although they may occupy a small percentage of the landscape, riparian areas provide important habitat for many terrestrial and aquatic species, including connectivity of habitat from headwaters to downstream areas.

The composition of the vegetation and structure and the pattern of the riparian areas and wetlands across the Forest are highly diverse. Plant communities may be dominated by shrubs with few trees, or they may be forested. Riparian vegetation may be dominated by hardwood trees, particularly black cottonwood and paper birch or coniferous species. Spruce and subalpine fir are most common, with grand fir and western red cedar on the warmer sites. Other species, such as Douglas-fir and western larch, are also present in many riparian areas. Shrubs include alder, willow, red-osier dogwood, elderberry, buckthorn, thimbleberry, twinberry, and hawthorn. Forbs and grass-like plants that occupy these sites are quite diverse. The vegetative structure may include many decayed and dead trees and multiple layers of vegetation that include submerged vegetation along open water margins, as well as plants that grow in conditions with variable amounts of soil saturation. The pattern of riparian and wetland ecosystems varies from relatively narrow strips of land along perennial and intermittent streams in deeply incised, steep mountain valleys to marshes and adjacent wetlands within the wide valleys of the major river bottoms. They may be interconnected in a linear fashion down hillsides and in valleys, they may occur in clusters,

or they may occur as isolated microsites in other ecosystems. They are widely distributed across the Forest, occurring at all elevations.

Riparian ecosystems are equally important habitat to wildlife for feeding, drinking, cover, breeding season habitats, and habitat connectivity. They are often rich in bear foods such as skunk cabbage and other herbaceous plants with nutritious bulbs. Many wildlife species are associated with riparian ecological systems, including the Canada lynx, grizzly bear, common loon, and fisher. Rocky sites behind waterfalls provide key breeding habitat for black swifts. A federally listed threatened plant, *Howellia aquatilus*, has been found in only one type of riparian pothole or wooded vernal pool in Montana, and it occurs on the Forest.

Riparian management zones

Riparian management zones (and riparian habitat conservation areas in alternative A) are areas where riparian-dependent resources receive primary emphasis and management activities are subject to specific standards and guidelines. These areas consist of riparian and upland vegetation adjacent to streams, wetlands, and other bodies of water and help maintain the integrity of aquatic ecosystems by (1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality (Robert J. Naiman et al., 1992). Fish and other aquatic life benefit greatly from riparian area protection due to these functions.

Upland vegetation within riparian management zones in combination with the riparian vegetation create zones that provide important wildlife habitat and connectivity values. Most wildlife use riparian management zones and/or aquatic habitats for at least some of their daily or seasonal needs. Due to their widespread distribution and linear or clustered pattern, riparian management zones provide extensive and important habitat connectivity areas for numerous species of wildlife. Refer to section 3.7 for information on riparian-associated wildlife species and connectivity of habitat.

During the past few decades, land managers have recognized the importance of riparian ecosystems in maintaining water quality, terrestrial habitat, and aquatic habitat. As a result, riparian conservation measures have been developed for Federal, State, and private lands—helping to preserve and protect the integrity of the riparian and wetland habitats as well as the water quality of associated waterbodies. On NFS lands, site-specific standards and guidelines are applied to riparian management zones, helping to provide connectivity and maintain composition, structure, and function.

Natural disturbance processes

This section summarizes the natural role and general effect of fire within riparian areas and terrestrial forests adjacent to water features to provide context for the discussion of effects to aquatic resources due to fire. For more detailed information on fire regimes, fire history, and natural range of variation of fire, see the assessment (USDA, 2014a), sections 3.3.1 and 3.8.2 of this final EIS, and Trechsel (2017f). Also refer to appendix 3, which provides a discussion and analysis of natural range of variation and projected conditions of early-successional habitat (shrubs/deciduous tree habitat) within riparian management zones in the context of wildlife-associated with riparian areas.

In the ecosystems of the Flathead, primary natural disturbances that affect riparian areas include flooding, fire, insects, disease, and weather events (i.e., windstorms). These disturbances are an integral part of the creation, maintenance, and renewal of forests. Periodic flooding in wide, low-gradient drainages (such as the Swan River) maintains a diverse mosaic composed of vegetation patches of varying compositions and structures, interspersed with sloughs and wetlands. Flooding is much less of a factor in moderate- or

steep-gradient streams or for wetlands farther removed from rivers and streams. Fire and other disturbances play a larger role.

Fire effects vary according to fire intensity, severity (defined in terms of mortality to trees), and frequency, the primary factors that define fire regimes. About 90 percent of the Flathead is characterized by a mixed- to high-severity (stand-replacement) fire regime (see the assessment). The most common fire regime (approximately 53 percent of the Forest) features high-severity fire, where greater than 75 percent of the trees are killed across both small (e.g., less than 100 acres) and very large (e.g., tens of thousands of acres) areas. About 37 percent of the Forest is characterized by a mixed-severity fire regime, which creates more complex burn patterns. In a mixed-severity fire, less than 75 percent of the trees are killed within the total fire area, with portions of the area burning at high severity, portions at moderate severity, and portions at low severity, and some portions remaining unburned. For both fire regimes, fire frequency is every 35 to 100 or more years.

Fire has shaped the vegetation conditions across the Flathead National Forest for millennia, influencing forest ages, structure, plant species composition, productivity, carbon storage, water yield, nutrient retention, and wildlife habitat across all areas of the Forest, including riparian areas. Under the natural fire regimes, whether fire did or did not burn into riparian areas or whether they burned at low, moderate, or high severity was influenced by a combination of factors, including weather (i.e., wind speed and direction), fuels/vegetation conditions (i.e., moisture level, downed wood, forest densities, and tree species), terrain (i.e., steepness, which may affect the spread of fire), climatic conditions (i.e., drought period), and just plain chance.

Very large areas of the Forest burning in high-severity fire events were a relatively infrequent occurrence historically (i.e., 100-year intervals or longer) and were typically associated with extended dry climatic periods. These types of fires would often burn at high or moderate severity through riparian areas as well, especially in the steep, deeply incised stream channels typical across much of the Forest landscape. In this terrain, fires can move up the drainage very rapidly due to upslope winds and a chimney-like effect that preheats fuels and winds. The moist conditions within riparian areas also tends to support more dense forest and vegetation conditions which provide abundant fuels. High severity fires would convert large areas of forest within riparian areas to an early-successional stage dominated by grasses, forbs, shrubs and seedling trees. Moderate severity fires would also burn through riparian areas, creating a more diverse pattern of forest conditions that included early successional openings of various sizes where tree mortality was high.

In more normal or wet climatic periods, under a natural fire regime the fires tended to be smaller in size and of more mixed severity (low, moderate and high severity within a fire area). Within riparian areas where more moist vegetation types occurred, the fires tended to either not burn, burn in smaller patches, or to burn at lower and moderate severity. Thus, during these climatic periods, more of the existing forest in the riparian areas would tend to remain intact across the landscape, with mostly small to medium sized patches of early successional forest, but occasional large patches (e.g., 100 acres or more), in areas where there had been recent fire. The early successional forest openings are dominated by grass, forb, shrubs, and young trees, including hardwoods.

Although openings created by fires might be large and extend to the edges of streams or wetlands, in the relatively moist sites of riparian areas on the Flathead they typically revegetate rapidly. There is often a higher diversity and density of plants in riparian areas in this early-successional stage compared to upland terrestrial sites, and this includes hardwood trees (such as aspen, birch, and cottonwood) that benefit from the open forest conditions. There are various wildlife species that utilize the diversity of habitats within riparian zones, including the early successional forest openings. Refer to section 3.7.4, subsection

“Aquatic, wetland, and riparian habitats,” for information on wildlife associated with riparian areas and a summary of the natural range of variation for early successional openings in riparian management zones.

Other natural disturbances that historically influenced the forests within riparian areas are insects, disease, and weather events such as windstorms and blowdown. These effects cause varying amounts and extents of tree mortality, from nearly all trees killed (such as in a mountain pine beetle epidemic in a lodgepole pine-dominated stand) to only scattered trees killed. As with fire, forest structure is affected, including changes to and decreases in forest density and canopy closure and increased amounts of dead wood. Reduced canopy closure may stimulate growth of understory grasses, forbs, and shrubs as well as improve growth on remaining live trees. Tree species compositions may change.

3.2.6 Environmental consequences introduction

The effects of the proposed action and alternatives on resources associated with the aquatic environment are discussed in this section, which is divided into five separate sections: soils, watersheds (water quality), aquatic species, riparian areas, and wetlands. These resources are all closely related, and there are considerable connections in terms of the effects of proposed management. For example, increases in roads could lead to increases in sediment reaching a stream, which could lead to a reduction in water quality that, if high enough, could lead to the stream’s listing as an impaired waterbody under the Clean Water Act. That same sediment, if high enough, could smother fish eggs in the gravel and lead to a reduction in local fish populations. The soil resource is connected to these features as the primary medium for regulating the movement and storage of energy and water, with the physical, chemical, and biological properties of soils affecting hydrologic response and site stability. Soil is also closely connected to terrestrial ecosystems, and those aspects are discussed in this section where appropriate.

Summary of best available science—Riparian areas

In order to provide context for the discussion of effects for each aquatics resource area in this section, a summary of the latest and best available science related primarily to conditions and management within riparian areas is provided below.

Background

In response to studies in the 1960s and 1970s that documented the harmful effects of timber harvest methods and road building on streams, States and Federal agencies began passing a series of management requirements for activities on State and Federal lands near streams. These are referred to as “best management practices.” Everest and Reeves (2007) disclosed the following regarding the development of best management practices for the Pacific Northwest: “The [best management practices] were developed through the normative process that weighed, evaluated, and incorporated many types of information. The best available scientific information for protection of riparian and aquatic habitats was not always incorporated into forest practice rules” (p. 77). This cycle of not including best available science was repeated several times over the decades, even as successive monitoring efforts continued to document degraded stream conditions (Reeves et al., in press).

A crisis point was reached in the early 1990s in the western United States when several stocks of salmon and trout were reaching critically low numbers (Nehlsen et al., 1991) and ultimately were listed as threatened or endangered under the Endangered Species Act. By the mid-1990s, the Forest Service and Bureau of Land Management had completed three broad-reaching documents (all three hereafter referred to collectively as “the strategies”) that amended forest plans across much of the public lands in the West to improve their conservation function. The Northwest Forest Plan (USDA, 1994) and PACFISH (USDA, 1995a) addressed the protection of migratory salmon and steelhead; these do not apply to the Flathead National Forest. INFISH (USDA, 1995b) addressed inland native fish from eastern Oregon and

Washington across western Montana, including the Forest. These strategies departed significantly from past management philosophy and established more stringent requirements in order to protect species' habitat. One feature of the new strategies was the extension of the distance from the stream to riparian management zones (i.e., riparian reserves in the Northwest Forest Plan and riparian habitat conservation areas in PACFISH/INFISH) compared to previous direction in order to better protect ecological processes next to streams. Also, the precautionary principle was invoked. Reeves et al. (in press, p. 5) described this principle as, "Forest managers who wanted to alter the comprehensive default prescriptions for riparian management under the NWFP [Northwest Forest Plan] in order to pursue other management goals were required to demonstrate through watershed analysis that changes would not compromise established riparian-management goals." Not only did the burden of proof shift, but these new strategies also required managers to consider ecological processes at the watershed scale. The components used in the Northwest Forest Plan, including the concept of the precautionary principle, were included in PACFISH and INFISH.

Riparian management has remained controversial, in part because of competing values and uses (P. Lee, Smyth, & Boutin, 2004). Strategies employed by the Northwest Forest Plan, PACFISH, and INFISH appear to have been successful at halting the loss of old growth due to timber harvest within riparian areas and at preventing damage to aquatic systems in the Pacific Northwest (J. W. Thomas et al., 2006) and the intermountain region. However, some suggest a protection mindset emerged that has prevented management within riparian areas that would be desirable to sustain and/or promote ecological processes beneficial to aquatic or terrestrial ecosystems (Liquori, Martin, Coats, Benda, & Ganz, 2008; D. Ryan & Calhoun, 2010; J. W. Thomas et al., 2006). Speaking of the need to restore ecological conditions and make good on social, economic, and ecological commitments in the Northwest Forest Plan, Thomas et al. (2006) wrote, "Minimization of short-term risks (the modus operandi of regulatory agencies and the federal courts) has a price tag, and a very big one, related to significantly increased longer-term risks of failure to meet objectives over very long time frames. Unless the federal agencies consider the peril of inaction equal to the peril of action, the goals of the NWFP [Northwest Forest Plan] will not be reached" (p. 286). Richardson, Naiman, and Bisson (2012) wrote: "In an increasingly complicated management arena, the challenge will be to find alternatives to fixed width buffers that meet the multiple objectives of providing clean water (minimizing nutrient and sediment inputs), aquatic habitat, habitat for riparian species, connectivity across landscapes, and related responses" (p. 236).

Riparian zones and ecological functions

Regarding the widths of management areas next to streams, the interim minimum distances listed in INFISH for fish-bearing streams (300 feet) and perennial streams (150 feet) arguably remain the most controversial components of the existing strategies. Numerous studies have been completed since the strategies were first published that investigate how management affects the different ecological processes that are a function of riparian management zones. The ecological processes that function within riparian zones are first discussed individually below and then in combination, as they affect both aquatic and riparian conditions and biota.

Stream temperature

Among the more commonly studied management concerns as they relate to ecological processes near streams are the effects of nearby timber harvest on stream temperature. Initial studies completed by Chen et al. (1993) and the Forest Ecosystem Management Assessment Team (FEMAT, 1993) found that streamside buffers of approximately 125 meters were needed to protect ecological processes such as wind speed and humidity near streams, which at the time were thought to be able to increase stream temperature. This finding was partially responsible for the second tree height (which added another 150 feet on each side of the creek to riparian habitat conservation areas) applied to riparian reserve and

riparian habitat conservation area widths in the existing strategies (Everest & Reeves, 2007; Reeves et al., 2016).

A study that modeled the effects of riparian reserves on stream temperature in Washington found that the first 10 meters were the most important in protecting stream temperature and that buffers greater than 30 meters did not appreciably lower stream temperatures (Sridhar, Sansone, LaMarche, Dubin, & Lettenmaier, 2004). A study on headwater stream microclimate by Anderson et al. (2007) found that the first 10 meters had the most effect on microclimate above the stream and that temperatures in the streambed increased only when streamside vegetation closer than 50 feet to the edge of the stream was removed (Paul D. Anderson & Poage, 2014). A review of studies by Moore et al. (R. D. Moore, Spittlehouse, & Story, 2005) suggested that a riparian reserve that was the width of one tree height was likely large enough to protect the ecological processes that control stream temperature. A subsequent study completed by Rykken et al. (2007) found that stream effects helped to offset the edge effects documented by Chen et al. (1993). Pollock et al. (2009) did not find a correlation between recent (< 20-year-old) streamside harvest 600 feet upstream of a monitoring site and increased stream temperature, but they did find a significant relationship between basins with greater than 25 percent harvest in the last 40 years and increased stream temperature. Although the increased temperature reported by Pollock et al. (2009) is significant, it is unclear whether there is a corresponding biological effect on native salmonids in the region where the studies were conducted (Reeves et al., 2016).

Recently, many researchers have suggested that a 30-meter buffer next to fish-bearing and perennial streams is generally likely to be sufficient to protect against stream temperature increase (Paul D. Anderson & Poage, 2014; Reeves et al., 2016; Sweeney & Newbold, 2014; Witt, Barton, Stringer, Kolka, & Cherry, 2016). Even so, consideration of context and geography is also appropriate. In a discussion of fixed-width riparian buffers, Richardson et al. (2012) state that although these types of protections are administratively simple to implement at a reach scale, watershed considerations and location within the catchment provide additional important context. Reeves et al. (2016) state that with the tools currently available, widths can be more easily adjusted and justified for both wider and narrower buffers.

Large wood

The fate of large wood in streams has been an important focus for aquatic scientists and managers in the western United States for decades (Richardson et al., 2012). Up until the 1980s, many managers were concerned about how wood in streams affected water quality and about how accumulations of wood in streams could sometimes block fish migration. These concerns led to instream wood removal programs (Mellina & Hinch, 2009). By the 1980s, scientists more fully recognized wood’s role in channel formation and maintenance (FEMAT, 1993). As with stream temperature, the precautionary principle applied by the strategies to riparian reserves and riparian habitat conservation areas also ensured that the interim widths were set wide enough to encompass any trees that could be delivered to streams, especially the two-tree width for fish-bearing streams (Everest & Reeves, 2007).

Regarding the riparian width needed to ensure streamside wood delivery to streams, debate and scientific inquiry has continued since the strategies were adopted. Studies have been completed to help identify where wood in streams comes from (L. Benda et al., 2003; Reeves, Burnett, & McGarry, 2003) and the fate of wood once it is delivered above or to the stream (T. J. Beechie, Pess, Kennard, Bilby, & Bolton, 2000). In addition to streamside delivery, disturbance combined with topography can deliver a significant percentage from outside riparian management zones, especially steeper watersheds that are more dissected. Models have also been developed to help identify the likelihood of riparian trees being delivered to the stream channel (Lee Benda, Miller, Bigelow, & Andras, 2003; Meleason, Gregory, & Bolte, 2003; Pollock, Beechie, & Imaki, 2012; T. Spies, Pollock, Reeves, & Beechie, 2013; Welty et al., 2002). Models focused on wood delivery from the riparian areas consider distance from the stream,

median tree height, and the direction that trees fall. Benda et al. (2016) also discuss how to implement tree tipping (manually falling trees into a stream) to balance the effects of thinning dense second-growth stands to accelerate large wood development. Modeling completed by Meleason et al. (2003) found that > 90 percent of wood was contributed from within 30 meters of the stream edge for modeled conifer riparian stands in western Oregon and Washington. In a literature review, Spies et al. (2013) found that 95 percent of wood delivered to streams from hardwood stands came from within 82 feet, and from conifer stands from within 148 feet, in forests in the western cascades of Oregon and Washington.

Sediment and nutrients

Forest management practices such as road building and timber harvest have long been a concern regarding their potential to generate fine sediment and the subsequent effects on water quality (Beschta, 1978). Altered sediment rates have also been linked to changes in stream condition and ultimately trout and salmon survival in cold-water streams (Jensen, Steel, Fullerton, & Pess, 2009). Some activities that have led to degraded stream conditions and water quality, i.e., clearcutting next to streams and aggressive forest road building, are highly unlikely to occur today on NFS lands in the Northern Region. Reductions in sediment and nutrient delivery have resulted from sequentially improving best management practices (Everest & Reeves, 2007) and from regional strategies that have offered greater protection (USDA, 1995a). In recent decades, researchers interested in forest management and water quality have investigated the effectiveness of management policy and law (T. C. Brown, Brown, & Binkley, 1993; Cristan et al., 2016; Rashin, Clishe, Loch, & Bell, 2006). In general, more recent forest practice reviews have found very little unnatural introductions of total suspended sediments and nutrients when best management practices are properly installed before activities begin and are maintained throughout management efforts (Cristan et al., 2016; B. D. Sugden et al., 2012). Depending on the geology of the planning area, sediment introduction from roads receiving little use can be quite low (R. Al-Chokhachy et al., 2016). Increased nitrogen levels may be an exception and may still have levels outside of expected natural conditions (Gravelle, Ice, Link, & Cook, 2009). Standards and guides carried forward from existing strategies combined with conservation and improvement strategies discussed elsewhere in this document should help to continue improving trends.

Management practices that maintain suitable stream temperature, amounts of large wood, and levels of sediment and nutrients are also beneficial to aquatic and terrestrial wildlife species associated with riparian management zones (see section 3.7.4 for more details).

Riparian management zone widths

The best available science since the strategies were published has sharpened focus on aquatic/riparian interactions. One review found that buffers at least 30 meters in width are large enough to protect water quality and aquatic biota in small streams (Sweeney & Newbold, 2014). In some circumstances, such as a narrow band of riparian-dependent vegetation alongside an intermittent stream that has low wildlife connectivity, vegetation and stream characteristics could lead to a reduced width of the riparian management zone if only aquatic functions are being considered. However, the focus on riparian management zones has increased in relation to their ability to support terrestrial organisms and processes. According to Richardson et al. (2012), “Protection of riparian-associated terrestrial organisms has become an explicit conservation objective associated with protection of streams,” starting as far back as the Forest Ecosystem Management Assessment Team in the early 1990s (FEMAT, 1993).

After considering new science, Reeves et al. (2016) proposed two options to direct management in riparian management zones in the Northwest Forest Plan area. Their first option, which the authors considered a “one-size-fits-all-approach,” retains the fixed buffer width, with the inner 75 feet next to the stream managed strictly to conserve aquatic function and the outer 75 feet managed to allow ecological

forestry to meet other resource objectives, including commercial harvest. The use of the term "ecological forestry" is referring to Franklin and Johnson's paper (2012); it means that harvest retains structural and compositional elements of the pre-harvest stands, follows natural stand development principles, and applies return intervals that are consistent with disturbance regimes. In addition, all management activities and applications are informed by landscape considerations.

The second option, described as a "context-dependent approach" by Reeves et al. (in press), does not have a fixed inner width; instead, the inner width is variable and context-dependent based on characteristics of the stream reach: "susceptibility to surface erosion, debris flows, thermal loading, and habitat potential for target fish species" (p. 54). The second option allows for natural variation and will require more analysis to inform decision maker choices to benefit all resources. The context-dependent approach depends on landscape considerations that are expected to be taken into account through watershed analysis. Unlike the past, when earlier attempts at watershed analysis struggled because of a lack of analytical tools (Reeves et al., 2006), better tools and data are now readily available (L. Benda et al., 2007; Burnett et al., 2007; Irvine et al., 2015; Isaak et al., 2015; McKelvey et al., 2016). Both options proposed by Reeves et al. are for second-growth stands less than 80 years old in areas designated for multiple use. Although the options were developed for the Northwest Forest Plan Area and therefore are influenced by the conditions in that region, the underlying concepts of both options can be applied to the USDA Forest Service Northern Region.

The debate continues among scientists and the public as to whether active vegetation management should occur anywhere in riparian management zones, even when large percentages of those zones were previously managed for strictly economic purposes and no longer match the distributions of conditions that would have occurred naturally. Consequently, differing opinions between scientists make it difficult for managers to design and implement restoration actions in riparian management areas (Reeves et al., in press). Pollock and Beechie (2014) urge caution when considering vegetation treatments near streams because there are many trade-offs to consider. Their study shows that emphasizing the development of large-diameter trees via thinning to create key pieces available for streams can have negative consequences for terrestrial vertebrate species that depend on large dead wood (see section 3.7.4 for more details). Reeves et al. (in press; 2016) discuss how tree tipping can be used to offset short-term deficiencies of woody debris in small streams and adjacent riparian areas. Rieman et al. (2015) suggest that it is not clear whether the considerable funding expended to date on habitat restoration treatments has been successful. Going forward, they recommend, "(1) a scientific foundation from landscape ecology and the concept of resilience, (2) broad public support, (3) governance for collaboration and integration, and (4) a capacity for learning and adaptation" (p. 124). Monitoring and adaptive management will be essential to continually learn from and refine riparian management, including on sites where only passive management occurs.

3.2.7 Soil environmental consequences

Analysis focuses on activities that could have measurable impacts to soils over the next planning cycle, examining direct, indirect, and cumulative effects on the "footprint" of Federal land managed by the Flathead National Forest. Management activities that harvest timber, reduce fuels, and decommission roads would have the highest potential of affecting soil condition. The effects of herbicide activities would be small and relegated to primarily administrative areas, such as roadside spraying; adverse impacts to soils are controlled through limits on herbicide type and application rates (USDA, 2001a). To address cumulative effects, the analysis discusses past and foreseeable future impacts on soil within the Flathead National Forest. Activities on adjacent private, State, and Federal ownership were not found to have detectible impacts to soil condition and therefore are not discussed in this section.

The direction for Forest Service management of soil directly tiers to the National Forest Management Act (16 U.S.C. 1604), which requires national forests to “ensure . . . evaluation of the effects of each management system to the end that it will not produce substantial and permanent impairment of the productivity of the land.” Past forest plan standards along with current guidance at the regional and Washington Office levels interpret the National Forest Management Act’s direction to manage for sustained soil productivity. The forest plan would continue to conserve soil function and long-term productivity (FW-DC-SOIL-01). Areas dedicated to infrastructure such as administration sites, mines, NFS roads, and campgrounds are not part of the productive land base.

The 2012 planning rule broadened the soil management direction, requiring plans to maintain or restore terrestrial ecosystems, described more succinctly as ecosystem services. The Forest Service Manual outlines these services as soil biology, soil hydrology, nutrient cycling, carbon storage, and soil stability and support (Forest Service Manual 2500, chap. 2550, 2500-2010-1). By creating these lists of ecological services, the manual enables the Forest Service to better explain the interaction of management with soils and discuss this in terms of soil function (Craigg, Adams, & Bennett, 2015). For example, the topsoil serves as a nexus of biological activity where soil organisms, plants, and soil mix to form the biochemical processes that create habitat for soil biology and plants, nutrient cycling, and carbon storage. The soil functions as a stable base for vegetation growth while also facilitating water storage and percolation into groundwater. Finally, the evolution of soils from the chemical decomposition from rocks together with the annual decay and release of mineral nutrients from organic matter creates nutrients that sustains soil organisms and plants. Thus, when designing and implementing land management activities, adverse impacts to soil productivity can be better minimized through the conservation and enhancement of soil physical, chemical, and biological function.

Since soil function is difficult to measure in the field, associated factors that can be readily observed and measured are used. These include disturbance to surface organic matter and to topsoil. Most management activities affect surface organic matter that can rebound relatively quickly as surface leaf litter and roots in the soil rebuild organic matter stocks. In contrast, the mineral topsoil could be considered a summation of a site’s potential to support growth based on bedrock, terrain, climate, and rate of soil development. When management activities displace or remove portions of the topsoil, this impact involves a longer-term recovery than disturbance. These consequences can vary depending on the soil depth and the place in the landscape. Topsoil disturbance on drought-prone sites could proportionally affect the soil’s ability to provide water to trees more than on wet sites where seasonal moisture stress is less.

Management can also use soil function to inform prescriptions (Craigg et al., 2015). Managers often refer to the historic range of variation as an analogue to use in managing for tree species composition and structure. Soils provide a historic record of vegetation distribution, with grassland types and deciduous trees creating darker topsoils than sites dominated by forests and shrubs. Soil characteristics of depth, texture, and even the accumulation of ash-laden loess can indicate areas most able to provide water through the summer. These characteristics indicate the best locations to plant species requiring high summer water and sites where trees have the best growing conditions.

Stressors

Wildfire, prescribed fire, timber harvest and fuels management will continue to affect soil condition over the next planning period. The steep topography of the Forest naturally predisposes slopes bared after wildfire to erode and deposit soil materials. Wildfire followed by intense rainfall will continue as a natural geomorphology agent as it has occurred episodically in Rocky Mountain forests for millennia (Kirchner et al., 2001). When taking a closer look over a century scale, fire incidence coincides with warm phases of the Pacific Decadal Oscillation (Morgan, Heyerdahl, & Gibson, 2008). This latest warm cycle has

continued with periods of dry springs with hot summers. These conditions align with large scale fire pattern based on tree-ring research (Morgan et al., 2008). Climate change predictions suggest a continued increase in monthly temperatures along with longer periods of summer drought that increase wildfire hazard (see section 3.8). It's uncertain whether climate change trends will prevent the cyclic return to cooler conditions (Joyce et al., in press).

Fire impacts soils by burning up soil organic matter and producing surface conditions prone to soil erosion and deposition. The impact is described qualitatively as soil burn severity, which conveys the magnitude of energy released from the consumption of fuels and the duration of heating. When fires burn all the aboveground biomass and forest floor, a large portion of the nutrient supply is volatized into the atmosphere, while the residual products of burning create higher mineral nutrient contents in soil layers (Erickson & White, 2008; Neary, Klopatek, DeBano, & Ffolliott, 1999). The soil's inherent quality may remain intact after wildfire since wind-driven fire rarely heats deep into soil (Hartford & Frandsen, 1992). However, after the wildfire, the lack of forest canopy and bare soil creates conditions for high erosion hazard. Water and wind erosion transport and deposit soil material incrementally downslope until slopes stabilize. Erosion is highest where fires burn severely on steep hillsides; typical fires result in 10-30 percent of the fire area burning with high severity based on burned area emergency rehabilitation maps for the Flathead National Forest. Although natural, recovery in these areas depends on available moisture and recolonization from neighboring vegetation and soil patches. Dry southern slopes may recolonize more slowly from droughty conditions and thin soils.

Timber and fuels projects would continue to be the management activities that have the highest areal impact on soil condition over the next planning period, albeit at reduced levels than in the past. Timber harvest treatment averaged about 11,000 acres per year at the inception of the 1986 forest plan, whereas now the timber harvest averages around 2,000 acres per year (years 2010 through 2012). The amount of regeneration harvest cutting has trended downward, and intermediate harvest (thinning) has trended upward. There has also been increased emphasis on timber harvest in the wildland-urban interface.

The majority of harvest would occur on lands designated as suitable for timber production in the plan (see section 3.21). The exact location of future timber harvest will depend largely on factors related to road access and site-specific forest conditions relative to the desired conditions as outlined in the forest plan. However, uncertain disturbance events will also influence location and extent of harvest. For example, harvest peaks in the 1970s and 1980s largely responded to outbreaks of mountain pine beetle in lodgepole pine stands. Harvest in the 2000s followed large wildfire events, with salvage harvest accounting for about 25 percent of the harvest acres in that decade (USDA, 2014a). Timber harvest may also include some areas regenerated in the 1970s that reach commercial size. However, young forests within recent wildfire areas will not reach commercial size during the life of the plan.

Road access will largely dictate timber harvest since the Flathead National Forest continues to reduce the road network Costs of road maintenance and managing for habitat factor into the Forest's decision to decrease the road template. At the time of the 1986 forest plan, the Flathead National Forest was still actively building roads and extending its operational footprint. The network in the early 1990s was 3,842 miles, whereas NFS roads account for 3,559 miles as of 2016. The difference is actually much more striking than it appears since road decommissioning has already taken off the system 787 miles of classified roads from 1995 through 2015. Road management shifted to decommissioning roads in the late 1990s, with attention to maintaining grizzly security core area and the corresponding need to reduce watershed effects.

Effects from timber harvest

Harvesting timber requires machinery to cut and yard trees to landings that can compact and displace soils (Cambi, Certini, Neri, & Marchi, 2015; Deborah S. Page-Dumroese, Jurgensen, & Terry, 2010). The intensity and extent of impacts are managed by project mitigation and best management practices. Using soil monitoring, the Forest Service evaluates the efficacy of forest treatments by comparing disturbance extent against soil quality thresholds. When soil disturbance surpasses these thresholds, then long-term impairment could occur and the disturbance is considered detrimental to soil quality (Forest Service Manual R-1 supplement 2500-2014-1). Forest monitoring on the Flathead National Forest has found that the harvest methods that result in the highest disturbance use ground-based harvesting and skidding methods (Basko, 2007; USDA, 2010b). Contemporary methods have reduced impacts with equipment that has lower-pressure, wider tracks or treads. Economics and advances in mechanization have driven operators to favor ground-based equipment. Over the last five years, the Flathead National Forest used ground-based equipment methods to harvest 98 percent of the treated acres.

Within an activity area, typically defined as a treatment unit, timber harvest over the next planning cycle will likely impact soils at the same disturbance intensity as over the last 15 years. Flathead National Forest soil monitoring over this period found that logging systems result in detrimental soil disturbance, on a percent area basis, of 10-15 percent for ground-based, 2-8 percent for skyline, and less than 2 percent for helicopter yarding (USDA, 2010b). The most pernicious impacts from ground-based harvest remain at roughly 3 to 5 percent, mainly along high-traffic skid trails and excavated skid trails (Gier, 2015; USDA, 2010b). In contrast, historical timber harvest and site-preparation practices left up to 30 percent of the soil area severely impacted (Clayton, 1990; Klock, 1975), or at least twice the disturbance area of contemporary harvest practices. Monitoring in the 1990s revealed that dozer piling systems were replaced with feller bunchers and low-severity broadcast burning for site preparation (Basko, 2002).

A recent shift in timber practices that may increase soil disturbance over the next planning period is the use of a mixed ground-based and skyline system on grounds with greater than 40 percent slope pitch. Feller bunchers can range up to 50 percent slope pitches and have a lower unit cost than hand felling. In these steep areas, feller bunchers harvest the trees and skyline systems yard the material to landings. Traditional ground-based yarding does lead to the highest soil disturbance from repeat travel and heavy loads but is excluded for these reasons from slopes greater than 40 percent. Monitoring has shown that these mixed ground-based/skyline systems produce higher levels of soil disturbance than standard hand felling with skyline yarding but can remain below the 15 percent areal standard. The use of mixed harvest systems will depend on site characteristics and operator performance. FW-STD-SOIL-01, FW-STD-SOIL-02, and FS-GDL-01 provide plan direction to ensure that the Forest minimizes damage to soil productivity.

Current findings from the Forest Service's long-term soil productivity study suggest that the extent of the negative impacts of vegetation management activities is related to soil texture and organic matter (Deborah S. Page-Dumroese et al., 2010; Powers et al., 2005), but often as confounding variables. For example, coarse-textured soils appear resistant to compaction (Gomez, Powers, Singer, & Horwath, 2002) but are also nutrient poor and so particularly at risk to the nominally least risky treatments that remove forest floor (Deborah S. Page-Dumroese et al., 2010; D. S. Page-Dumroese & Jurgensen, 2006). Forestry research has underscored the importance of organic matter by documenting the soil benefits of downed wood (Graham et al., 1994; Harvey, Jurgensen, Larsen, & Graham, 1987), forest floor, and soil organic matter (Jurgensen et al., 1997). However, at this time the Forest has no clear guidance on target levels by habitat or soil type since organic matter levels vary in step with forest succession. The Rocky Mountain Research Station has initiated studies to establish minimal necessary amounts of organic matter by habitat type. In the interim, the soil management program on the Forest has adopted guideline FW-GDL-SOIL-04, which conserves the forest floor and coarse wood levels. The forest floor can act as a mulch and

buffers the soil's microclimate to hold water on droughty sites for soil and plant processing in addition to providing a nutrient cache. Cold sites do not have the same water issues, and thus adequate forest floor can be less constraining for growth. Across all sites, project activities should provide sufficient effective ground cover with a post-implementation target of 85 percent to provide nutrients and reduce soil erosion (FW-GDL-SOIL-03). The 85 percent represents a threshold level above which erosion was minimal for shallow to steep slopes using disturbed water erosion prediction project (WEPP) model simulations, an online application of the Water Erosion Prediction Project (W. J. Elliot & Hall, 2010).

Coarse wood debris in the form of slash can provide a practical and effective mitigation of timber harvest impacts on soil physical function and processes (Graham et al., 1994; Harvey et al., 1987). Leaving harvest slash along skid trails can prevent compaction (Han, Han, Page-Dumroese, & Johnson, 2009) and enhance soil recovery (Deborah S. Page-Dumroese et al., 2010). The coarse wood debris contains very little nutrient value (Laiho & Prescott, 1999), but its benefits of providing groundcover and tempering soil climate promote soil biologic activity. Target coarse wood levels balance needs for fuels reduction, soil production, and wildlife. Optimal ranges for Montana and Idaho forests were reported as 5 to 20 tons per acre for warm sites and 10 to 30 tons per acre for cooler sites (J. K. Brown, Reinhardt, & Kramer, 2003). The forest plan offers flexibility by allowing coarse wood levels to vary at the project level depending on the fire risk, site type, and soil condition, but guidelines range between 8 and 30 tons per acre (FW-GDL-TE&V-08).

Level of timber harvest by alternative

The alternatives vary by annual harvest level, as described in section 3.21.2. The average annual acres of commercial timber harvest estimated to occur in the first decade would be 1,699 acres under the no-action alternative A, 3,138 acres for alternative B modified, 2,577 acres for alternative C, and 1,833 acres for alternative D (table 14). These estimates were modeled and are best used for comparison rather than considered absolute values. For context, all action alternatives would be less than the 3,300 acre average annual treatment harvest during the decade 2000 to 2009 (not counting salvage). All alternatives were equally limited by budget. Alternative D has a lower amount of acres mainly due to the higher level of regeneration harvest and selection (by the model) of forest conditions more cost effective to treat. Of the action alternatives, alternative C has the second highest annual projected acreage in the first decade after alternative B modified, but nearly all acres would have intermediate treatments (modeled as commercial thinning). Refer to sections 3.3.1 and 3.21 for more information on timber harvest outputs by alternative.

Table 14. Average annual acres of commercial timber harvest by alternative for decade 1, under reasonably foreseeable budget levels

Type of Harvest	Decade	Alternative A	Alternative B Modified	Alternative C	Alternative D
Even-aged Regeneration	1	1,199	2,138	77	1,833
Commercial Thinning	1	-	1,000	1,500	-
Uneven-aged Regeneration	1	500	-	1,000	-
Total	1	1,699	3,138	2,577	1,833

Under alternative C, less regeneration harvest theoretically reduces the intensity of soil disturbance due to less equipment travel and landing needs. Basko (2007) accounted for this potential reduction in soil disturbance predictions for the Flathead National Forest. However, forest monitoring has not found forest treatment intensity to equate to disturbance because skid trails are a far greater disturbance factor than the degree of tree removal. Soil compaction largely occurs after only three passes by equipment and is most

pronounced on skid trails (Han et al., 2009). Because the same skid trail networks are used for both thinning and regeneration harvests, they have nearly equal rates of soil disturbance (USDA, 2010b).

The Forest's reduction in miles of NFS roads has increased the reliance on temporary roads to access timber. Most temporary roads are historical routes that have existing prisms. Management direction for temporary roads continues to evolve, although once the Forest removes the roads from administrative infrastructure then these areas become part of the productive land base. Under the forest plan, the Forest would consider both stabilizing and improving soil recovery on these temporary road templates. Soil function would be restored on temporary roads (and decommissioned road prisms used as temporary roads) when management activities that use these roads are completed. Restoration treatments would be based on site characteristics and methods that have been demonstrated to measurably improve soil productivity (FW-STD-SOIL-03).

The beneficial effects of road decommissioning would depend largely on the site's potential for recovery (Switalski, Bissonette, DeLuca, Luce, & Madej, 2004). For example, droughty slopes with high evaporative loss on sunny aspects will recover more slowly than moist northern aspect slopes. Road treatments will stabilize the surface from erosion while soil biological, chemical, and hydrologic properties slowly recover as plants recolonize. Lloyd et al. (2013) quantified soil recovery on the Nez Perce-Clearwater National Forest, showing faster soil recovery for treated roads where the road prism was outsloped along with some level of revegetation vs. abandoned roads. They found topsoil developed on treated roads three times as deep over one decade as the topsoil on roads that had been abandoned for 30 years. Although not quantified, observations suggest that on droughty sites the persistence of forest canopy on either side of the road increases the rate of soil recovery by lowering water loss because of shade. These observations highlight the importance of site characteristics when prescribing road reclamation treatments. See appendix C for examples of road obliteration treatments.

Standard mitigation techniques to limit soil damage from ground-based equipment would be carried forward under the forest plan. The guideline reflects standard practices by constraining operations on steep slopes (FW-GDL-SOIL-01) and controling seasonal operation when soils are more vulnerable to compaction and displacement. The forest plan, however, does not stipulate operation restrictions to particular conditions. Such limitations would be evaluated at the project level due to variable soil properties.

The forest plan further addresses potential soil damage by avoiding sensitive soils prone to soil saturation and thin rocky soils that may be unstable. These areas were considered not suitable for timber production because harvest operations could produce irreversible soil damage and reforestation would be uncertain. The areas were selected using mapping from the Flathead National Forest land system inventory (Martinson & Basko, 1983) and the Region 1 potential vegetation type layer (J. Jones, 2016) (see table 15). All action alternatives exclude these sensitive soil areas. In addition, the forest plan would lower the risk of soil damage outside of these unsuitable areas by providing guidance that ground-disturbing management activities should not occur on landslide-prone areas (FW-GDL-SOIL-02).

Table 15. Landtypes with sensitive soils that are not included within the lands suitable for timber production

Landtype	Name	Sensitive Attribute
10-2, 10-3, 14-3	Wet alluvial deposits that include floodplains and moraine depressions with lakebed sediments	Poorly drained, saturated conditions
12	Moraine depressions with lakebed sediments where wet meadow grasses, sedges, shrubs grow	Poorly drained, saturated conditions
17	Avalanche debris fields	Steep and rocky thin soils
54	High-elevation cirque basins, rockland	Steep and rocky thin soils

Landtype	Name	Sensitive Attribute
55	Low- to mid-elevation rocky hillsides with sparse forest cover	Rocky thin soils
72	Steep, high-elevation cirque headwalls and ridges; rockland, talus mosaic with soils	Steep, rocky thin soils and short growing season
75	Rock cliffs and limestone areas with sparse forest cover	Rocky thin soils and alkali soil conditions that restrict growth

Predicted effects from fuels management

Fuels treatment would continue as a method to reduce fire risk. Prior to the year 2000, fuels treatment was primarily an action connected to timber treatment. After the development of the National Fire Plan in 2000 (see Pinchot Institute for Conservation, 2002), fuels treatment intensified steadily in tandem with commercial harvest and as a separate treatment. Fuels treatment also involves managing wildfire for resource benefit since many of the habitats on the Forest have not had fire over the last 100 years.

For the past 20 years, fuels have been treated primarily with a combination of mechanical treatment and underburning instead of broadcast burning. Figure 8 shows a proportional increase in underburning over broadcast burn since about the year 1990, as well as the dramatic increase in wildfire acres. Broadcast burning removes slash and understory vegetation to facilitate reforestation but has had negative consequences by consuming the forest floor and leaving scant groundcover. Underburning, on the other hand, results in low and moderate burn severity that retains soil groundcover and forest floor. It is also used in conjunction with whole tree yarding that removes fuel even before the burning. A tradeoff of whole tree yarding, however, is the export of nutrients offsite due to the removal of nutrient-rich green foliage.

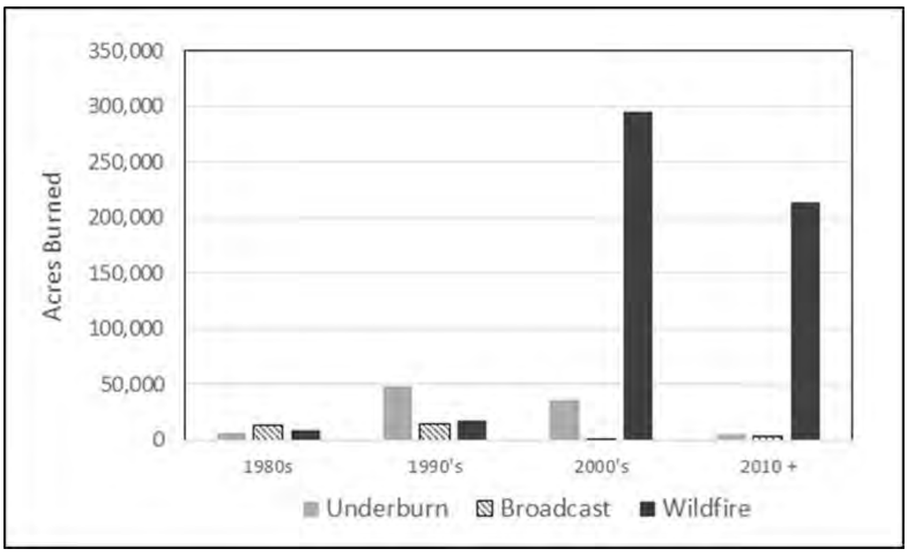

Figure 8. Prescribed and wildfire acres burned from the 1980s to the present

Under the forest plan, the Forest would continue to treat fuels in the wildland-urban interface using a mixture of pile burning, mechanical removal, and underburning. As noted above, the treatment type affects soil condition by removing vegetation that would otherwise decompose in soil and build up soil carbon. The loss of vegetation due to treating fuels is not far removed from natural processes since fire regularly removes vegetation by volatizing biomass. However, the impact may vary by site type. Areas with organic soils in topsoil that grow abundant grasses and forbs on dry sites likely experienced frequent fire. In these areas, treating fuels aligns with ecological processes and the soils have a higher proportional

amount of organic matter in the mineral soils to buffer the removal of vegetation. For moist types of vegetation, the fuels treatment may not directly align with natural cycles. Treating fuels temporarily removes dense growth, but the moist conditions favor quick regrowth. Repeated removal of vegetation to mitigate fire hazard would be out of sequence with the long periods between fires that these vegetation communities typically experience. These treatments would reduce vegetation leaf and root litter contributions to soil, with overall impacts dependent on soil fertility.

One benefit of fuels treatments that reintroduce fire is that the fire can improve soil condition. Burning creates a net increase in available nutrients, both in terms of the products of fire contained in ash residue and the higher decomposition rates after the fire. Almost immediately, burning increases the amount of mineral nitrogen levels for plants and soil organisms (Choromanska & DeLuca, 2002; Hart, DeLuca, Newman, MacKenzie, & Boyle, 2005), which is a limiting nutrient in most forest ecosystems (Binkley, 1991). In drier habitats, this increase can be detected as much as 50 years after fire (McKenzie, Gedalof, Peterson, & Mote, 2004). The burning also increases charcoal production that conditions soils, increasing water-holding capacity and providing exchange sites for plants and soils to acquire nutrients (DeLuca & Aplet, 2008).

Acknowledging that fuels treatment often requires the use of ground-based equipment, the Flathead National Forest would apply to fuels treatment the same mitigation used for timber harvest to limit the amount of soil disturbance from equipment travel. The guidelines for timber would also apply regarding retaining a minimum level of soil organic matter and groundcover (FW-GDL-SOIL-04). The levels would vary at the project level depending on the fire risk, site type, and soil condition (FW-GDL-TE&V-08).

When comparing the impact of fuels treatment across the alternatives, all action alternatives would lead to greater acreage burned than under the 1986 forest plan due to managing wildfire for resource benefit. Active reduction of fuels would likely track with timber harvest, with descending levels of treatment as follows: alternative B modified, alternative D, and alternative C. The amount of fuels treatment would be budget controlled, similar to timber harvest activities

Effects from infrastructure

The Forest would continue to reduce the NFS road system. Over the last 20 years, about 19 miles of road were built and about 787 miles of road were decommissioned. Future road building would likely be confined to realignment, and the main emphasis would continue to be on decommissioning roads. Where roads are built, the average amount of soil extracted is 3 acres per mile, assuming a 50-foot-wide prism. The road decommissioning treatment repurposes the road area back to productive land base and no longer manages the road as an administrative area.

The net effect of reallocating more area back to productive purposes would largely be positive. As a means to sustain productivity, the Forest would evaluate not only stabilizing these repurposed areas but also prescribing treatments to promote soil recovery (FW-STD-SOIL-04). See appendix C for examples of road rehabilitation prescriptions.

Reducing risk of soil erosion

Adequate canopy and groundcover is the best protection against soil erosion. Tree canopy foliage intercepts rainfall, and understory vegetation and forest litter slow runoff to allow for rainfall to infiltrate into the soil. Overland flow and surface erosion are rare in Rocky Mountain forests (Wondzell & King, 2003). Using Disturbed WEPP, a soil erosion model amended for forested environments, soil erosion rarely occurs if groundcover exceeds 85 percent cover (William J. Elliot, Hall, & Graves, 1999). The Flathead National Forest’s monitoring of soil disturbance shows that, in general, timber harvest activities do leave areas of bare soil that exceed 10 percent (USDA, 2010b). Standard practices in addition to new

reclamation measures would contain offsite erosion. FW-GDL-SOIL-03 would lessen surface soil erosion by ensuring that management activities maintain at least 85 percent cover. Use of slash on skid trails is one measure currently being adopted that increases groundcover and facilitates vegetation regrowth on disturbed soil surfaces.

Managing prescribed fire and wildfire for resource benefit poses temporary risk of erosion and deposition for at least three years post fire, depending on the remaining groundcover. After fire, the blackened ground stabilizes as plant cover and roots secure the surface and loose, exposed soil transports downslope. Across blackened areas, the net effect of the burn residue and surface sealing of soil pores can exacerbate erosion potential by slowing infiltration (Larsen et al., 2009; Wondzell & King, 2003). This post-burn condition is highly variable spatially and decreases over time (Doerr et al., 2006). All action alternatives would have similar direction for this aspect of fire management.

The forest plan states, as a desired condition, that management does not destabilize areas with highly erodible soils or mass failure potential. Most of the erosion issues from road failures are associated with either decommissioned or abandoned roads. The Forest has a generally low risk for mass failure overall due to the stable Belt metasedimentary geology. The most extreme failure potential was found in the Skyland/Puzzle Creek area, which the 1986 forest plan excluded from timber suitability based on an environmental analysis in 1974. However, due to current engineering techniques and harvest equipment, the risk would be less than the initially proposed jammer logging in the 1970s. The main triggers for road failure involve saturating rain-on-snow events. FW-GDL-SOIL-02 guides management to avoid landslide prone areas.

Climate change impacts

The Forest lies along the border of the warm maritime climate from the West Coast and the cool, dry continental climate from the east. As the climate continues to warm, the outcome may be difficult to predict because of the interaction of topography and the uncertain dominance of the continental vs. maritime climate influence. Also, with increasing precipitation, the moisture can buffer rises in temperature so long as there is enough stored water. Shifts in climate could play out mostly in mid-elevation forests where winter moisture comes as rain rather than snow and where a decrease in snowpack could result in prolonged periods of soil moisture deficit. It is likely this would continue the trend of an earlier spring, which might be as much as two months earlier over the next century (Charles H. Luce, in press).

A decrease in the snowpack could extend the soil drought that is now common in lower-elevation ponderosa pine forests to the mid elevations. The seasonal water deficits could stress mesic species such as western larch, lodgepole, and alpine fir that make up the mixed-conifer forests. It is possible that drought stress would affect mid-elevation forests even more because forest species shift primarily according to aspect in this zone. Concave slope areas would grow mesic species since these areas have moist deep soils due to converging slope water. The upper extent of the timber line would likely move up in elevation as the growing season extends in these normally cold, limited environments.

Any future changes to the length of the growing season would affect soil and plant respiration. Typically, soils become active when temperatures exceed 44 °F and decrease in activity when soil moisture declines below 10 percent moisture (Davidson, Belk, & Boone, 1998). The combination of an adequate temperature for growth is expressed as growing degree days. Using a 30-year compilation of mean annual data (Holden et al., 2015), growing degrees on the Forest vary according to topographic gradient, aspect, and valley form. Bottomlands can have up to a 220-day growing season except where cold air drainage constrains growth. Middle elevations have from a 160- to 200-day growing season, varying mostly by aspect. In upper elevations, the cold air temperatures restrict the growing season down to 100 days, with

the greatest limitations above 7,500 feet. On areas that could experience longer seasonal drought, the effective growing degree days for soil respiration would decrease while upper elevations might have a longer growing season. As warming occurs, available soil moisture would be the primary control at mid to lower elevations. In Colorado, a study found that in complex terrain, available water was the limiting factor on soil respiration for ponderosa and lodgepole (Berryman et al., 2015). On finer scales, the outcome becomes complicated by the interaction of the forest canopy and topographic position. Soil water can be maintained by the shading of forest canopy that reduces evaporative losses from wind and sun, but forest transpiration also draws soil water down.

Cumulative effects

Past actions and foreseeable future actions primarily affect soils in situ. Influence from adjacent management on private, State, or federally managed areas would have undetectable effects on site-specific soil conditions. Legacy disturbance from wildfire and timber harvest could affect the soil condition where future management activities are planned.

During the 1980s, the footprint of forest management was still expanding into new forest stands. At the same time, rules and guidelines were beginning to take effect in controlling soil disturbance and limiting the offsite transport of sediment (Binkley & Brown, 1993). The Forest Service had begun working with the state to adopt best management practices that reduced the adverse effects of timber harvest on soil and water.

The vegetation section shows the increased use of forest intermediate cuts (including salvage cuts) relative to stand regeneration since the 1980s (table 18). During the latter part of the last planning period, forest harvest began to enter stands with prior harvest, usually conducting commercial thinning within immature forests. These prior harvest stands had remnant systems of roads and skid trails that could be reused, but these additively increase the soil disturbance footprint when combined with the disturbance due to the contemporary harvest. Under the forest plan, re-entry into stands to conduct intermediate harvest would continue. Regeneration harvest in stands that had prior treatment is not likely since these areas are not projected to grow to commercial grade during the planning period (generally 15 to 20 years). These regenerated areas would likely receive hand thinning, which does not additively increase soil disturbance.

Where new forest treatments have residual effects from past harvest, soil remediation could improve the trajectory of soil recovery. Soil remediation involves actions to obliterate old temporary roads and landing piles while also conserving organic matter from slash to harness biologic processes for faster soil recovery and improved soil quality overall. Using soil disturbance criteria, standard FW-STD-SOIL-01 directs the improvement of soil condition where management actions are planned to treat areas that exceed 15 percent detrimental soil disturbance from prior management. The benefit of remediation measures are better portrayed using terms related to soil function, such as the ability of the soil to hold water and support soil organisms and plants with adequate organic matter stocks. Previously, the management direction was to account for soil remediation in terms of detrimental disturbance. See appendix C for examples of soil remediation.

Based on recent trends in wildfire and more emphasis on prescribed burning for restorative purpose, more fire is expected to occur during the next planning period than in the previous. Much of this fire may burn through recovering areas that experienced moderate or severe wildfire. Burning through past fire areas that have “jackstrawed” dead trees could produce heat that penetrates deeper into the soil because of longer burn durations. There is concern that this heating could sterilize soils and impede forest growth. Research has shown that despite this heating, reburn rarely sterilizes soil even in reburn scenarios where concentrated fuels may increase fire severity; instead, the recovery is controlled by fire severity, tree

overstory level, soil texture, and the timing of the burn (Hebel, Smith, & Cromack, 2009). The fire may reorganize the soil community, with generalist species dominating early on (Egerton-Warburton, Graham, & Hendrix, 2005; Jiménez Esquilín, Stromberger, & Shepperd, 2008). The soil condition will improve as vegetation recolonizes the site and organic matter stocks rebuild.

3.2.8 Watersheds: Water quality and quantity environmental consequences

Effects of forestwide direction on water quality

Alternative A

The Inland Native Fish Strategy (INFISH) (USDA, 1995b), as it was amended to the Flathead forest plan in 1995, is unchanged from its original wording in alternative A. INFISH reduced the risk to watersheds and riparian and aquatic resources by improving riparian zone protections. INFISH has standards and guidelines for timber, roads, grazing, recreation, minerals, and fire management that have improved water quality and stream habitat on the Forest. As mentioned above in section 3.2.3, the year after the implementation of INFISH, 22 streams on the Forest were listed as impaired due to siltation. During the TMDL development for streams on the Forest from 2004 to 2014, no TMDL was required for 17 of those streams because data collected to support TMDL development indicated that they were no longer impaired for sediment; they were removed from the 303(d) list without a required TMDL (MTDEQ, 2014). In other words, sediment, which was a leading contributor to impairment, was no longer adversely impacting beneficial uses. The implementation of INFISH direction along with best management practices, reduction of road construction, and reduction of timber harvest along streams due to riparian habitat conservation areas likely helped reduce sediment delivery.

Alternatives B modified, C, and D

The most significant change between the action alternatives and the existing 1986 forest plan (alternative A) is the incorporation of forestwide desired conditions, standards, and guidelines that together provide more detail and clarity regarding the conditions and management of watersheds that would contribute to the overall goal of maintaining the integrity and resilience of the aquatic ecosystems on the Forest.

Desired conditions provide a vision of the future landscape and serve to focus management attention by describing the specific desired ecological characteristics of the watersheds within the plan area towards which management of the land and resources would be directed. The multiple benefits and values associated with watershed and aquatic ecosystems are acknowledged in the desired conditions within the Aquatic Ecosystems section of the plan, such as the instream and riparian habitat of plant and animal species; the physical integrity of aquatic and riparian ecosystems; channel characteristics; spatial connectivity within and between watersheds; sediment regimes and water quality; streamflow regimes and water flows; floodplain and groundwater-dependent ecosystems; vegetation conditions adjacent to water features; and non-native species. Refer to the desired conditions sections within the Aquatic Ecosystems section of the forest plan. Standards and guidelines in this section are designed to protect aquatic resources when conducting activities that might affect them. Specific discussions of effects to water quality, aquatic species, and other watershed resourced are provided in the sections below and are related to different types of management activities or land uses.

Because plan components for aquatics do not vary between action alternatives, any differences in the effects to watershed resources with implementation of the forest plan would be based on differences in management area allocations and projected amounts of land management activities or uses between the alternatives. These different effects are discussed in the sections that follow, if applicable.

All streams with assigned TMDLs would receive special emphasis to improve water quality conditions under all alternatives due to the Forest Service's legal obligation to meet the requirements of the Clean Water Act. For the action alternatives, this obligation has been addressed with a forestwide desired condition (FW-DC-WTR-06) to meet or exceed all applicable State water quality standards, to fully support beneficial uses, and to meet the ecological needs of native aquatic and riparian-associated plant and animal species. This is complemented by a guideline designed to require sediment-producing activities in watersheds to comply with the TMDL implementation plans (FW-GDL-WTR-01). This direction would help maintain or improve water quality conditions within the Flathead National Forest and assist in achieving conditions needed for these streams to fully support their beneficial uses.

All action alternatives (FW-DC-WTR-06) are designed to ensure that restoration in impaired watersheds (Logan, Sheppard, Coal, Goat, and Jim Creeks) occur per the developed TMDLs. The rate and effectiveness of active restoration combined with the emphasis on 303(d) listed segments could shorten the time for bringing 303(d) waters into compliance compared to alternative A. It is assumed that alternative C, due to more recommended wilderness allocation and less intense vegetation management overall, would be least likely to lead to further impairment of waterbodies. However, plan direction for recommended wilderness for all action alternatives would protect streams from impairment from land management activities such as timber harvesting and road building.

Activities that disturb the soil surface have the greatest potential to adversely affect water quality if they occur in proximity to waterbodies. These effects are typically expressed as inputs of fine sediment where activities occur along stream channels and have an associated crossing or other surface disturbances. Watersheds whose physical, chemical, or biotic function is at risk may be near their capacity to assimilate further impacts or may need remedial action to reverse a downward trend. Therefore, alternatives that propose higher levels or intensity of land-disturbing activities, such as alternative D, may pose greater inherent risks to aquatic and riparian resources. Plan direction (desired conditions, objectives, standards, and guidelines) for watersheds and associated resources is designed to provide necessary protections to water quality. Monitoring would continue to occur to evaluate the effectiveness of the standards and guidelines at protecting riparian and aquatic habitat.

The implementation of most land management activities carried out on the Forest and described in this analysis has the potential to adversely affect aquatic and riparian resources to some degree. Activities that alter the quantity, timing, or quality of water resources have the greatest potential for adverse effects, and the risk of adverse effects generally decreases as the distance away from streams or wetlands increases. Some land management actions would be undertaken with the explicit purpose of improving water quality, such as planting in riparian areas, installing larger-capacity culverts in roads, or undertaking road storage or decommissioning. Actions that are intended to improve water quality often result in short-term adverse effects to water quality, particularly if implementing actions in a waterbody. Short-term adverse effects are anticipated and considered acceptable, particularly when activities are needed to provide long-term protection or improvement of water quality.

Implementation and effectiveness monitoring of best management practices are performed primarily through three administrative processes: the biennial Montana State Forestry best management practices review, forest plan monitoring, and the Forest Service's national best management practices program (2012 planning rule, Forest Service Manual 2532). During the 2014 Montana best management practices review, the best management practices applied on Federal lands, including Forest Service and Bureau of Land Management lands, were found to be over 96 percent effective at preventing impacts to water quality (Ziesak, 2015). Implementation and effectiveness monitoring of watershed conservation practices and forest plan standards and guidelines can be carried out by a variety of personnel, including timber sale administrators, contract officer representatives, resource specialists, and line officers. Documentation of

this monitoring can include field notes, memos, contract daily diaries, or monitoring reports. Systematic monitoring and adjustment of land management activities, where necessary, will ensure the highest possible level of best management practice implementation and effectiveness.

Monitoring to assess watershed conditions will continue to occur using the database developed from the Interior Columbia Basin Monitoring Strategy (ICBEMP, 2014)that resulted from PIBO monitoring. Since 2010, additional methodologies have been developed that allow comparison between managed and reference stream conditions on national forests (Robert Al-Chokhachy et al., 2010). These methods will be utilized in plan monitoring.

All action alternatives retain protections established under the 1986 forest plan for Haskill Basin, the only currently designated municipal supply watershed within the Forest, and no new municipal watersheds have been designated. A desired condition (GA-SM-DC-08) is included in the forest plan under the Salish Mountains geographic area that emphasizes the management of this municipal watershed to reduce the risk of high-intensity fires that have the potential to reduce water quality. This desire is further emphasized by the inclusion of an objective (GA-SM-OBJ-03) to implement vegetation treatments within this basin that contribute to achieving the desired condition.

Source water protection areas

As discussed under the “Affected environment” section, source water protection areas have been delineated by Montana Department of Environmental Quality on and downstream of NFS lands. There are two surface water intakes on the Forest and four surface water intakes downstream from NFS lands. The greatest concern is with surface water intakes. It has been found that pollution impacts on water quality from forestry activities are generally local in nature, short-lived, less frequent, and less extensive in nature than activities related to either agricultural or urban activities (Dissmeyer, 2000). In addition, 20 public water systems withdraw groundwater at 22 locations within or near NFS lands, which includes 21 wells and 1 infiltration gallery.

Vegetation management activities that can cause non-point-source pollution include road and skid trail construction, timber harvest, site preparation and stand regeneration treatments, herbicide application, and prescribed burning. The major types of potential pollutants produced by these sources are sediment, logging equipment fluids, nutrients from harvested areas, and forestry pesticides. Effects depend on elevation, slope, and the rate at which vegetation recovers following harvest. However, in general, if best management practices are properly designed and implemented, the adverse effects of forestry activities on hydrologic response, sediment delivery, stream temperature, dissolved oxygen, and concentrations of nutrients and pesticides can be minimized and water quality and associated aquatic resources can be protected.

Plan components have been developed to protect groundwater, water quality, and source water protection areas by ensuring that activities are consistent with State source water protection plans, that best management practices to control non-point pollution are implemented, and that beneficial uses are provided for. Desired conditions (FW-DC-WTR-06, 10, and 15) address the desire to support beneficial uses and be consistent with State water quality standards. Standard FW-STD-WTR-02 addresses the control of non-point pollution to protect beneficial uses. These components are expected to provide adequate protection to source water protection areas and to maintain water quality under all the action alternatives.

Effects of recommended wilderness and inventoried roadless areas on water quality

Background

Areas of minimal human development such as existing wilderness areas are often sources of high-quality runoff (Thomas C. Brown & Binkley, 1994), and the importance of such water will increase as development proceeds. In general, the same can be said of recommended wilderness areas or other areas that are largely unroaded and have minimal development. These areas typically provide the highest quality water. Surveys by Haas et al. (1986) and Cordell et al. (2008) indicate that, of the many reasons that citizens value wilderness, protection of water quality consistently receives the highest ranking.

The general high quality of water in wilderness and large, unroaded, and undeveloped areas can be attributed to the lack of the ground-disturbing activities, human development, and pollution sources such as roads and timber harvest. However, no studies explicitly compare water quality data from within and outside of designated wilderness lands or similarly managed areas. There is habitat data from PIBO for managed vs. reference streams, and much of the data for reference streams is from with wilderness areas. Many of the Flathead National Forest's managed streams have habitat conditions similar to reference streams (C. N. Kendall, 2014).

The Flathead National Forest has approximately 1,072,040 acres of existing wilderness (45 percent of the Forest's lands). Outside wilderness, there is approximately 478,758 acres of inventoried roadless areas (20 percent of the Forest's lands). The recommended wilderness areas and relatively undeveloped inventoried roadless areas are largely high-elevation lands that would protect headwater habitats that provide cold clean water downstream to fish and habitat. This high proportion of unroaded and largely undeveloped lands would contribute to the generally high water quality found across much of the Forest under all the alternatives.

Alternative A

The current forest plan, as amended, includes an estimated 98,388 acres of recommended wilderness, which is 4 percent of the Forest. Recommended wilderness occurs across approximately 20 percent of the inventoried roadless areas. The remaining lands in the inventoried roadless areas are allocated mostly to backcountry management areas (equivalent to management areas 5a, 5b, 5c, or 5d), where minimal levels of vegetation management or other developments would occur. Alternative A would continue to provide long-term protection to water quality and watershed conditions.

Alternatives B modified, C, and D

Alternative B modified includes approximately 190,403 acres of recommended wilderness, which is 8 percent of the Flathead National Forest. Recommended wilderness occurs across approximately 37 percent (177,161 acres) of the inventoried roadless areas under this alternative. Approximately 316,770 acres (13 percent of the Forest) are allocated to backcountry management areas under this alternative. These backcountry management areas occur across about 54 percent (259,666 acres) of the inventoried roadless lands. Therefore, approximately 21 percent of the Flathead is allocated to either recommended wilderness or backcountry management areas under alternative B modified, and most (92 percent) of the inventoried roadless areas are within recommended wilderness or backcountry management areas.

Alternative C includes approximately 506,919 acres of recommended wilderness, which is 21 percent of the Flathead National Forest. Recommended wilderness occurs across approximately 97 percent of the inventoried roadless areas on the Forest. Approximately 134,919 acres (6 percent of Flathead National Forest lands) are allocated to backcountry management areas 5a, 5b, 5c, or 5d under alternative C, and about 1 percent of the inventoried roadless lands are allocated to these backcountry management areas. Therefore, approximately 27 percent of the Forest is allocated to either recommended wilderness or

backcountry management areas under alternative C, and most (98 percent) of the inventoried roadless areas are within these management areas.

Alternative D has no recommended wilderness areas. Approximately 468,132 acres (20 percent of Flathead National Forest lands) are allocated to backcountry management areas 5a, 5b, 5c, or 5d, which occur across about 86 percent of the inventoried roadless lands.

The overall effect of the recommended wilderness areas and the backcountry management areas, especially when within inventoried roadless areas, is expected to be beneficial to water quality and quantity because of the limitations on land management activities. All alternatives would provide a fairly similar high degree of protection based on the proportion of Flathead National Forest lands outside existing wilderness that is allocated to recommended wilderness or backcountry designations (ranging from 20 percent of the Forest under alternative D to 27 percent under alternative C). When existing wilderness lands are added into this, the proportion of the Flathead National Forest in these areas that would remain largely undeveloped areas is relatively high, ranging from 65 percent under alternative D to 72 percent under alternative C. This would provide a high degree of protection to water quality and to other resources associated with aquatic ecosystems.

Alternative C has the highest potential benefits to water quality because of the larger amount of area allocated to recommended wilderness and backcountry management areas. This provides the greatest assurance that characteristics associated with wilderness would be maintained and protected. In addition, the number of stream miles located within recommended wilderness boundaries are increased over the existing condition. By altering recommended wilderness boundaries to include hydrologic divides, aquatic habitats are expanded from the existing condition due to the increase in the amount of stream miles that are afforded additional protection under recommended wilderness direction. By extending recommended wilderness allocation to the downstream lengths of stream segments that are located within existing wilderness, aquatic biota (designated beneficial uses) would benefit from management direction limiting activities that might have a detrimental effect, in some instances, and would also benefit from the additional protection afforded streams located within wilderness areas (e.g., as Montana Department of Environmental Quality Class I waters). The difference here compared to the 303(d) streams discussed above is that wilderness designation (if and when Congress designates recommended wilderness as wilderness) would afford the ultimate protection to aquatic resources, and the forest plan’s standards and guidelines would prevent impairment that might lead to a 303(d) listing. Alternative B modified would be the next most favorable to water quality based upon the amount of area allocated to recommended wilderness and backcountry. Alternative D would be the least beneficial.

Effects on water quality from livestock grazing

Background

Improper livestock grazing can have numerous direct and indirect effects on soil infiltration due to trampling, soil compaction, and loss of vegetation cover on both upland and riparian sites. Reduced infiltration by soil compaction can lead to overland flow of sediment and fecal waste. Fecal wastes can increase bacterial concentrations in water through direct introductions into water or riparian areas. Soil and water quality can be indirectly affected by the resulting increased soil runoff, erosion, and sediment delivery to adjacent riparian areas and streams. Impacts are often greater in riparian zones because these areas are preferred by livestock due to the availability of shade, water, and more succulent vegetation. Over long time periods, grazing can result in increased fine sediment loads from streambank erosion, loss of riparian habitats by stream channel widening or degradation, and lowering of water tables through channel degradation.

Overgrazing by livestock can reduce bank stability through vegetation removal and bank trampling, compact soil, increase sedimentation, or cause stream widening or downcutting, and it often changes riparian vegetation, resulting in insufficient overhead cover for fish (Platt, 1991). Stream widening and sedimentation can reduce instream cover and habitat quality for fish through mechanisms similar to those described for vegetation removal by timber harvest or fire, but grazing impacts can be compounded by repeated yearly use of the same areas by livestock.

Alternative A

The Forest has nine active grazing allotments. Seven of the nine allotments have been inactive for various periods over the last five years, so detrimental effects on watersheds have been limited. Monitoring of allotments over the last decade has shown some bank alteration and reduction in stubble height. In addition, there is elevated percent fines as monitored at the PIBO locations. Alternative A would continue to have a minimal effect on watersheds as a whole; however, localized stream impacts may continue to occur unless cattle are excluded.

Alternatives B modified, C, and D

The action alternatives provide forestwide standards and guidelines that would protect and minimize the effects of grazing on aquatic resources. One guideline establishes management constraints specific to grazing on or near the water's edge (FW-GDL GR-04), including limitations on streambank alterations and utilization of herbaceous and woody vegetation by grazing. Other direction (FW-GDL-GR-03, FW-STD-GR-08) restricts the trailing, bedding, watering, salting, loading, and other handling activities associated with livestock within riparian management zones. These guidelines are designed to reduce bank trampling and alterations, and protect water quality. Direction to incorporate appropriate grazing practices during the allotment management planning process to protect values associated with riparian management zones (such as adjusting stocking levels or timing of grazing) is provided by guideline FW-GDL-GR-01. Reducing the length and timing of the grazing season in riparian management zones would allow for more growth of grasses and forbs, which capture overland flow and prevent rills from forming and prevent erosion from delivering sediment to waterbodies, thereby lowering turbidity and fine sediment deposition in the waterbody. It would also reduce potential bacteria such as *E. coli* that have been shown to affect nutrients.

In addition, standard FW-STD-GR-08 requires new livestock handling or management facilities to be located outside of riparian management zones. Under all alternatives, watershed conservation practices designed to protect water quality and riparian areas would be included in allotment-management plans as they are revised and updated.

Monitoring of the Swaney allotment has shown that the proper implementation of livestock grazing standards adopted from INFISH (alternative A) has led to improved stream conditions, and that trend is anticipated to continue under the action alternatives. There are no differences in effects between the action alternatives except that alternative D might create more transient forage since more land might be affected by regeneration harvest activities. However, the forage would be away from the waterbodies due to limitations on harvest within the riparian management zones.

Effects on water quality from minerals and oil and gas

Background

Locatable minerals

Locatable or hard rock minerals include deposits of gold, silver, and copper. Historically, the Forest has had approximately 63 patented and unpatented mining claims, according to the Montana Bureau of Mines

and Geology. A 2002 Montana Bureau of Mines and Geology report (McDonald, Hargrave, Kerschen, Metesh, & Wintergerst, 2002) found that the Big Four Mine on the Swan Lake Ranger District near the West Fork of Dayton Creek was the only site of the 63 historic mines identified on the Forest that had the potential to adversely affect water quality. Water quality samples collected upstream and downstream of the site have indicated no adverse impacts. The samples were collected as part of a Montana Bureau of Mines and Geology study to determine whether there were any water quality impacts. That mine is no longer active.

Recreational mining, such as suction dredging, may occur although the Forest has not received requests for special-use permits. Suction dredging is regulated by Federal and State mining laws and regulations. Montana Department of Environmental Quality has closed many of the Forest's bull trout and cutthroat streams to suction dredging, and therefore impacts will not be seen in those streams. Large increases in mining activity are not anticipated for the future but cannot be ruled out. The 1872 mining law limits Forest Service authority over mining activities but allows the setting of terms and conditions to minimize impacts to NFS lands.

Leasable minerals (oil and gas)

The Flathead River Basin contains federally owned subsurface mineral estate under NFS lands that the Federal government has leased for oil and gas development. In 2010, there were 115 oil and gas leases in the North Fork watershed that the Bureau of Land Management issued between 1982 and 1985. The leases, which cover over 238,000 acres, are inactive and under suspension as a result of the 1985 court case Conner v. Burford. At the request of Montana senators Max Baucus and John Tester, leaseholders have voluntarily relinquished 76 leases consisting of almost 182,000 acres. The Bureau of Land Management has not offered any other leases in the Flathead National Forest since the Conner v. Burford litigation suspended the existing leases in 1985.

The North Fork Watershed Protection Act of 2013 (H.R. 2259) withdrew Federal lands (430,000 acres) within the North Fork and Middle Fork of the Flathead River watershed from all forms of location, entry, and patent under the mining laws and from disposition under all laws related to mineral or geothermal leasing. H.R. 2259 does not affect valid, existing rights, including the 39 leases in the North Fork watershed that are suspended under the Conner v. Burford litigation.

Salable minerals

Salable minerals include common varieties of sand, stone, gravel, and decorative rocks. The Forest Service salable mineral material policy (Forest Service Manual 2850) states that disposal of mineral material will occur only when the authorized officer determines that the disposal is not detrimental to the public interest and that the benefits to be derived from the proposed disposal will exceed the total cost and impacts of resource disturbance. The Forest uses materials such as gravel, riprap, and crushed aggregate for maintenance and new construction of roads, recreation sites, and repair of damage caused by fire, floods, and landslides. These materials come from Forest Service pits and quarries. Generally, gravel pits on the Forest are situated away from riparian areas. The type, volume, and source location of in-service mineral material varies year by year and according to need. Free-use permits can be issued to any State, Federal, or territorial agency, unit, or subdivision, as well as to the general public. An individual may obtain a free-use permit to collect rock, as long as it is not for commercial use, sale, or barter. Only hand tools can be used to collect the rock, no digging is permitted, and collection of loose rock only is authorized. Usually around 75 permits are issued each year.

Alternatives A, B modified, C, and D

There are no active mineral, oil, or gas leases on the Forest and thus no effect from existing mining activities on watersheds, fish, or riparian areas under any of the alternatives. There are no effects on

watersheds, fish, or riparian areas from any of the alternatives from the free-use permits issued to the general public to collect limited amounts of rocks.

Alternatives B modified, C, and D

All action alternatives include forest plan direction that would provide adequate protection to water quality and other aquatic resources from the potential impacts due to energy or mineral extraction. Forestwide plan direction addresses the availability, management, and reclamation aspects of energy and mineral resources, with desired conditions (FW-DC-E&M-02, 03 and 04) that recognize the importance of reclaiming lands developed for mineral resources in an appropriate manner, in order to protect other resource values and human health. Standards and guidelines direct the implementation of new operations by requiring measures to mitigate for potential impacts to vegetation and potential water table alterations (FW-STD-E&M-03). FW-GDL-E&M-07 states that mineral operations should not be authorized in riparian management zones. This is similar to the requirements under INFISH and is designed to minimize effects on water quality. If operations within riparian areas cannot be avoided, then measures to maintain, protect, and rehabilitate fish and wildlife habitat would need to be included in the authorization. FW-GDL-RMZ-06 restricts the establishment of new sand and gravel mining and extraction operations within riparian management zones. Hauling of gravel, rocks, or materials from these sites might impact water quality along haul routes; this effect would be the same under all alternatives.

Effects on water quality from recreation

Background

In general, people who recreate in national forests often participate in activities such as driving, hiking, horseback riding, hiking, and camping in the vicinity of lakes and streams. General effects from recreational use, construction of facilities, and maintenance of facilities and sites on watershed resources can include undesirable changes to (1) upland and riparian soil and vegetation conditions, causing increased erosion and runoff, decreased soil-hydrologic function, loss of vegetative cover and wood recruitment, and reduced water quality; (2) stream morphology, water quality, streamflow, and substrate; and (3) water quality due to spills of fuel, oil, cleaning materials, or human waste associated with equipment and the pumping of toilets.

Streambank trampling, camping along the stream’s edge, heavy fishing, and wheeled motorized vehicle use on designated routes and areas usually result in loss of vegetation within riparian areas. Loss of vegetation from shorelines, wetlands, or steep slopes can cause erosion and water pollution problems (Burden & Randerson, 1972).

Trail maintenance can affect large wood recruitment and function that influences stream channel morphology and aquatic habitat. Bucking out fallen trees can reduce the tree’s length and sever the bole from its root wad. Smaller tree lengths are not likely to contribute as much to stream channel stability and are more likely to be washed out during high streamflow events. Smaller instream wood also delays the recovery of channel features needed to maintain habitat for aquatic species, including overhead cover and low-velocity refugia during high-flow events.

Impacts from the use of trails may include rutting, erosion, and loss of groundcover from user-created trails; trampling of vegetation; vegetation removal; and soil compaction of streamside and upland sites. Rutting may increase surface erosion associated with heavily used trails. High-use campsites may cause root damage in trees, resulting in reduced vigor and mortality. In combination, these activities can lead to increased erosion and a reduction in water quality.

Effects common to all alternatives

Recreational use is anticipated to increase in the coming decades. Projected increases in recreational use would be similar under all alternatives, including uses in or near stream and lake environments. Protection of water quality and quantity and of riparian habitat near waterbodies associated with recreational uses is achieved through the implementation of best management practices. However, increased use would likely increase the potential of impacts to stream and lake environments under all alternatives.

Alternative A

The Inland Native Fish Strategy amended the forest plan in 1995 and provided three standards and guidelines for recreation management, mainly relocating or constructing new developed and dispersed sites outside of riparian areas. No developed recreation sites have needed to be relocated since 1995 due to adverse impacts to riparian management objectives and fish. Dispersed and developed sites are often located within riparian areas; the ground is often hardened and ground vegetation may be removed. However, areas where there is concern about excessive sediment production from dispersed or developed sites have not been identified. Dispersed sites typically do not have toilet facilities, and concentrations of human waste have been found at some locations. Trees have been felled for safety reasons in campgrounds, and this would continue. Under current direction, these trees would be removed or used as firewood and would not contribute to streambank stability, thermal regulation, or fish habitat needs. This impact is limited to developed recreation sites, and PIBO monitoring does not show that large wood is limited in the Forest's streams.

Alternatives B modified, C, and D

Plan components under all the action alternatives direct new developed recreation facilities to be located outside of the inner riparian management zone to protect fishery resources and riparian-associated plant and animal species (FW-GDL-REC-06). Exceptions may occur if actions are to address human health and safety issues or if the new facility is water-related, such as a boat ramp. In addition, new solid and sanitary waste facilities should not be placed in the inner riparian management zone (FW-GDL-REC-02). However, it is assumed that minor, localized impacts to riparian vegetation, woody debris, and water quality would still occur where existing recreational use and facilities are located.

Effects on water quality from motorized and nonmotorized winter recreation

Background

Nonmotorized winter uses may include but are not limited to cross-country and alpine skiing, snowshoeing, and ice fishing. Motorized winter uses include motorized over-snow vehicle use. Damage to vegetation and soil erosion may occur if there is inadequate snowpack to protect these resources. Also, winter motorized activities can result in compacted snow caused by grooming which often forms barriers that alter spring runoff patterns and can lead to soil erosion and gullies. A guideline (FW-GDL-IFS-09) directs snowplowing to provide breaks in the snow berms to reduce erosion and sediment.

Alternatives A, B modified, C, and D

The Forest has identified very few impacts from winter recreation on water quality, quantity, or habitat. An old bridge used by groomers collapsed into Challenge Creek in the mid-1990s and plugged the channel. This situation was easily remedied by removing the footing and installing a larger bridge. The Forest has also had water running down groomed or plowed roads where breaks were not established in the berms to dissipate the water. This resulted in some localized gullying but no identifiable impacts to water quality. Effects would differ little between all alternatives, but alternative C would have the least amount of area identified as suitable for motorized over-snow vehicle use and alternative D would have

the most. There would be little to no effects on water quality and watershed resources, largely because winter use does not result in ground-disturbing activities since it occurs over snow.

Contamination due to leaks or accidents of petroleum products such as motor oil and gasoline might degrade water quality in waters adjacent to areas of concentrated use such as parking lots and snowmobile staging areas. The likelihood and magnitude of impacts due to these activities is dependent on site-specific factors such as average slope, aspect, elevation, vegetation, weather conditions, available facilities, and the amount of use. Because site conditions vary and because these sites are relatively small in area and widely dispersed, it is reasonable to assume that cumulative impacts would not be measurable at the forestwide scale.

Effects on water quality and quantity from winter recreation ski facilities

Background

Whitefish Mountain Resort and Blacktail Ski Resort operate under special-use permits. Ski area development can lead to increased runoff and erosion through timber clearing for lifts, runs, and other facilities. Ski areas and snow resorts typically remove forest vegetation from much of the area. Snowmelt runoff is increased, especially when cleared areas are compacted or snowmaking has artificially increased the snow depth. Substantial amounts of such disturbances can increase the size and duration of spring high flows. Stream channel damage can result from increased runoff that leads to erosion. Ski areas also typically disturb soils throughout cleared areas. Erosion and sediment can result, especially from soils that are near streams, unstable, or highly erosive. Aquatic habitat can be damaged as a result. In addition, these uses can also degrade wetlands and riparian areas by draining or filling them or by altering their vegetation.

The City of Whitefish water supply originates partly on Whitefish Mountain Resort in Haskill Basin. Water from First Creek, which is within the permitted ski area boundary, is no longer used. The City still uses water from Second and Third Creeks, which are the primary source of water. Significant contaminants that could potentially threaten the City of Whitefish water supply include nitrate, pathogens, herbicides, pesticides, volatile organic compounds, petroleum hydrocarbons, and total dissolved solids. The City of Whitefish routinely monitors for more than 80 constituents in drinking water, according to Federal and State laws. The City also has in place a set of management recommendations for preventing significant contaminants from entering drinking water resources and for addressing specific sources of contaminants should they pose a threat to the system. The 2014 Annual Drinking Water Quality Report for the City of Whitefish Water Utility concluded that the City’s drinking water is safe and meets Federal and State requirements (City of Whitefish, 2014).

Alternatives A, B modified, C, and D

Management of the Whitefish Mountain Resort in Haskill Basin with regards to the water supply for the City of Whitefish would not differ between the alternatives. The City’s drinking water supply is expected to remain safe.

Past effects on water quality have been identified with regards to operation of developed winter sites. For example, Whitefish Mountain Resort uses groomers that have concentrated snow in the headwater tributaries of Big Creek. A culvert below Chair 7 plugged and partially failed, which led to increased sediment entering the stream. Impacts from these types of activities are highly localized and few in nature, but they can and do occur at times and can be prevented through proper monitoring and sizing of culverts. All alternatives would continue to permit the existing downhill ski areas as well as the cross-country ski areas at Round Meadows, Blacktail, and Izaak Walton. Management of the permitted winter recreation areas would be the same under all alternatives, with no new forest plan direction related

directly to how these sites are managed for watershed conditions. Thus, any potential effects would not change, and localized impacts would be addressed site specifically as they occur. Effects associated with potential increases in water yield from clearing for ski runs would be the same as the effects of timber harvest discussed later in this section.

Effects on water quality from hiking and stock trails (nonmotorized trails)

Background

Trail networks and trail use can adversely affect water quality. Hiking and stock trails are popular among Forest users. This popularity, combined with the expected increase in recreational use on the Forest, makes it reasonable to expect demands by the public for additional hiking trails over the coming decades. An expanded trail system could result in the alteration and degradation of water resources.

Demand for a variety of recreational opportunities will continue to increase on the Forest whether there are adequate recreational facilities to meet the increased demand or not. If facilities are insufficient for developed recreation, then recreational use may shift to dispersed sites, the result of which could be additional and unregulated deleterious effects on soils, vegetation, and riparian values. Recreational use is expected to increase under all alternatives, and impacts are anticipated to be the same between alternatives because nonmotorized trails generate very little sediment and are often located on a ridge leading from a trailhead to a higher location with a view.

Alternatives A, B modified, C, and D

Nonmotorized trails typically have very little impact on water resources compared to roads. Sediment erosion from trail use generally gets routed onto the forest floor with no impact on water quality, but sediment can be routed to stream crossings as well. At times, trails have slumped into streams due to their location paralleling a stream, not due to their use. Wildfires as well as high flow events have washed out trails both inside and outside of wilderness areas. Once again these impacts are localized and do not result in watershed-scale impacts. Guidelines FW-GDL-IFS-03, 05, and 08 are designed to maintain the hydrologic integrity, preventing the delivery of water, sediments, and pollutants by providing for water drainage systems, ensuring that water bars are in place, hardening stream crossings, and reducing the risk of slumps. Thus, any potential pollutants such as sediment, nitrogen, or phosphorus would be routed to the forest floor rather than the stream network.

Effects on water quality and quantity from motorized trails, travel management, and roads

Background

A summary of the science related to road impacts on water and aquatic resources is discussed in this section to provide context to the effects related to the alternatives.

Road networks have been shown to have detrimental effects on water and aquatic resources in forested landscapes. Road systems can change a natural hydrologic regime by altering natural flow patterns and increasing sediment delivery to streams. Roads have been shown to destabilize side-casted material and hillsides, expand the lengths of gullies and stream channels, increase sediment delivery, and alter streamflow and channel adjustments (Furniss et al., 1991; Quigley & Arbelbide, 1997).

Natural drainage patterns can be affected over the long term by the mere presence of roads. Roads intercept subsurface drainage in cutslopes, capture rainfall on hardened road surfaces, and route excess runoff into the stream channel system. These impacts increase as the road system becomes more connected hydrologically to the natural channel network. Where a dense road network is well connected

to the stream network, it can become an "extension" of the actual stream network and alter streamflow regimes. These alterations can increase the delivery of water to the mouth of a watershed during snow melts and storm events, which can increase peak flows in streams and water levels in ponds, lakes, and wetlands.

Sediment from the road system can be delivered to streams by direct erosion of cut and fill slopes associated with stream crossings or by surface runoff from roads and ditches that carries sediment-laden water directly or indirectly to streams. In general, roads lacking surface rock, those with steep grades and steep sideslopes, and those that cross streams or are in proximity to streams are the greatest contributors of sediment from surface erosion. In steep terrain, roads can increase the rate of hillslope failures and soil mass wasting. Excessive fine sediment loading can lead to changes in channel morphology and water temperature because of pool filling, widening of the channel, and making the channel shallower, which can result in water temperature increases as a result of having a shortened water column that takes less solar energy to heat. Such changes in channel morphology are typically found at road-stream crossing locations and in response to mass failures associated with road runoff. Sometimes roads capture flow out of the channel and result in the stream rerouting down the road, which typically results in road failure and more sediment delivery to streams.

Vehicular traffic also has the potential to contribute to sediment delivery from roads, particularly if ruts develop in the road and if traffic is heavy during shoulder seasons when the ground is more saturated. Log haul during timber sales is typically down the same road system for weeks or months at a time, and the quantity and repeated nature of this traffic can make it a systematic, recognizable source of sediment on NFS roads.

The location and design of valley bottom roads may also create long-term effects on water resources. Poorly placed roads can encroach on stream channel and floodplain areas. Many older roads were constructed very close to stream channel areas, often in the floodplain. Often streams were straightened to accommodate road placement. Roads can affect stream channels directly if they are located on active floodplains or directly adjacent to stream channels. For example, a road located adjacent to a stream can be a chronic source of sediment. If the road changes the morphological characteristics of the stream, this can set forth a chain reaction of channel adjustments that can result in accelerated bed and streambank erosion, producing excessive sediment.

Not all sediment production from roadways reaches the aquatic system. Many of the aforementioned effects of roads can be mitigated by design changes that disperse rather than concentrate road runoff. Properly designed and maintained road treatments can decrease runoff and sediment loading to streams. Good design provides stable cut and fill slopes and adequate drainage that allows water to filter through vegetated strips or sediment traps before entering the stream channel. The effectiveness of these vegetative strips generally increases with increased width and lower hillslope gradient, but the effects of large-scale or chronic road impacts may still impact streams even when streams are protected by wide and intact vegetative strips. Other design elements used to mitigate road interception and runoff are the addition of gravel surfacing and seasonal road closures. Road treatments can upgrade or remove problem culverts to allow sediment and wood to move downstream instead of accumulating upstream of roads and leading to culvert blockage and failure. However, temporary, short-term, and long-term sediment and turbidity increases can occur from project implementation as well as from post-project stabilization.

Turbidity and sediment increases may result from the construction of roads, road grading, ditch cleaning, culvert replacement, road ripping or decompaction, and the installation of water bars due to the heavy equipment excavation that these activities require. Minor amounts of fine sediment could be delivered to streams during implementation of road treatment activities and during the first substantial runoff event. Subsequent runoff events would contribute less sediment production over time but are expected to last up

to one year or until vegetation is established on bare-soil areas adjacent to streams. Design criteria and best management practices are used to minimize the amount of fine sediment entering stream channels while work is in progress and after the work is completed; this includes promoting vegetation establishment through seeding.

Roads that are at high risk of failure and have the potential to cause extensive resource damage are candidates for relocation or decommission. Preferred locations for roads are away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas, and areas of high mass movement. Realignment of roads so they traverse riparian areas and streams at perpendicular angles rather than parallel angles would improve the quality of riparian and aquatic habitats in presently impacted stream reaches by reducing chronic sediment sources. If relocation is not possible, seasonal restrictions could limit road damage and subsequent sedimentation.

The potential risk of detrimental effects of a road exists as long as the road is retained. The continued use and existence of roadway segments that interact with stream corridors pose a risk of erosion, slope failure, and sediment delivery to receiving waters. Road obliteration reduces the long-term risk of sediment delivery to streams from roads and roadside ditches through reducing culvert failures and landslides, eliminating vehicular traffic, improving infiltration of water into the ground through decompaction of road surfaces, and reducing overland and ditch flow into streams. Although some sediment is expected to be delivered to streams during culvert removal and decommissioning processes, the risk of sediment delivery to streams is expected to be significantly less than would occur if the roads were left under current maintenance. Cook and Dresser (2007) found that stream crossings that were restored through decommissioning delivered to the stream only 3 to 5 percent of the amount of fill material that was originally located at each crossing.

Removal or closure of roads adjacent to streams can have a short and long-term positive effect on soil-hydrologic function, soil productivity, and stream water temperature. Trees and other riparian vegetation can re-colonize a ripped roadbed and help provide shade. How much water or stream temperature improves depends on the existing stream shade to block solar radiation and water temperature, the stream's size, and how much riparian road is removed or closed.

Flathead National Forest roads

The road network on the Forest affects water and aquatic resources on both a short- and long-term basis. Within the boundary of the Forest, 1,393 miles of NFS roads are open to the public and 1,191 miles of NFS roads are for administrative use only. There are 933 miles of NFS roads (nearly all maintenance level 1) that are closed to vehicular traffic by physical barrier. In total, there are about 4,610 miles of road within the Forest's boundary. Of all of these motorized routes, approximately 607 miles of roads and 18 miles of motorized trails are located within riparian management zones, and there are over 3,500 road-stream crossings. The routes located closest to water resources potentially provide a background level of disturbance that contributes to direct and indirect effects on aquatic and riparian resources. There are also about 226 miles of wheeled motorized use NFS trails on the Forest. Motorized trails function similarly to roads in terms of soil disturbance, but the impacts may be less because less surface area is disturbed.

Past culvert failures and road slumps have impacted water quality on the Flathead National Forest, particularly at the site scale. National Forest System roads that are maintained on an annual basis are typically those roads that have the most administrative and visitor use. In 2015, 494 miles of NFS roads were maintained, which included 73 percent of the roads suitable for passenger cars (maintenance levels 3-5) and 16 percent of the roads open and suitable for high-clearance vehicles (maintenance level 2). Closed roads receive less maintenance than open roads, and not all of these roads have been put into long-term storage and had their culverts removed, which reduces risk of culvert failure and minimizes erosion

into streams. Over 1,500 stream crossings are located on closed NFS roads, and some have culverts that do not receive regular maintenance. Inspection and monitoring of culverts is a monitoring item (MON-IFS-02) to address this concern and provide maintenance.

Alternative A

Standards and guidelines from INFISH and the 1986 forest plan would be carried forward under alternative A and would continue to require, among other things, fish passage, upsizing of culverts to allow passage of the 100-year flow plus sediment and debris on streams, and the application of best management practices, all of which would be beneficial for water quality. Detrimental effects to water quality would continue to occur when culverts fail or roads slump, and unmaintained roads and stream-crossing culverts pose the greatest threat to water quality.

Portions of the road network would be treated to repair and improve drainage structures, improve the running surface of the road, and clear vegetation along roadsides. Road maintenance would be expected to continue at similar levels or slightly decreased levels compared to more recent management. Short-term increases of sediment delivery to streams and waterbodies would be expected as a result of road surface grading and culvert and ditch cleaning near waterbodies.

Portions of the road system that are in particularly poor condition or are currently closed and in long-term storage will be reconstructed periodically, particularly in connection with land management activities such as timber harvest projects. Road reconstruction includes application of surface rock, replacing damaged or poorly functioning culverts, adding stream-crossing or ditch relief culverts where necessary, some road widening, and the removal of roadside vegetation that is encroaching on the road surface and preventing vehicular passage. Again, these activities would be expected to create some turbidity increases in nearby waterbodies, but best management practices would be employed to minimize erosion and sediment transport to waterbodies.

Watershed restoration actions on the Forest over the last 20 years have primarily focused on culvert removals, road decommissioning, road relocation, and slump stabilization. The 1986 forest plan, as amended, has resulted in the decommissioning of over 900 miles of roads, primarily to meet amendment 19 requirements. Under alternative A, an additional approximately 518 miles of roads would need to be retained on the transportation system as reclaimed or taken off the transportation system as decommissioned to meet amendment 19 requirements. In addition, about 57 miles of trails would no longer allow wheeled motorized use in order to fully meet amendment 19, unless site-specifically amended. Water resources might benefit from this decommissioning in the long term, depending upon the extent of roads near water that are decommissioned. As described in the general effects, there would be some short-term impacts to water quality from the sediment delivery anticipated during excavation activities in or adjacent to waterbodies.

Decommissioning or storing a road can eliminate the long-term effects from roads. Approximately 2,130 miles of NFS roads (using the 2016 roads layer) on the Forest are closed yearlong, of which 2,099 are maintenance level 1 and no longer receive maintenance, but the impacts of these roads on aquatic resources have not always been eliminated. Culverts that are not maintained or are undersized may become blocked with sediment and debris, eliminating their ability to pass water, bedload, and debris downstream and increasing the likelihood of road failure and mass wasting. The Forest has approximately 1,500 stream crossings located on these closed roads, with some stream-crossing culverts remaining on the landscape that have not been mapped or inventoried. Similarly, some historic and decommissioned roads have been found to still contain culverts at stream crossings, but the majority have been removed. The Flathead National Forest had a culvert inventory and monitoring program from 2007 to 2009 and is reinitiating this program in 2017; thus, this issue will be further addressed under all the proposed

alternatives. Under alternative A, there would be no requirement to reduce the number of stream crossings or the length of roads in riparian management zones within the conservation watershed network (FW-GDL-CWN-01), as required under the action alternatives.

Motorized use on the Forest is only allowed on designated routes and areas. The Swan Lake Ranger District near Blacktail Wild Bill Trail System has a network of trails that is primarily located on ridgetops and away from streams, so there is little impact on watershed conditions. Cedar Flats Off-Highway Vehicle Area and Hungry Horse Off-Highway Vehicle Area are two areas that allow wheeled motorized use, and there are a few ephemeral stream crossings in Cedar Flats that go subsurface and thus have no impact on watershed conditions. Additional motorized trails on the Swan Lake and Tally Lake Ranger Districts may contribute sediment at stream crossings during certain times of the year. The motorized trail in Puzzle Creek drainage on Hungry Horse Ranger District is on a gated road, and effects are the same as if it were a road.

Alternatives B modified, C, and D

Forestwide direction includes guidance that would alter road management on the Forest to address the detrimental effects of roads on water quality, wetlands, riparian areas, and aquatic species. Although INFISH amended forest and road management on the Forest, the forestwide plan components for alternatives B modified, C, and D would further mitigate the effects of roads on water resources.

The forest plan includes a plan component (FW-DC-IFS-07) that directs the application of best management practices and other design features to minimize sediment input to waterbodies. This desired condition, along with those under other resource areas—watersheds, conservation watershed network, riparian management zones, and soils—are intended to focus future road management to address the impacts of roads on aquatic and riparian habitat and water resources.

Many of the proposed plan components that affect water quality related to routes and/or road management are the same as or have been modified slightly from current direction, including the following:

- FW-GDL-IFS-10, which is comparable to INFISH RF-2d, requires the Forest to route new or reconstructed roads away from potentially unstable channels, fills, and hillslopes. This guideline would reduce the amount of sediment delivered to streams both directly off roads and from gullies and mass failures associated with unstable areas adjacent to streams.
- FW-GDL-IFS-13, which is comparable to standard Water 3a under the 1986 forest plan, requires that the transportation infrastructure should maintain and protect natural hydrologic flow paths (e.g., streams should be kept flowing in original channels). This guideline would ensure that streams are not routed down ditches and into other stream channels in order to maintain current discharge and streamflow patterns and not increase erosion in roadside ditches.
- FW-GDL-IFS-09, which is comparable to INFISH RF-2f, directs that sidecasting into or adjacent to waterbodies should not be done when blading roads and plowing snow. Breaks should be designed in the snow berms to direct water off the road. This guideline is intended to prevent sediment and debris that are mobilized through blading and plowing from reaching streams and affecting water quality (amount of suspended sediments) and fish habitat.
- FW-GDL-IFS-06, which is comparable to standards Water 2c and 2i under the 1986 forest plan, requires that new and relocated roads, trails, and other linear features should avoid lands with high mass wasting potential. This standard is intended to reduce road-related mass wasting and sediment delivery to watercourses and is expected to prevent the degradation of water quality at individual sites.

Several plan components are modified slightly from current direction to provide increased benefits for water quality and aquatic resources, including the following:

- FW-STD-IFS-07, which is comparable to INFISH RF-4, requires that new, replacement, and reconstructed stream crossing sites accommodate at least the 100-year flow, including associated bedload and debris. This standard addresses stream-crossing structures installed on roads and trails, including bridges and culverts, in order to, at a minimum, pass the 100-year flow plus associated bedload and debris, which would reduce the likelihood of blockages and mass failures at stream-crossing sites. This standard differs from previous direction in that it applies more broadly to road and trail crossing structures, whereas INFISH RF-4 only requires installation of a 100-year crossing structure where "a substantial risk to riparian conditions" exists (USDA, 1995b, p. E-8).

- FW-STD-IFS-06 prohibits sidecasting fill material when reconstructing or constructing new road segments within or adjacent to riparian management zones, which is comparable to the second part of INFISH RF-2f. This standard would apply across the entire Forest, whereas the INFISH RF-2f standard only applied to INFISH priority watersheds. This standard is intended to expand benefits to riparian and water resources to a larger geographic area, thereby reducing the likelihood of road failures and mass wasting into waterbodies across the entire Forest.

Several plan components are new or expand upon existing concepts and benefits, such as the following:

- FW-GDL-IFS-04 requires that roads that are to be decommissioned, made impassable, or stored would need to be left in a hydrologically stable condition. This standard would apply the concept of leaving a road in a stable condition if it is expected to no longer receive routine maintenance, including roads that are actively or newly stored, closed, or made impassable on the Forest. Similarly, FW-GDL-IFS-05 states: Prior to placing physical barriers such as berms on travel routes (e.g., roads, skid trails, temporary roads, or trails), the Forest should ensure that road drainage features are in place to protect aquatic and other resources. These two guidelines would improve water quality downstream and adjacent to roads as a result of reducing the likelihood of sediment delivery.

- FW-GDL-IFS-03 requires that the water drainage systems on roads, skid trails, temporary roads, and trails should have water drainage systems that possess minimal hydrological connectivity to waterbodies (except at designated stream crossings). This is designed to prevent the delivery of sediment and pollutants and maintain the hydrologic integrity of watersheds. This guideline is a critical element to reduce non-point source pollution from NFS roads and trails and is expected to have the greatest impact in terms of maintaining current water quality, preventing increased peak flows and water elevation in waterbodies, and maintaining current hydrologic regimes across the Forest. Under this guideline, water that is collected on hardened surfaces or in road ditches would be routed to the forest floor and allowed to infiltrate subsurface water systems in stable areas.

- FW-GDL-IFS-07 requires that new or redesigned stream crossing sites should be designed to prevent the diversion of streamflow out of the channels in the event that the crossing becomes plugged or experiences more water than the crossing was designed to handle. Under this guideline, stream-crossing structures would be designed and installed to route high flows directly over the top of the road at the site to prevent water from running down the ditch or road surface, which could exacerbate more road failures and sediment delivery to streams. This guideline could be considered similar to INFISH RF-2e, which requires each existing or planned road to avoid disrupting natural hydrologic flow paths.

- FW-GDL-CWN-01 requires that for subwatersheds included in the conservation watershed network, net increases in stream crossings and road lengths should be avoided in riparian management zones unless the net increase improves ecological function in aquatic ecosystems. For example, moving a road out of a floodplain and up onto a hillside may warrant a longer road length but is expected to provide greater benefits to the stream and floodplain. This net increase is to be measured from beginning to end of each project. The prohibition of a net increase in road lengths within riparian management zones is also expected to reduce the impacts of roads on water quality because there would be less likelihood for road failures and mass wasting in the riparian management zone that could deliver sediment to streams.

- FW-GDL-RMZ-11 requires that new road construction, including temporary roads, avoid being constructed in category 1, 2, or 3 riparian management zones except where necessary to cross streams. This guideline is consistent with and similar to the requirements of Montana's streamside management zone law, which only allows road construction within the streamside management zone to cross streams, but the riparian management zones under the proposed plan are larger in size than the state-mandated streamside management zones. This guideline is expected to maintain water quality by reducing the likelihood of road failures and mass wasting in the riparian management zone that could deliver sediment to streams.

- FW-STD-SOIL-03 and 04 require that soil function be restored when temporary roads are no longer needed and when existing roads are decommissioned. The exact treatments necessary at any site would be determined based on site-specific characteristics, but in many cases these standards would result in the decompaction of these road surfaces and the application of available slash. If the road has already revegetated and is found to already be in a hydrologically stable condition, these roads may not receive further treatment (to avoid disrupting the natural restoration process that has begun). When roads have been decompacted and covered in slash, rainfall and water drainage would be expected to infiltrate into the ground and no longer be delivered to waterbodies, which would reduce the likelihood of concentrating flow and would improve water quality.

Under the action alternatives, the effects of proposed road construction on the existing road network would be minimal because the provision for no net increase in road densities in the primary conservation area for grizzly bears would limit the extent of the future transportation system. The maintenance, reconstruction, and decommissioning of roads would be expected to influence aquatic resources more than new road construction during the life of the forest plan.

Due to the programmatic nature of this final EIS, it is difficult to specifically determine the effects of alternatives with respect to the use of roads during timber harvest. For example, alternative D removes the most timber volume, but alternative C harvests the most acres over the planning period (see sections 3.3 and 3.21). The effect of log hauling on aquatic resources is dependent upon a number of variables, such as road surface, miles to access harvest units, proximity of a road to a stream, the amount of volume on a log truck, etc. These types of impacts are evaluated on a project-specific basis. Plan direction discussed above relative to road and trail (i.e., skid trail) management is expected to minimize effects on aquatic resources that might result from motorized activity associated with vegetation management.

The removal of stream-crossing culverts and reestablishment of the natural stream grade is expected to have the greatest impact on water quality under the action alternatives. As mentioned previously, Cook and Dresser (2007) found that stream crossings that were restored through decommissioning delivered only 3 to 5 percent of the amount of the fill material that was originally located in the road prism at the stream-crossing location. Alternatives B modified, C, and D would sequentially improve crossings and reduce the risk of failure across the Forest as funding became available, particularly in the conservation

watershed network, and this would decrease the amount of sediment delivery to streams due to road failures. These reductions would also result from the application of best management practices that prevent gully formation and downcutting through newly excavated stream channels, such as establishing a streambed that mimics the natural stream gradient above and below the crossing, placing cobble-size rock in newly excavated streambeds, and distributing any uprooted vegetation and slash across disturbed areas adjacent to streams. Overall, all the action alternatives would be expected to lead to a decrease in stream turbidity in Forest waterbodies and streams as well as improved bedload size distribution and channel morphology over the long term.

All the action alternatives include objectives for decommissioning or placing into intermittent stored service 30 to 60 miles of roads, with priority on roads causing resource damage in priority watersheds and/or within bull trout watersheds (FW-OBJ-IFS-01). Another 100 to 300 miles of reconstruction or road improvement projects are also included as an objective (FW-OBJ-IFS-02). These objectives recognize the importance of maintaining a road system that contributes to the desired conditions for watersheds, which would improve watershed conditions by, for example, decreasing current or future sediment delivery to streams resulting from road failures.

Effects on water quality from lands and special uses

Background

The Forest issues a variety of permits for projects under its lands and special uses programs. Forest Service permits can lead to interrelated and interdependent effects on private lands that result from the issuing of a road-use permit or a right-of-way grant.

Management activities that result in ground disturbance near streams or other waterbodies have the potential to affect water quality. These potential increases are based on site-specific factors such as slope, soil types, proximity to waterbodies, residual groundcover, revegetation, etc. Conversely, soil erosion, loss of long-term soil productivity, stream sediment, and turbidity can increase due to increased road activity resulting from the issuance of road use permits or the granting of rights-of-way. Road-related effects are discussed in the previous section.

Alternative A

Current direction under INFISH, as adopted in 1995 by amendment to the 1986 forest plan, addresses new and existing hydroelectric and surface water development proposals and certain permits authorized by the Forest, with requirements to avoid effects that would adversely impact native fish. The Forest consults with USFWS before issuing special-use permits, and design measures are incorporated into permits to avoid or minimize effects on native fish. Impacts to native fish have been largely avoided under the current management direction.

Alternatives B modified, C, and D

Under the action alternatives, lands and special uses guidelines (FW-GDL-LSU-02 and 03) would mitigate management activities that may be associated with special-use permits and represent a modification of existing direction under INFISH in alternative A. Under FW-GDL-LSU-02, authorizations for new special-use permits would include requirements to apply best management practices and restoration of in-stream and riparian conditions after permit conclusion, if necessary. Under FW-GDL-LSU-02, new support facilities associated with special-use permits would be required to be located outside of riparian management zones. Permitted power and telephone line construction and maintenance would continue under all alternatives. Maintenance of utility lines usually requires vegetation to be cleared 10 to 50 feet from the power line either side of the right-of-way. Clearing brush

and trees in riparian areas may increase solar radiation to streams and the forest floor, increasing water temperature. The limbing, topping, or removal of hazard trees near utility lines can also reduce in-channel wood. Power and telephone lines result in the reduction of riparian vegetation where they cross or are adjacent to the stream network. The permitting process for new authorizations would look at options to minimize this effect. These guidelines are designed to minimize effects to watersheds and water quality from these types of special-use actions and would require the use of measures within permits to protect the aquatic resources.

However, it is assumed that temporary and short-term impacts would still occur in some site-specific cases where special uses are allowed or mandated. Actions may also occur where the risk of short-term effects is worth taking because of the significant benefits to watershed resource conditions over the long term. Where facilities cannot be located outside of riparian management zones, effects would be minimized to the greatest extent possible but would not be completely eliminated.

Effects on water quality from restoration projects

Background

A wide variety of watershed restoration activities would be allowed to occur throughout the life of the forest plan to move towards or meet the desired conditions in the plan associated with aquatic resources, as described earlier in the section on the effects of forestwide direction. These activities would include instream restoration projects, including the installation of large woody debris, riparian planting, fish barrier installations, and road restoration projects, including road relocation projects, road decommissioning, and fish passage projects. The effects of road restoration projects on water resources are not discussed here; these are discussed in the earlier section regarding the effects from roads on water quality.

Removing aggrading substrate behind structures placed in streams can reduce the low-flow wetted channel width and the width-to-depth ratio, increase sinuosity and meander pattern, and over time restore floodplain connectivity. Installing woody debris structures can stabilize stream channels over the long term and make them more resistant to erosion by dissipating stream energy during periods of high runoff. Gravel bars typically revegetate with riparian species such as alder or willow, ultimately leading to channel narrowing and stabilization. Restoration of floodplain connectivity over time will result in more frequent inundation of the floodplain, fostering the creation of side channels, seasonally flooded potholes, and other kinds of off-channel fish habitats.

The placement of large wood in stream channels can improve sediment routing while creating more physically complex fish habitat. The stability or longevity of this wood within streams is strongly linked to its size, orientation to flow, channel dimensions, watershed area above the structure, and percentage of the log that is in the active channel. Eventually, some movement downstream will take place. Pieces that move can become incorporated in larger wood complexes or hang up on streamside trees or other channel features.

Alternative A

The Inland Native Fish Strategy amended the 1986 forest plan in 1995 to include four guidelines for restoration of watersheds. Restoration actions since that time have primarily focused on culvert removals, road decommissioning, road relocation, and slump stabilization. These activities have had adverse short-term sediment impacts on streams but ultimately have resulted in long-term watershed benefits. These activities would be likely to continue into the future under this alternative.

Alternatives B modified, C, and D

Restoration effects can have a long-term positive effect to watersheds and water quality but have a short-term negative effect. Typically, short-term effects occur during implementation due to increased sediment. Under the action alternatives, standards and guidelines that guide how actions and management activities are implemented would mitigate the general short-term negative effects.

Alternative C has the most recommended wilderness and unroaded backcountry areas, and potentially the fewest impacts and lowest need for restoration activities. Alternative D would potentially have the greatest impact due to expected higher-intensity vegetation management; however, various standards and guidelines (FW-GDL-RMZ-08 through 14; FW-STD-RMZ-01 through 06; FW-GDL-IFS-03 through 10) would limit management in riparian management zones as well as road construction and reconstruction activities. The funding of restoration projects is a constraint under all the alternatives. With higher amounts of timber harvest, there might be more money generated from timber receipts that could be applied to the implementation of restoration projects for watersheds and fisheries, resulting in a greater short-term impact but greater long-term improvement. Under the action alternatives, the highest priority for these restoration actions would be within the conservation watershed network to benefit native fish. It is expected that temporary and short-term impacts to fish, stream channels, water quality, etc., from culvert removals, in-channel restoration, and habitat surveys would still occur. It is also expected that long-term positive effects would occur from these restoration activities.

Effects on water quality and quantity from timber harvest and vegetation management

Background

Managing vegetation on Forest lands can impair water quality by routing runoff and sediment onto bottomland stream areas. Under the 1986 forest plan, the Forest addressed these impacts by regulating the extent of upland timber harvest, applying best management practices, and minimizing entries into riparian habitat conservation areas to provide protection from upslope activities and filter runoff. These best management practices were instituted in the 1980s to control non-point source pollution (Binkley & Brown, 1993), and the riparian habitat conservation areas were established with the INFISH amendment to the 1986 forest plan in 1995. According to State of Montana audits of best management practices, the Forest Service’s best management practices were effective 96 percent of the time (Ziesak, 2015). Using a similar audit scheme, the Forest Service was 100 percent effective in establishing the correct buffer to meet the State of Montana’s design standards for streamside management zones (Ziesak, 2015)

Forest management disturbs uplands through the removal of tree canopy and the yarding of the material to a central processing facility. Site preparation for reforestation and removal of logging slash for fuel hazard reduction purposes typically occurs by either piling slash mechanically or by broadcast burning. Past mechanical piling or burning methods (i.e., the 1980s and earlier) tended to be more intense, with fire severities and piling practices that removed protective groundcover and sometimes nearly all of the downed woody material. The Forest has largely moved away from these earlier approaches. Mechanical piling and burning with prescribed fire are still the primary methods for reducing hazardous fuels; however, current approaches recognize the ecological importance of groundcover and downed woody material, so site preparation and fuel hazard reduction methods are less intensive. The change in contemporary timber practices to whole-tree yarding has helped to achieve desired post-harvest fuel reduction while preserving protective groundcover that covers at least 85 percent of the area, based on soil monitoring data (USDA, 2010b).

Studies have documented increased sediment erosion associated with timber harvests, but the primary agent is sediment from roads (Charles H. Luce & Black, 1999; Brian D Sugden & Woods, 2007). Management controls non-point delivery of sediment within harvest areas through the use of water and

soil conservation practices and best management practices (Forest Service Handbook 2509.22 chap. 10, Region 1/Region 4 Amendment No. 1) (USDA, 2012c), focusing on the stabilization of log skidding and landing networks where erosion is most probable. Otherwise, forests generally have very low erosion rates; chronic erosion after disturbance typically lasts one to three years (W. J. Elliot, Hall, & Scheele, 2000). After timber harvest and site preparation, regrowth of vegetation covers the soil surface with plant litter, soils armor, and potential erosion hazard becomes low (W. J. Elliot et al., 2000).

Where prescribed fire is applied and blackens an area, runoff can increase from reduced infiltration. Blackened soil areas can accelerate runoff due to soil sealing from ash that lowers the infiltration capacity of soils (Doerr et al., 2006). These conditions vary spatially and decrease over the first year as products of burning in the soil degrade, (Doerr et al., 2006). Natural forest conditions have hydrophobic characteristics such as plant litter waxes and resist infiltration when soils dry, but the main difference after a prescribed fire is that burned areas lack the surface roughness to dissipate rain splash energy and interrupt runoff. Other factors that increase runoff from harvested and burned areas are steep slopes, low groundcover, and long slope lengths (W. J. Elliot, 2013). Runoff transports loose soil particles and deposits sediment down the slope proportional to runoff energy. One reason sedimentation decreases over time is that the sediment supply decreases after bare surfaces armor, lacking a ready sediment supply. During the previous planning period, the Forest has mitigated prescribed fire by not lighting fire within stream buffer areas and by burning during cool and moist conditions, which results in low- and moderate-severity fire (see section 3.2 for additional information).

The loss of forest canopy on harvest sites changes the water balance, and studies in the Pacific Northwest have documented cases where excess water from timber harvest areas influenced the peak and timing of streamflows (Keppeler & Ziemer, 1990; R. D. Moore & Wondzell, 2005; Stednick, 1996). In reviews, these cases depended largely on the extent of the harvest and the climatic regime (Grant, Lewis, Swanson, Cissel, & McDonnell, 2008). The effect diminishes over time as vegetation reestablishes. Peak flow increases were raised as a concern due to their potential to alter stream morphology and degrade water quality. The altering of streamflow can also influence stream temperature (Swanston, 1991), although the principle factor affecting stream temperature is changes to riparian cover that shades streams (Beschta, Bilby, Brown, Holtby, & Hofstra, 1987; Gomi, Moore, & Dhakal, 2006; Lee H. MacDonald & Stednick, 2003).

Watershed yield studies specifically targeted timber harvest activities that would generate a response, so these may not necessarily mimic current forest practices. Beschta et al. (2000) found a weak relationship between forest harvest and increased peak flows and reported “mixed messages” about the relationship between forest harvest and peak flow responses. Numerous studies have documented the effects of forest canopy removal on peak flows in the Pacific Northwest (Beschta et al., 2000; Hubbart, Link, Gravelle, & Elliot, 2007; J. A. Jones & Grant, 1996; Kuras, Alila, & Weiler, 2012; R. B. Thomas & Megahan, 1998; Tonina et al., 2008), but, surprisingly, very few demonstrated a direct link between water yield/peak flow changes and measured channel impacts in forested environments. In the latest review of Pacific Northwest studies, Grant et al. (2008) suggested that when degradation occurs, the channels most sensitive to peak flow changes are low gradient channels with gravel bed and sand bed substrates.

Forest Service analysis techniques rely on relationships between canopy cover area and generalized recovery trends to evaluate the risks of timber harvest. One of these approaches uses equivalent clearcut acres to equilibrate area harvested to runoff potential (Ager & Clifton, 2005) in order to evaluate potential effects on streams. However, establishing a direct relationship between equivalent clearcut area metrics and channel conditions has proved to be difficult. Schnakenberg and MacDonald (1998) found no correlation between equivalent clearcut area and stream channel characteristics in forested catchments in Colorado. MacDonald and Hoffman (1995) studied the relationship between WATSED-predicted water

yield/peak flow increases and channel characteristics on the Kootenai National Forest. The WATSED model takes a similar approach by equilibrating the area harvested to potential sediment. None of the channel types (pool riffle or colluvial step-pool) showed any increase in bankfull width or width/depth ratio under more intensive management. In addition, there was no apparent correlation between the amount of timber harvested and the magnitude of peak flows; climatic differences were the dominant control on the size of peak flows in the study area (L. H. MacDonald & Hoffman, 1995). These studies highlight the difficulty of associating size of harvest to effects at a reference scale of a watershed.

The concern over changes to peak flow from timber harvest was raised when timber was harvested on a larger scale than it is currently. The Flathead is not currently harvesting timber at the rate it was in the 1960s and 1970s. Average annual harvest rates were about 8,000 to 10,000 acres in the 1970s and 1980s compared to roughly 3,000 acres annual average acres (not including fire salvage) in the 1990s and 2000s. In addition, many of the classic watershed studies could not disentangle the effects of roads and timber harvest when at least 2 percent of the study areas had roads and skidding networks (Grant et al., 2008). Flathead National Forest management has somewhat alleviated these effects by establishing streamside buffer zones (riparian habitat conservation areas with INFISH), reducing road construction, and implementing best management practices. Plan components limit further road construction within the primary conservation area for grizzly bears and within the conservation watershed network; this applies to 87 watersheds out of a total of 220 watersheds on the Forest.

Alternatives A, B modified, C, and D

This section focuses on the effects of the alternatives in respect to the removal of forest canopy through timber harvest (including the use of logging systems), fuel-reduction activities, and prescribed fire. Effects from roads are treated separately due to their higher risk for affecting water quality and quantity. Water quality effects attributed to timber harvest could include increased sediment, nutrient load, and temperature.

The action alternatives would not increase the risk of impaired water quality over the current conditions as guided by direction in the 1986 forest plan (alternative A). For uplands, the forest plan would continue using best management practices to reduce off-site transport of sediment to streams from either timber harvest areas or prescribed burn slopes. Standard FW-STD-WTR-02 would reinforces this commitment. Additional improvements to water quality might offset past adverse impacts with objectives FW-OBJ-WTR-01 and 04 that direct restoration activities to priority watersheds. The effectiveness of best management practices at avoiding sediment was reviewed in a contemporary study in California. Out of 220 units examined, skid trails delivered sediment to streams in 16 instances (Litschert & MacDonald, 2009). The authors concluded that, in most cases, best management practices were effective. Surface roughness on skid trails was one of the factors that was found to alleviate overland flow and sediment delivery. The Forest uses slash in addition to water bars to stem overland flow and reduce sediment delivery. Also, the belt rock geology of the Forest has less potential of producing sediment than the granitics in the Litschert and MacDonald study area, based on findings from Sugden and Woods (2007).

Table 19 displays projected annual timber harvest rates (acres harvested per year) over the next two decades as modeled using the Spectrum model (refer to appendix 2 for a detailed description of the modeling process). Harvest amounts are constrained by budget and distinguished by type of harvest. Projected annual average harvest acres (all harvest types except salvage harvest, which is not modeled) over the next two decades are as follows: alternative A at 1,640 acres, alternative B modified at 3,092 acres, alternative C at 2,908 acres, and alternative D at 2,121 acres. Projected average annual harvest acres over the next two decades for even-aged regeneration harvest only are as follows: alternative A at 1,140 acres, alternative B modified at 2,091 acres, alternative C at 244 acres, and alternative D at 1,370 acres. These estimates are a product of the modeling process and as such do not necessarily reflect the

acres or types of treatments that would actually occur on the ground. They are useful for comparison, but, in reality, treatment types are site-specifically determined based on forest conditions and project objectives.

The effects from these alternatives were compared using projected regeneration harvest acres since regeneration harvest clears more forest canopy and might have higher level of equipment use than thinning or group selection harvest. However, these differences may be small since the skid trail network would not vary between regeneration harvest and intermediate harvest and since forest canopy is a poor correlate for impacts to streams (refer to section 3.2 for more details). Based on modeled outputs for even-aged regeneration harvest acres, alternative C would potentially have the least risk for connecting harvest area runoff and sedimentation to streams by using the least amount of regeneration cutting. Alternatives A and D would have a similar level of risk based on similar regeneration harvest treatment acres. Alternative B modified would potentially have the highest risk based on the proportion of regeneration harvest.

The action alternatives would continue similar protections using best management practices to stabilize skid trails and landings and disconnect them from road ditch and stream networks, drawing on Region 1 Soil and Water Conservation Practices (Forest Service Handbook 2509.22, Region 1/Region 4 Amendment No. 1). The effect would be reduced risk for runoff and sediment to waterbodies. Protections were strengthened in the forest plan by increasing the widths of riparian management zones and limiting designated skid trails and landings in riparian management zones (see section 3.2.10). Alternative A minimizes construction of these features in riparian areas as well, following INFISH direction.

Potential risk to water quality and other differences between the alternatives may be subtle since the extent of timber harvest within a watershed is typically limited by many factors, including forest plan direction associated with other resource considerations (such as providing for wildlife habitat) and physical conditions such as terrain and access. Also, recent studies showing the water yield changes due to beetle epidemics have brought out the complex relationships between forest canopy and water yield in snow-dominated regimes (Biederman et al., 2015). Although decreases in forest cover can increase snowpack and available moisture, the lack of shading can accelerate snowpack runoff (Varhola, Coops, Weiler, & Moore, 2010). Shading can offset snowmelt losses where the forest canopy remains. Furthermore, Grant et al. (2008), in a review of water yield studies, showed that fall soil deficits between cut and uncut stands explained water yield differences; cut stands lacked transpiration and thus were prone to generate greater yield since their soils had more available water and thus were less prone to infiltrating fall storm moisture. On the Forest, soils rarely have saturated soil conditions during the fall, and thus these differences would be subtle.

The effects from timber harvest on nutrient loads in streams would not vary measurably across the alternatives. The controls placed on vegetation treatments within riparian habitat conservation areas, and in the action alternatives riparian management zones, has substantially reduced increased nutrient loading from adjacent harvest areas. The reasoning is based on current actions, alternative A, not showing a strong connection of upland vegetation treatments producing nutrient loads beyond state standards. Although not comprehensive across the Forest, two streams in the heavily managed watersheds of Fish and Sheppard Creeks were recently delisted from prior impairments for phosphorus and nitrate/nitrite nutrient load. In 2014, Montana Department of Environmental Quality reassessed Fish and Sheppard Creeks. The assessment was performed according to the Montana Department of Environmental Quality nutrient assessment methods in order to update the 2014 303(d) list of impaired waterbodies. The assessment concluded that aquatic life uses are not impaired by nutrients. Total phosphorus and nitrate/nitrite were delisted as causes of impairment affecting aquatic life/fishes (MTDEQ, 2014). Goat Creek remains listed for total suspended sediments from silviculture and roads and bridges.

Timber harvest contributes to nutrient loading by changing water temperature, hydrologic regimes, flow pathways, primary production, and the organic matter content of soils (Gravelle et al., 2009). However, because of the natural variability in geology, climate, atmospheric inputs, and vegetation, as well as the wide range of forest management practices that can be applied, the measured effects of timber harvest are highly variable. The effects also depend on the potential for runoff either from roadwash or indirectly through shallow throughflow in soil which can deliver water. The greatest changes to nutrients comes from burning slash piles, broadcast burning across the harvest area, and prescribed burns. The burning decomposes plant material, leaving high rates of ammonium and nitrate. Nitrate remains highly mobile in soil. This is a natural process and one of the beneficial results of fire. However, in the aftermath of watershed-wide wildfire, the ammonium and nitrate concentrations within streams can increase to levels toxic to fish.

Under the action alternatives, prescribed burning would occur within harvest units to achieve multiple objectives, including reduction of fuel hazard, preparation of the site for tree regeneration, and stimulation of the growth of shrubs and other plants to benefit wildlife. Prescribed fires are also expected to be applied to lands outside of timber harvest units, for example, to restore fire as a natural ecological process and create desired vegetation structures and composition across the landscape. Depending upon the action alternative, an estimated 4,000 to 5,000 average annual acres of non-harvest-related prescribed fire is modeled to occur across the Forest over the next five decades (see section 3.3.1). The amount projected is lowest under alternative D and highest under alternative B modified. Alternative A has no prescribed fire modeled due to the lack of objectives for this treatment in the 1986 forest plan. However, in reality, it is expected that a similar amount of prescribed fire would continue to be applied to the landscape under alternative A as has been projected to occur under the forest plan, with a similar amount anticipated to occur under all the action alternatives. The impacts from prescribed burning activities across the Forest are expected to be minor since the burning is mostly anticipated to be low- and moderate-severity, with low potential of delivering sediment. The effects of prescribed burning have been identified as generally insignificant with regard to a wide range of hydrologic and water quality variables (Robichaud, Beyers, & Neary, 2000). In addition, guideline FW-GDL-RMZ-13 directs that when conducting prescribed fire activities, ignition should take place outside the riparian management zone and fire should be allowed to spread naturally into the riparian management zones. This is intended to reduce the potential severity of fire within riparian management zones but support the natural ecological process of fire.

Another potential source of nutrients is phosphorus bonded to sediment (Ballantine, Walling, Collins, & Leeks, 2008; Wood, Heathwaite, & Haygarth, 2005). Detachment of soil particles and associated phosphorus is often linked to soil erosion, which provides a physical mechanism for mobilizing phosphorus from soil into water (Wood et al., 2005). The greatest input of sediment comes from roads. Few studies have found statistically significant increases in phosphorus concentrations associated with clearcuts. Considering the average annual acres of harvest displayed in table 19, alternative C would likely have the least potential of off-site erosion and delivery to nearby streams of sediment with bonded phosphorus.

Under all the alternatives, water temperature would likely not increase because of management actions. The established riparian habitat conservation areas under the 1986 forest plan have preserved streamside vegetation that shades streams. The forest plan has direction that would continue to limit the extent of timber harvest within riparian management zones, including reserving live trees (no clearcuts) (FW-GDL-RMZ-08) and preserving cover for wildlife habitat connectivity (FW-GDL-RMZ-09).

Effects on water quality and water quantity from wildfire and burning for resource benefits

Background

Fire is a natural disturbance process that has historically influenced the forests within watersheds, including riparian areas and forests adjacent to water features (see section 3.2.5, subsection "Natural disturbances processes"). Fire is expected to continue to function as a natural process across the Forest, especially within designated wilderness and unroaded lands. Wildfires can affect water chemistry, water quantity, and stream channel structure through changes in transpiration, infiltration, groundwater recharge, erosion and mass wasting, riparian shading, and the recruitment and delivery of coarse debris (Lee Benda & Dunne, 1997; Gresswell, 1999; Moody & Martin, 2001a, 2001b; Wondzell, 2001). Potential post-wildfire risks from floods, landslides, and debris flows to human life, property, and/or municipal supply watersheds are an increasing concern across the western United States (Moody & Martin, 2001a).

Climatic events following wildfire can trigger surface erosion or mass failures (landslides), which in turn can deposit sediment that alters stream-channel structure and function. Severe wildfire can result in large expanses of blackened area that have a high risk of generating runoff and delivering sediment to streams when intense rainstorms occur. When wildfire burns through a riparian area, it may leave the area with no shade, thus increasing water temperatures. This effect may be offset by cooler groundwater from adjoining slopes.

Alternatives A, B modified, C, and D

Wildfire suppression tactics can affect watershed resources due to the building of fire lines and large fuel breaks and the use of fire retardant, causing soil disturbance and removing vegetation. Ground disturbance from wildfire suppression, as well as the baring of ground by wildfire, can cause a net decrease in effective groundcover so that it no longer resists rainfall runoff. These activities can route sediment to streams along compacted machine paths and linear features that channel runoff. Rehabilitation after fire mitigates these effects across the fire area. The action alternatives would mitigate these effects by limiting fire suppression activities away from the most sensitive areas, which are riparian management zones. The action alternatives would carry forward 1986 forest plan components related to locating fire camps away from riparian areas where risk of sedimentation and degradation of water quality is highest (FW-GDL-RMZ-03). The action alternatives would contain stronger language related to avoiding degrading water quality due to suppression activities by minimizing suppression activities in riparian management zones (FW-GDL-RMZ-05) as well as specific direction to avoid prescribed fire ignitions in riparian management zones (FW-GDL-RMZ-13).

Impacts to riparian management zones and riparian habitat may still occur in certain circumstances when no other suitable locations for incident bases, camps, helibases, staging areas, etc., exist (FW-GDL-RMZ-03). Delivery of chemical retardant, foam, and other additives near or on surface waters may occur when there is imminent threat to human safety and structures or when a fire escapes, causing more degradation to riparian management zones than would be caused by the addition of chemicals, foam, or additives to surface waters in riparian management zones. Conversely, where management treatments are used to reduce wildfire hazard, positive long-term effects may be realized.

Other fire suppression effects to water quality occur from fire retardant drops. Large quantities of retardant can kill fish, stream invertebrates and cause eutrophication of downstream reaches (Spence, Lomnicky, Hughes, & Novitzki, 1996). The action alternatives would improve management direction related to fire retardant drops. Rather than relying solely on resource advisors to avoid risks, as under

alternative A, areas of high risk would be mapped to improve the communication of where aerial operations need to avoid dropping fire retardant (FW-GDL-RMZ-02).

The effects of wildfire on stream runoff, sedimentation, and nutrients are largely beyond the scope of the forest plan because the Forest cannot predict when and where wildfires will burn. However, monitoring of these effects has shown that the effects of wildfire on water quality are mostly temporary and transient. Monitoring by MFWP of percent fines in the North Fork in Trail, Whale, Coal, and Big Creeks following the Moose Fire (2001) and Robert Wedge Fire (2003) showed only small increases in sediment in the year following the fires, with a return to base levels within several years.

All action alternatives would increase the area where fire may be used as a tool for resource benefit when compared to current direction under alternative A (see section 3.8). Managing fire (both planned and unplanned ignitions) for resource benefit could increase the incidence of sediment deposits but would promote ecological processes by allowing low- and moderate-severity fire at a more natural rate. Potentially, alternative C would have the highest amount of acres burned for resource benefit because this alternative has the most area in management areas where mechanical treatments would likely not occur, and fire would be the most commonly used forest management tool.

Effects on water quality from noxious weed treatments

Background

Noxious weeds are often treated with an integrated approach, with a combination of control methods that include mechanical, biological, and chemical. The effects of some of these methods are discussed here.

Effects from herbicide application depend on the type, extent, and amount of herbicide that is used, the site's proximity to a stream or wetland, the stream's ratio of surface area to volume, and whether transport from the site is runoff or infiltration controlled. Chemical persistence in the soil profile and surface water depends on the potential for the chemical to leach through groundwater, the size of the treatment area, the velocity of streamflow, and the hydrologic characteristics of the stream. Herbicide use on the Forest abides by Montana Code Annotated 75-5-605 and section 402 of the Clean Water Act.

Mechanical treatments can result in localized soil disturbance because plants are pulled. Increased sediment to streams along road cuts and fills within riparian areas is possible, but the increase would likely be undetectable due to several factors. First, not all vegetation in a treated area would be pulled, so some groundcover would still be in place. Second, not all sediment from pulling weeds along roads would reach a stream because many relief culverts divert ditch flow onto the forest floor away from streams. Finally, handpulling is very labor intensive and costly; thus, only a few acres per year could be treated using this technique across a watershed.

Alternatives A, B modified, C, and D

Although many threats to water quality from chemical application may be reduced by applying best management practices, they cannot be eliminated. Standard FW-STD-RMZ-04 would apply to riparian management zones to minimize effects to water quality by using alternatives to chemicals for treatment within riparian management zones, thus reducing leaching or drift from chemicals into the water.

Effects on water quality from wildlife management

Alternative A

The Flathead National Forest plan was amended in 1995 by INFISH, which will continue to provide standards and guidelines to limit management actions that may impact water quality. Amendment 19

amended the plan in 1995 for grizzly bear security core and reduced road densities, thus improving water quality. Under the no-action alternative, the Forest would continue to strive to meet amendment 19 standards to reduce road densities. Benefits to water quality would be due to reducing road densities, although there would be short-term impacts related to potential sediment increases. More information can be found above in the section on effects from motorized uses and travel management.

Alternatives B modified, C, and D

Alternatives B modified, C, and D propose several standards and guidelines to benefit grizzly bears that would be beneficial to watershed conditions because they would limit the amount of road construction, grazing, recreational development, or mining surface occupancy that might adversely impact water quality. The greatest benefits will be derived in the primary conservation area, followed by the demographic connectivity area and zone 1, in that order (refer to figure B-10 in appendix B to the forest plan). The following is a synopsis of beneficial standards or guidelines (there are no standards and guidelines designed for grizzly bears that would have adverse effects on fish):

- FW-STD-IFS-01. This standard would limit the amount of administrative vehicle use on roads with public restrictions in the primary conservation area, which would allow some vegetation to become established on the road surface and would limit sediment production. Gated roads would also benefit native fish by making fishing access more remote.
- FW-STD-IFS-02. This standard would limit road construction in the primary conservation area, which would reduce sediment production.
- FW-STD-REC-01. This standard would limit the number of developed recreation sites in the primary conservation area which, if they are proposed near streams, would provide benefits in the long term since there can be no more than one increase above the baseline per decade of developed recreation sites within a bear management unit.
- FW-GDL-IFS-02. Restoring temporary roads in the primary conservation area within one year would reduce potential sediment inputs following management activities.
- FW-STD-GR-05. Capping the number of active cattle allotments in the primary conservation area might reduce impacts to aquatic species, depending on the location of the allotment.
- FW-STD-E&M-05. Measures would provide for riparian management zone restoration and maintenance for operating energy and mineral plans.
- FW-STD-E&M-08. Within the NCDE primary conservation area and zone 1(including the Salish demographic connectivity area), new oil and gas leases would include a no surface occupancy stipulation that would benefit aquatic species by limiting surface disturbance, depending on the location of the proposal.

3.2.9 Aquatic species environmental consequences

Effects of forestwide direction on aquatic species

Alternative A

The Inland Native Fish Strategy (USDA, 1995b), as it was amended to the 1986 forest plan in 1995, is unchanged from its original wording under alternative A. Refer to effects of forestwide direction on water quality in section 3.2.8 for a discussion of effects that would also apply to effects on aquatic species.

Alternatives B modified, C, and D

Refer to effects of forestwide direction on water quality in section 3.2.8 for a discussion of effects that would also apply to effects on aquatic species. Plan direction would be the same under all the action alternatives, and the effects on aquatic species would not vary between alternatives. Although alternative D proposes more timber harvest and the potential to generate more Knutsen-Vandenberg revenue for restoration actions such as best management practices, road decommissioning, and culvert replacements that would benefit aquatics, it is anticipated that money would still be available from partnerships and appropriated watershed dollars to implement restoration projects regardless of how much money is generated from timber sales. Conversely, alternative C might provide greater protection for aquatic resources because there would be more recommended wilderness allocation under this alternative; however, the standards and guidelines in the forest plan are designed to protect riparian and aquatic resources during implementation of management activities, based upon past monitoring, and are expected to continue to do so into the future. Wilderness does provide the ultimate degree of resource protection for aquatic resources because land management activities are generally very limited in wilderness and management activities that would be more likely to impact aquatic species, such as road building or timber harvest, are prohibited.

Alternatives B modified, C, and D identify a conservation watershed network that would protect and maintain strongholds for native fish and refine management in riparian management zones using the concept of inner and outer areas. Standards and guidelines have been developed in the Riparian Management Zones section of the forest plan to guide management while maintaining the riparian and stream habitat conditions that were afforded under alternative A. Most aquatic standards and guidelines from INFISH have been retained. The impacts to aquatic resources under alternatives B modified, C, and D would be expected to be about the same as those under alternative A, However, the conservation watershed network developed under the action alternatives would be a benefit to native fish that would not be present under alternative A. There would also be a 300-foot-wide minimum riparian management zone on all ponds and wetlands greater than 0.5 acre, and the riparian management zone would be increased to 100 feet minimum for intermittent streams in all watersheds rather than just priority bull trout watersheds, as under INFISH, which is a change from alternative A. Riparian management zones are not exclusion zones, but forest management would have more options in the outer portion of riparian management zones while maintaining sufficient protection measures for riparian and aquatic habitat. Standards FW-STD-RMZ-01 through 06 and guidelines FW-GDL-RMZ 08 through 15 are designed to protect riparian and aquatic resources by building from INFISH while clarifying management direction. See also section 3.2.10.

The conservation watershed network (see appendix E) provides a network of watersheds designed to emphasize conservation of westslope cutthroat and bull trout by protecting and restoring components, processes, and landforms that provide quality habitat. The objective of selecting conservation watersheds is to provide long-term protection for native fish to a distributed group of the strongest populations across the Forest. These watersheds would include the entire South Fork of the Flathead River drainage and all bull trout watersheds that have designated “critical habitat” stream reaches. An objective of the watershed conservation network is to identify and conserve watersheds that will have cold water to support native fish into the future in the face of climate change. Isaak et al. (2015) identified bull trout and westslope cutthroat trout probabilities of persistence into the future under different climate warming scenarios as well as identifying cold water refugia for these species. The Climate Shield Model (Isaak et al., 2015) was used as a starting point to identify watersheds with cold water that may persist into the future. A key strategy in these watersheds is to allow no net increase in the road network and stream crossings, as identified in guideline FW-GDL-CWN-01. Reducing roads would reduce potential sediment inputs and benefit aquatic species. Upsizing culverts to reduce the likelihood of failures in anticipation of increasing fall rain events (Warner, Mass, & Salathe, 2015) is also part of the strategy.

Restoration activities would focus on stormproofing the existing road network in light of climate change (FW-OBJ-CWN-01 and 02). Maintaining migratory life histories is an important element of conservation. Thus, selecting numerous watersheds rather than a select few would provide the greatest opportunity to maintain connectivity and a migratory life history. Watersheds with bull trout and westslope cutthroat trout populations that are genetically pure or are nearly genetically pure match up nicely with the primary conservation area for grizzly bears, which would also limit the road network (refer to the section above on effects on water quality from wildlife management).

The action alternatives address potential impacts from non-native and invasive species, which are not addressed in alternative A, the 1986 forest plan. Forest plan components such as guidelines FW-GDL-WTR 06, 07, and 08 would help educate the public about invasive aquatic species. They would also require the inspection and cleaning of equipment that has been in contact with a waterbody when it arrives on the Forest, such road and fire-related equipment. These actions would help in the detection of these invasive species and would help deter invasion.

Effects of recommended wilderness and inventoried roadless areas on aquatic species

Background

The best remaining trout habitat conditions are found in wilderness and unroaded landscapes (Jeffrey L. Kershner, Bischoff, & Horan, 1997; Rhodes, McCullough, & Espinosa Jr., 1994). Across the West, roadless areas tend to contain many of the healthiest of the few remaining populations of native trout, and these are crucial to protect (Western Native Trout Campaign, 2001). Roadless areas are a source of high-quality water essential to the protection and restoration of native trout. The high-quality habitats in roadless areas help native trout compete with non-native trout because degraded habitats can provide non-natives with a competitive advantage (Behnke, 1992). Roadless areas tend to have the lowest degree of invasion of non-native salmonids (Huntington, Nehlsen, & Bowers, 1996). Unroaded areas also act as the foundation for the needed restoration of larger watersheds.

Most of the Forest's strongest fish and purest westslope cutthroat trout populations are within the Bob Marshall Wilderness Complex. There is a strong correlation between healthy fish populations and wilderness and areas with low road densities (D. C. Lee et al., 1997).

Alternative A

The 1986 forest plan, as amended, includes an estimated 98,388 acres of recommended wilderness, which is 4 percent of the Flathead National Forest. Recommended wilderness occurs across approximately 20 percent of the inventoried roadless areas. The remaining lands in the inventoried roadless areas are allocated mostly to backcountry management areas (equivalent to management areas 5a, 5b, 5c, or 5d), where minimal levels of vegetation management or other developments would occur. Alternative A would continue to provide long-term protection to water quality and thus to aquatic species.

Alternatives B modified C, and D

Alternative C would provide the greatest benefit to aquatic species because it would allocate the highest amount of recommended wilderness, and Alternative D would be the least beneficial because it would allocates no recommended wilderness. However, all the action alternatives would have an equal amount (approximately 478,758 acres) of inventoried roadless areas, which would cover about 20 percent of the Forest. Under all of the action alternatives, all acres within the inventoried roadless areas are identified as unsuitable for timber production, and the majority of the inventoried roadless areas (that are not allocated to recommended wilderness) are within management areas 5a, 5b, 5c, or 5d (backcountry). Thus, all the action alternatives would provide a fairly similar and high degree of protection to aquatic species based upon the proportion of Forest lands outside existing wilderness that would be allocated to recommended

wilderness or backcountry designations (ranging from 20 percent of the Forest under alternative D to 27 percent under alternative C). When existing wilderness lands are added in, the proportion of the Forest in areas that would remain largely undeveloped is relatively high, ranging from 65 percent under alternative D to 72 percent under alternative C. This condition would provide a high degree of protection forestwide to aquatic species and to other resources associated with aquatic ecosystems. See also the earlier section on effects of recommended wilderness and inventoried roadless areas on water quality.

Effects on aquatic species from livestock grazing

Background

There are nine grazing allotments on the Forest; only one of these (Piper Creek) is within a bull trout watershed, and it has only five cow/calf pairs. Holland Lake allotment is below Holland Lake and thus has no effect on bull trout since bull trout occur in the lake and directly in the mouth downstream of Holland Falls. Seven of the nine allotments have been inactive for periods over the last five years, so exposure to detrimental effects on riparian zones and fisheries has been limited. The allotments are in the Swan Valley and Salish Mountains geographic areas and include streams that support brook trout only. Westslope cutthroat trout are not present except in Piper Creek and Sheppard Creek in the Swaney allotment.

Alternative A

Alternative A would continue to have a minimal effect on native aquatic species because the number of grazing allotments and animal unit months would not change.

Alternatives B modified, C, and D

Under the action alternatives, the effects to fisheries would be similar to under alternative A because the standards and guidelines from INFISH for grazing were carried forward under these alternatives. The plan components and potential effects are discussed in the section above on effects on water quality from livestock grazing.

Effects on aquatic species from minerals and oil and gas

Alternatives A, B modified, C, and D

There are no active leases on the Forest, and there would be minimal to no effect on aquatic species under any of the alternatives. Refer to the earlier section on effects on water quality from minerals and oil and gas for a discussion of potential effects on water quality, which would be the same as effects on aquatic species.

Effects on aquatic species from recreation

Alternatives A, B modified, C, and D

Montana Fish, Wildlife and Parks has laws and regulations that are adequate to prevent the overexploitation of fish populations through angling with catch-and-release fishing for westslope cutthroat trout throughout most of the Forest. Fishing for bull trout is only allowed within the South Fork of the Flathead. There is some incidental mortality to fish when they are caught and released. Habitat alteration from recreational camping and day-use sites might cause some site-specific impacts but should not be extensive enough to measurably limit fish populations. Localized impacts to vegetation and banks in riparian areas occur at lakes with trout and at river access sites. The effects would be the same under all the alternatives. There would be little to no effects on aquatic and riparian resources from fishing.

Increases in recreational visitors increase the risks to aquatic communities. Arguably, the greatest threat from recreation is introduction of aquatic nuisance species. These species include any non-native plant or animal species or disease that threatens the diversity or abundance of native species, the ecological stability of infested waters, or the commercial, agricultural, or recreational activities dependent on such waters. The Montana Aquatic Nuisance Technical Committee (MTANSTC, 2002) has identified over 70 nuisance species. Some that are well known in Montana include the New Zealand mudsnail, curly-leaf pondweed, whirling disease, and various non-native fish. Although non-native fish such as brook trout and rainbow trout are desirable in many locations, there are places where they are not. An environmental assessment by the MFWP is now required before fish introductions can legally occur.

Most of the pathways of the introduction and spread of aquatic nuisance species are related to human activities, both accidental and intentional. The New Zealand mudsnail, zebra and quagga mussels, and whirling disease can be accidentally transported and spread by way of recreational boats and wading boots. The Forest will continue to support check stations for aquatic invasive species.

Effects on aquatic species from motorized and nonmotorized winter recreation

Alternatives A, B modified, C, and D

The Forest has identified very few impacts from winter recreation on aquatic species. Winter recreation generally does not result in ground disturbance because it occurs over snow, and therefore there should be no effects on aquatic species under any of the alternatives.

Effects on aquatic species from winter recreation ski facilities

Alternatives A, B modified, C, and D

Winter recreation ski facilities have no effect on aquatic species except for the possibility of a small amount of sediment inputs resulting from the grooming or maintenance of ski areas. The effects would be the same under all the alternatives. Refer also to effects on water quality in section 3.2.8 above.

Effects on aquatic species from hiking and stock trails (nonmotorized trails)

Alternatives A, B modified, C, and D

Nonmotorized trails typically have very little impact on aquatic species. Sediment erosion from trail use mainly gets routed onto the forest floor with no impact on water quality, and these impacts are localized. No measurable effects on aquatic species would occur. Guidelines FW-GDL-IFS-03 through 08 are designed to protect hydrologic integrity and prevent the delivery of water, sediments, and pollutants by providing for water drainage systems that minimize sediment input by ensuring that water bars are in place and by hardening stream crossings and reducing the risk of slumps; therefore, any potential pollutants such as sediment, nitrogen and phosphorus are routed to the forest floor rather than the stream network. Spread of invasive aquatic species is not a concern from use by hikers and stock. Spread of noxious weeds from nonmotorized recreation and resultant treatment with chemicals may cause negative impacts if improperly used. Use of chemicals is generally discouraged in riparian management zones. Effects would not differ between the alternatives.

Effects on aquatic species from motorized trails, travel management, and roads

Alternative A

Roads have the greatest impact on aquatic species due to increases in sediment and blocking upstream migration to spawning grounds. The Forest has made great strides over the last two decades under the

1986 forest plan in providing for fish passage by removing or replacing culverts. Standards and guidelines in alternative A from INFISH would be carried forward and would continue to strive for fish passage, upsizing of culverts, best management practices, etc., all of which would be beneficial for aquatic species. Detrimental effects would continue to occur to aquatic resources when culverts fail or roads slump. Also, effects may occur with heavy motorized use, reconstruction, and ditch cleaning and maintenance activities. Heavy motorized use can increase sediment generation greatly, depending on the composition of the surface material. Monitoring of sediment from McNeil core samples and PIBO has shown a decreasing trend in sediment levels in most locations.

Alternatives B modified, C, and D

Maintenance, reconstruction, and decommissioning of roads address the Forest's existing transportation system and are expected to influence aquatic resources more than road construction over the life of the forest plan. Plan components developed to minimize impacts from roads on aquatic species are a central focus of the plan, and related plan components are the same under all the action alternatives.

FW-GDL-CNW-01 directs no net increase in roads or crossings in the conservation watershed network. FW-GDL-IFS 03 through 10, 13, and 14 focus on the road system and ensure that roads are hydrologically disconnected from the stream network, provide for passage of fish, and minimize sediment from roads. This direction is designed to protect aquatic ecosystems, including aquatic species, from activities associated with roads and motorized trails.

The total miles of roads and motorized trails are expected to be less under alternative C. This would benefit aquatic species due to the decreased risk of road- and trail-related sediment. Alternative D has the greatest potential to adversely affect aquatic resources from motorized routes due to its anticipated higher intensity of timber harvest and other vegetation management, which might require more temporary or new road construction. Management areas 6b and 6c would be the areas where the greatest amount of road use and/or construction would be expected to occur to support timber harvest. However, within the primary conservation area for grizzly bears, there would be no net increase to the baseline open motorized route density or total motorized route density on NFS lands during the non-denning season under all the action alternatives (FW-STD-IFS-02). In addition, there would be no net increase in the length of roads and stream crossings inside riparian management zones for watersheds within the conservation watershed network (FW-GDL-CWN-01). These measures would be expected to minimize impacts to aquatic species from motorized activities.

Motorized use on the Forest is only allowed on designated routes and areas. The Swan Lake Ranger District near the Blacktail Wild Bill Trail System has a network of trails that is primarily located on ridgetops and generally away from streams. There are no native fish in this area and thus no impact to fish. Cedar Flats Off-Highway Vehicle Area and Hungry Horse Off-Highway Vehicle Area allow wheeled motorized use, and there are a few ephemeral streams in Cedar Flats that go subsurface where once again fish are not present. Additional motorized trails on the Swan Lake and Tally Lake Ranger Districts that may contribute sediment to brook trout and westslope cutthroat trout streams, bull trout are not present in these streams. The motorized trail in the Puzzle Creek drainage on the Hungry Horse Ranger District is on a gated road. Bull trout and westslope cutthroat are present in Puzzle Creek, and effects from sediment on these species is covered above under roads. In general, impacts on native fish from motorized trails would be extremely limited.

Effects on aquatic species from lands and special uses

Alternatives A, B modified, C, and D

Impacts to aquatic resources from lands and special uses would be primarily associated with impacts to riparian areas from special uses (see section 3.2.10). Other potential impacts would be through special-use permits to outfitters who guide fishermen and from whitewater rafting. Effects would be the same under all alternatives because the plan components are the same for the action alternatives and have not changed markedly from the INFISH amendment, with the exception of reauthorizations. Existing special-use permits were consulted on when bull trout were listed under the Endangered Species Act or had site-specific consultation if issued after the bull trout listing and were determined to largely be “no effect,” with the exception of some outfitter and guide permits and the Whitefish Mountain Resort. Special-use permits can allow for hatchery facilities such as the Sekokini Springs facility, which is used for the conservation of westslope cutthroat trout, thus providing great benefits for native fish.

Effects on aquatic species from restoration projects

Alternative A

The Inland Native Fish Strategy amended the 1986 forest plan to include four guidelines for restoration. Restoration actions since that time have primarily focused on culvert removals, restoration treatments associated with road decommissioning, road relocation, and slump stabilization. These activities resulted in improved fish passage and sediment reduction, and they would continue under alternative A.

Alternatives B modified, C, and D

The effects of restoration projects can have a long-term positive effect on water quality and aquatic species but can result in a short-term negative effect. Typically, short-term effects occur during implementation as a result of increasing sediment; however, long-term sediment reductions accrue. Standards and guidelines under all the action alternatives would mitigate the general negative effects. Refer to the section above describing effects to water quality from restoration projects, which would be the same as the effects to aquatic species

Effects on aquatic species from timber and vegetation management

Alternative A

Alternative A has the highest risk of potential adverse effects to aquatic resources from timber harvesting, not from vegetation removal but from potential associated road construction. The greatest impacts would be expected to occur in the Salish Mountains geographic area due to the proportion of area identified as suitable for timber production. However, this area has only a handful of native fish populations, so impacts to native fish would be limited. Timber harvest and vegetation management is currently limited inside of riparian habitat conservation areas due to INFISH standards; therefore, effects on riparian and aquatic resources since 1995 have been limited and will continue to be protected through the same standards.

Alternatives B modified, C, and D

Assessing effects at the programmatic level is difficult because project areas are not identified. Timber harvest and vegetation management activities would occur during the expected 15-year life of the plan, with more harvest and related management occurring, for example, in management areas that are in the general forest management areas (6a, 6b, and 6c) rather than recommended wilderness or backcountry (management areas 1b, 5a, 5b, 5c, 5d). Refer to the section above on the effects on water quality and water quantity from timber and vegetation management because the discussion and effects would be

similar for aquatic species. In that section, alternative C is noted as potentially having the least risk for connecting harvest area runoff and sedimentation to streams because it would have the least amount of regeneration cutting. This would result in the least potential of effects to aquatic species. Alternatives A and D would have similar risk based on similar regeneration harvest treatment acres. Alternative B modified would potentially have the highest risk of impact to aquatic species based on the proportion of regeneration harvest.

Riparian management zones are identified as unsuitable for timber production under all the action alternatives. Plan components that guide and limit management activities within riparian management zones are provided that would minimize ground disturbance and provide protection to water quality, stream channels, and riparian areas (refer to the more detailed information in section 3.2.10).

Vegetation management activities within the inner riparian management zones may only occur if they restore or enhance aquatic and riparian-associated resources, with a few exceptions (FW-STD-RMZ-06). As mentioned later under the riparian section, there is an exception for treatments within the inner riparian management zone for mechanical fuel treatment in the wildland-urban interface within 300 feet of non-NFS lands. This is necessary to protect private property. An analysis showed that there is about 10,500 acres of riparian area in the wildland-urban interface within 300 feet of non-NFS lands. There is only about 1,400 acres of riparian area that is in the wildland-urban interface within 300 feet of non-NFS lands in bull trout watersheds. Due to the potentially low amount of treatment that could occur and the fact that the treatment would most likely be below bull trout spawning given the Forest’s landownership pattern, vegetation management activities would likely have little effect on bull trout or bull trout critical habitat.

Standards and guidelines associated with the riparian management zone direct vegetation management activities to be conducted in ways that avoid or minimize ground disturbance that might deliver sediment to streams as well as ensure that desired ecological processes and structures would be present, such as the recruitment of large woody material that provides shade and cover for aquatic species (FW-STD-RMZ-01 through 06; FW-GDL-RMZ-08 through15). For example, FW-GDL-RMZ-12 states that vegetation management activities should be designed to minimize ground disturbance and prevent sediment from entering streams so that impacts to stream habitat and native fish spawning are minimized.

Maintenance of riparian and aquatic habitat function and processes will be provided for, which ensures that bull trout and bull trout critical habitat will be maintained. Refer to section 3.2.10 for more details.

According to standard FW-STD-WTR-02, project-specific best management practices shall be incorporated into project plans as a principle mechanism for controlling non-point pollution sources in order to meet soil and watershed desired conditions and to protect beneficial uses. Effective implementation of best management practices is crucial to avoiding or minimizing impacts to aquatic species and potentially affected streams under all the alternatives. New log landings and new roads (including new temporary roads) would generally avoid category 1, 2, or 3 riparian management zones unless they have to cross streams (FW-GDL-RMZ-11).

Effects on aquatic species from fire management

Background

The forest has experienced an increase in large fires over the last two decades (see section 3.8). Based upon monitoring by MFWP following the Red Bench (1988), Moose (2001), and Robert Wedge Fires (2003), juvenile fish populations increased in streams that experienced large fires. This is largely due to an increase in nutrients and solar input following fires. Overall, fire is beneficial to fish; fish have evolved

with fire over the last 10,000 years (Flitcroft et al., 2016; Gresswell, 1999). Adverse impacts to fish related to fire management are largely a result of fire suppression activities that involve increases in sediment, misapplication of retardant, withdrawing water when proper screens are not in place, etc.

Alternative A

Standards and guidelines for fire management were first adopted with INFISH (alternative A), and management would continue under the current direction in the 1986 forest plan under this alternative.

Alternatives B modified, C, and D

The INFISH management direction for fire management in the current 1986 forest plan would be carried forward to the forest plan. Plan components do not differ between the alternatives, and the effects will be the same under all the alternatives. Wildfires might result in short-term impacts with long-term benefits due to nutrients, large wood, and the recruitment of spawning gravels, and fire suppression activities would result in impacts that would be mitigated using plan components.

Additional direction is provided to protect aquatic resources when conducting fire management activities. FW-GDL-RMZ-05 requires the use of minimal impact suppression tactics for wildfires in riparian management zones. Temporary fire facilities should not be located within riparian management zones (FW-GDL-RMZ-03), and aerial application of fire chemicals should not occur in mapped aerial retardant avoidance areas (FW-GDL-RMZ-02). These plan components would protect aquatic species and associated ecosystems.

Effects on aquatic species from noxious weed treatments

Direct effects from herbicides and pesticides require that the affected organism and the chemical come in contact. Once in contact, the chemical must be taken up by the organism in an active form at a concentration high enough to cause a biological effect. Most direct effects of herbicides on trout are likely to be sublethal rather than causing outright mortality. However, sublethal effects of chemicals and pesticides can play a significant role in reducing the fitness of natural salmonid populations. Scholz et al (2000) and Moore and Waring (1996) indicate that environmentally relevant exposures to diazinon can disrupt olfactory capacity needed for survival and reproductive success, both of which are key management considerations under the Endangered Species Act (Scholz et al., 2000). The ecological significance of sublethal effects depends on the degree to which the effects influence behavior that is essential to the viability and genetic integrity of wild populations.

Indirect effects can include decreases in terrestrial or aquatic insects that result in a decrease in the food supply for fish and reductions in cover and shade for riparian resources. It is assumed that many chemicals used on the Forest would be benign. For example, glyphosate without surfactants (e.g., Rodeo®, Accord®) has little effect on fish. Some chemicals, such as picloram, which is highly soluble and readily leaches through the soil, may not be benign. This is in part due to the uncertainty surrounding sublethal effects to salmonids and other aquatic organisms. As discussed above, there are gaps in the scientific knowledge of how pesticides interact with the biology of trout. Effects to trout may occur that are not readily apparent, and these effects would be consistent under all the alternatives because management and plan direction would not differ between the alternatives.

Alternatives A, B modified, C, and D

Chemical treatments are discouraged in riparian areas under all the alternatives and are not applied directly to waterbodies.

Alternatives B modified, C, and D

Standards are provided (FW-STD-RMZ-04) that would apply to riparian management zones to minimize effects to water quality by using alternatives to chemicals for treatments within riparian management zones, thus reducing leaching or drift from chemicals into the water and reducing impacts on aquatic species. Effects on aquatic resources from noxious weed treatments would be the same across all the action alternatives.

Effects on aquatic species from wildlife management

Alternatives A, B modified, C, and D

Aquatic resources have benefited from wildlife management, such as road decommissioning, under alternative A and would continue to receive benefits as the Forest strives to achieve amendment 19. Benefits would be the same across the action alternatives since the plan components affecting wildlife and aquatic resources would not differ under the alternatives. Refer to the earlier section on effects on water quality from wildlife management.

Bull trout critical habitat is present within the primary conservation area and zone 1, any standard and guideline that limits roads or ground disturbance may provide beneficial effects. There are no potential adverse effects to critical habitat from any of the action alternatives.

3.2.10 Riparian area environmental consequences

Background

Riparian habitat conservation areas (alternative A) and riparian management zones (alternatives B modified, C, and D) are portions of watersheds where riparian-associated resources receive primary emphasis and management activities are subject to specific standards and guidelines. These areas consist of riparian and terrestrial vegetation adjacent to streams, wetlands, and other bodies of water, helping to maintain the integrity of aquatic ecosystems and provide for wildlife habitat use and connectivity.

Ponds, lakes, wetlands, streams and other water features have been identified and mapped across the Forest. Data sources include the National Hydrography Dataset (accessed in 2013), Montana Natural Resource Inventory Survey, USFWS National Wetland Inventory database and maps for known howellia ponds, Montana Natural Heritage Program data sets, and data sets produced and maintained locally on the Forest and by the Northern Region. This map of water features on the Forest forms the basis for the mapping of the riparian habitat conservation areas and riparian management zones for purposes of this analysis.

Effects of forestwide direction on riparian areas

Alternative A

The Inland Native Fish Strategy (USDA, 1995b), as it was amended to the Flathead National Forest plan in 1995, is unchanged from its original wording in alternative A. The Inland Native Fish Strategy reduced the risk to watersheds and riparian and aquatic resources by improving riparian zone protections. Riparian habitat conservation areas are established as management zones bordering streams, wetlands, and other water features. They are not mapped as a designated management area in the existing 1986 forest plan, but their delineation at the site-specific level is described in forest plan direction, including their minimum width. Table 16 displays the riparian habitat conservation area widths under INFISH, which are also the current direction in the 1986 forest plan (see also figure 1-08). (Note: these widths could be

adjusted in some cases, based on site-specific conditions, but these are the widths that would be used for the purpose of analysis at the programmatic level.)

There is an estimated 313,922 total acres of mapped riparian habitat conservation areas on the Forest, which is approximately 13 percent of NFS lands on the Forest (see figure 1-08).

Table 16. Minimum width in feet of riparian habitat conservation areas under alternative A, the existing 1986 forest plan (INFISH)

Water feature type	Minimum width (in feet) on each side of the stream or from the edge of the pond or wetland
Category 1—Fish-bearing	300
Category 2—Perennial, non-fish-bearing (all slopes)	150
Category 3—Ponds, lakes, wetlands > 1 acre	150
Category 4—Seasonally flowing or intermittent streams and wetlands < 1 acre in bull trout priority watersheds	100
Category 4—Seasonally flowing or intermittent streams and wetlands < 1 acre not in bull trout priority watersheds	50

All riparian habitat conservation areas are classified as not suitable for timber production, based on the determination that a scheduled flow of commercial timber products using a rotation age could not be expected to occur on these lands because of management requirements and desired conditions for other resources associated with riparian habitat conservation areas. Timber harvest is allowable within riparian habitat conservation areas, with limitations outlined in forest plan direction.

Forestwide goals and objectives in the 1986 forest plan address water quality, stream channel integrity, diversity of plant communities, riparian-dependent wildlife, and other features associated with aquatic and riparian areas that provide protection for the riparian-associated resources and values. Monitoring has shown an improvement in stream conditions since 1995 because riparian habitat conservation areas have been effective at protecting stream habitat (C. N. Kendall, 2014). The Inland Native Fish Strategy has generally stopped degradation to aquatic and riparian resources at the Forest scale, but some differences occur across the Forest. Indicators such as percent fines, bank stability, median particle size, large wood, and pools have improved, whereas others, primarily in the Salish Mountains geographic area, have declined or remained the same. Under alternative A, these protections would stay in place and the terrestrial and aquatic habitats within the riparian habitat conservation areas would continue to be protected. In addition, riparian habitat conservation areas established for wetlands, lakes, etc., would continue protecting wetland values such as shade, temperature, and downed wood.

Alternatives B modified, C, and D

The action alternatives would rename and redefine riparian widths instead of keeping them the same as under alternative A, replacing riparian habitat conservation areas with riparian management zones. Similarly to riparian habitat conservation areas in the existing 1986 forest plan, riparian management zones are not specifically allocated as a management area in the forest plan but are instead defined through forest plan direction. This direction includes standards that describe the delineation of riparian management zones and defines their minimum width. The reason they are not allocated as a management area is because riparian management zones are intimately linked to water features and to the unique terrain and site characteristics associated with each feature. They can only be accurately determined at the site-specific scale during project analysis. However, using the best available information, mapping of the riparian management zones has been conducted, and a map is provided in the final EIS (see figure 1-07)

to provide an estimate suitable for analysis at the broad scale and for preliminary information to inform future project analysis.

All action alternatives include a forest plan standard (FW-STD-RMZ-01) that establishes minimum widths of riparian management zones bordering streams, lakes, wetlands, and other water features, as defined below:

> **Category 1** Fish-bearing streams: Riparian management zones consist of the stream and the area on both sides of the stream extending from the edges of the active channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, which includes both sides of the stream channel), whichever is greatest.
>
> **Category 2** Permanently flowing non-fish-bearing streams: Riparian management zones consist of the stream and the area on both sides of the stream extending from the edges of the active channel to the top of the inner gorge, or to the outer edges of the riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, which includes both sides of the stream channel), whichever is greatest.
>
> **Category 3** Seasonally flowing or intermittent streams and lands identified as potentially unstable or landslide prone: This category includes features with high variability in size and site-specific characteristics. At a minimum, the riparian management zone must include (1) the intermittent stream channel and the area to the top of the inner gorge; (2) the intermittent stream channel or wetland and the area to the outer edges of the riparian vegetation; (3) the area from the edges of the stream channel, wetland, or landslide-prone terrain to a distance equal to the height of one site-potential tree or 100 feet slope distance (200 feet total, which includes both sides of the stream channel), whichever is greatest; or (4) the extent of unstable and potentially unstable areas (including earthflows).
>
> **Category 4a** Ponds, lakes, reservoirs, and wetlands greater than 0.5 acre and all sizes of howellia ponds and fens/peatlands: Riparian management zones consist of the body of water or wetland and the area to the outer edges of the riparian vegetation; or to the extent of the seasonally saturated soil; or to the distance of the height of one site-potential tree; or 300 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond, or lake—whichever is greatest.
>
> **Category 4b** Ponds, lakes, reservoirs, and wetlands less than 0.5 acre (except howellia ponds and fens/peatlands; see category 4a): Riparian management zones consist of the body of water or wetland and the area to the outer edges of the riparian vegetation; or to the extent of the seasonally saturated soil; or to the distance of the height of one site-potential tree; or 100 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond, or lake—whichever is greatest.

Based on these definitions, there are an estimated 410,863 acres of mapped riparian management zones on Forest lands, comprising approximately 17 percent of the NFS lands on the Forest (see figure 1-07). This is an increase of an estimated 96,941 acres forestwide compared to the area within riparian habitat conservation areas on NFS lands in the existing 1986 forest plan. This expansion is the result of increasing the size and distance of riparian management zone areas around wetlands, lakes, ponds, landslide-prone areas, and some intermittent streams.

Alternatives B modified, C, and D would have the same minimum width of riparian management zones for perennial fish-bearing and perennial non-fish-bearing streams as the current 1986 forest plan

(INFISH) of 300 and 150 feet, respectively. The riparian management zone minimum width for all intermittent streams would be 100 feet under the action alternatives, instead of varying from 50 to 100 feet as they do under the 1986 forest plan. All ponds, lakes, and wetlands greater than 0.5 acre (and all sizes of howellia ponds and fens/peatlands) would have a minimum 300-foot riparian management zone, an increase compared to the 50- or 100-foot width under the current forest plan. The riparian management zone width for all ponds, lakes, and wetlands less than 0.5 acre would also be increased to a minimum width of 100 feet. Howellia ponds would have the same 300-foot-wide riparian management zone as under the 1986 forest plan. The width for fens and peatlands of all sizes would increase to 300 feet compared to the 50 to 100 feet in the 1986 forest plan. As described in FW-STD-RMZ-01, there are qualifiers on the total widths of riparian management zones based on site-specific conditions, but, as mentioned, these minimum widths are used for analysis at the programmatic level in this final EIS.

Recent research (L. E. Benda et al., 2016) has looked at impacts from management within riparian management zones and what may be done to advance riparian condition while preserving the functional attributes for riparian and aquatic resources and water quality. The riparian management zone is divided into two areas called the inner and outer riparian management zones, with the inner area, the one closest to the waterbody, having more stringent management limitations. The minimum widths of the inner riparian management zone differ depending on the category of the water feature, and the widths may be made larger to protect sensitive resources. The minimum widths of the inner riparian management zone are defined as follows (FW-STD-RMZ-01):

For **category 1 and 2 streams**, the width of the inner riparian management zone shall be a minimum of 150 feet on each side of the stream.

For **category 3 streams** where side slopes are **greater than 35 percent**, the width of the inner riparian management zone shall be a minimum of 100 feet on each side of the stream or to the top of the inner gorge slope break, whichever is greater.

For **category 3 streams** where side slopes are **less than 35 percent**, the inner riparian management zone shall be a minimum of 50 feet on each side of the stream.

For **category 4a and 4b ponds, lakes, reservoirs, and wetlands**, the width of the inner riparian management zone shall be a minimum of 50 feet except for peatlands, fens, and bogs, where the minimum width is 300 feet.

The inner boundary would be established during project planning based on site-specific characteristics, such as terrain and slope. The specific reference to the inner gorge for category 3 streams with side slopes greater than 35 percent is carried forward from INFISH. Inner gorges occur when streams incise the hillslope, creating steep, erosion-prone side slopes. The top of the inner gorge represents the break in slope to shallow gradient hillslopes. If an already established road is located within the riparian management zone, a site-specific determination shall be made as to the width of the inner riparian management zone.

Riparian management zone direction under all action alternatives was refined through plan components to guide appropriate management based upon best available science. Monitoring and research reports over the past 20 years have documented the efficacy of riparian management zones and their ability to protect the functional attributes needed for riparian and aquatic resources and water quality. Using stream temperature as a response variable, a study in Oregon found no differences in temperature before and after a project using a no-cut buffer as small as 25 feet (Groom, Dent, Madsen, & Fleuret, 2011). Similarly, a comprehensive study in Oregon and Washington that evaluated various buffer widths found no increases in stream temperature using a 50-foot buffer (Paul D. Anderson & Poage, 2014). The latter study did point out that the efficacy depended on the adjacent disturbance and contrast in forest canopy.

Many researchers suggest that a 30-meter buffer next to fish-bearing and perennial streams is generally likely sufficient to protect against temperature increase (Paul D. Anderson & Poage, 2014; Reeves et al., 2016; Sweeney & Newbold, 2014; Witt et al., 2016). Even so, considerations of context and geography are also appropriate. In a discussion of fixed-width riparian buffers, Richardson et al. (2012) state that although these types of protections are administratively simple to implement at the stream reach scale, watershed considerations and location within the catchment provide additional important context. Refer also to more detailed discussion of best available science related to riparian areas in the introduction of section 3.2.6.

The forest plan establishes six desired conditions instead of using INFISH-defined riparian management objectives. These desired conditions describe vegetation composition and structure, species assemblage, and functional variables for riparian habitat (FW-DC-RMZ-01 through 06). The Forest would rely on PACFISH/INFISH biological opinion monitoring and collaborative monitoring with MFWP to ensure riparian conditions move towards or meet these desired conditions.

Four riparian management objectives are stream related, addressed in FW-DC-WTR-04, and applicable to forested systems: pool frequency, water temperature, large woody debris, and width/depth ratio. The PIBO monitoring effort systematically collects these parameters across the USDA Forest Service Northern, Intermountain, and Pacific Northwest Regions. In addition, PIBO monitoring also collects sediment data, which was not included as an INFISH riparian management objective. With over a decade of consistently collected data and improvements in data analysis, PIBO data can now be used to compare managed and reference watersheds on the scale of individual national forests. PIBO monitoring best meets the original intent of INFISH riparian management objectives by providing rigorously collected local data that can be statistically compared to reference conditions in the same geophysical province.

The entire riparian management zone on the Forest is classified as not suitable for timber production, based on the determination that a scheduled flow of commercial timber products using a rotation age could not be expected to occur on these lands due to management requirements and desired conditions for other resources. Timber harvest is allowable, with restrictions as specified in the plan. Other vegetation management activities are also allowed and are expected to occur to maintain desired conditions for riparian areas or other resources, as described further below. Refer also to the discussion later in this section on effects to riparian areas from timber and vegetation management.

Vegetation management in the inner riparian management zone of categories 1, 2, 3, and 4a water features would occur expressly for the purposes of restoring or enhancing riparian, fish, and aquatic resources (FW-STD-RMZ-05 and 06), with specific exceptions. Vegetation management in the outer riparian management zone would allow more opportunity to manage vegetation resources to achieve desired vegetation and riparian conditions so long as conditions in the inner riparian management zone were not adversely affected and wildlife needs in the outer riparian management zone were met.

Management within the outer riparian management zone could include treatments that contribute to desired vegetation conditions within the riparian management zone as well as to the desired pattern and diversity of vegetation outside the zone, as long as measures were included to avoid ground disturbance that might deliver sediment to streams or wetlands. Treatments would be designed to reflect the composition, structure, and pattern of vegetation consistent with the natural range of variation, as described in the desired conditions. Fire is a natural disturbance process that has historically influenced the forests within watersheds, including riparian areas and forests adjacent to water features (see section 3.2.5, subsection “Natural disturbance processes”). The natural role of fire and other natural disturbances in creating the diversity of successional stages, species compositions, and structures in riparian areas is incorporated into the design of the desired forest and vegetation conditions outlined in the plan (FW-DC-RMZ-01 through 06). In areas where the use of fire (including wildfire) or other natural disturbances is

limited or infeasible, vegetation treatments could be applied where determined appropriate to achieve desired conditions within riparian areas. Examples of treatments are prescribed fire to reduce forest density and favor fire-resistant species (such as western larch), stimulate understory shrubs and forbs, and create snags. Group selection or small even-aged harvest units could create small openings for the establishment and promotion of desired tree or shrub species less tolerant of shade, particularly hardwood tree communities. Thinning in young forests could occur to improve the growth of trees and understory plants and promote the development of large-diameter trees of desired species such as western larch and western white pine.

In addition to the desired conditions that define the purpose of management in riparian management zones and describe desired aquatic conditions and vegetation diversity and patterns, the forest plan includes direction that would result in the retention of forest conditions and cover that protect the functional attributes of riparian and aquatic resources when conducting vegetation treatments. This includes retention of live reserve trees when harvesting (FW-GDL-RMZ-08) and retention of forest cover to provide for wildlife habitat connectivity (FW-GDL-RMZ-09).

The forest plan includes standards and guidelines that serve to reduce the risk of impacts that might occur with vegetation management within riparian management zones, as discussed below.

- Standard FW-STD-RMZ-04 would control the use of herbicides, pesticides, and other toxic chemicals, with exceptions only if necessary for restoration and only if aquatic and riparian resources are maintained.
- Guidelines FW-GDL-RMZ-11, 12, 14, and 15 would restrict timber harvest activities that could result in ground disturbance that might lead to sediment input to streams or wetlands. New and temporary road construction and new landing construction would not be allowed within the entire width of category 1, 2, and 3 riparian management zones, except where needed to cross streams or when site-specific analysis and mitigation measures are determined appropriate by an aquatic resource specialist to protect resources (FW-GDL-RMZ-11). FW-GDL-RMZ-12 restricts logging and yarding methods that might cause ground disturbance in category 1, 2, and 3 riparian management zones.
- Guidelines apply the same restrictions on road and landing construction and logging methods to the inner riparian management zones for category 4a and 4b water features (wetlands, ponds, etc.) as for streams (FW-GDL-RMZ-14 and 15). This guideline applies only to the inner riparian management zone for category 4a and 4b water features because of the different physical characteristics and ecological values associated with wetland and ponds compared to linear streams. Although the results from studies and research are variable, there is some evidence (Sweeney & Newbold, 2014) that aquatic functions such as water quality would be adequately protected by restricting ground disturbance and potential sediment delivery within the inner riparian management zone of wetlands, ponds, and lakes, particularly considering the low slope gradient of the lands adjacent to many of these features. Refer to section 3.2.6 for detailed discussion of the science and uncertainties associated with the widths of riparian management zones (mostly for stream features) and to sections 3.7.3 and 3.7.4 (subsection “Aquatic, wetland and riparian habitat associates”) for detailed discussion of the science and uncertainties associated with terrestrial wildlife species and riparian management zones.
- The plan direction applying to the entire riparian management zone for all categories and protect stream- and wetland-associated values includes all riparian management zone desired conditions, standards FW-STD-RMZ-01 through 06, and guidelines FW-GDL-RMZ-01 through 11. For example, the desired conditions describe the diverse vegetation structure, habitat connectivity, and other key

ecological conditions the Forest should maintain or make progress towards in riparian management zones; the guidelines specify criteria for leaving live trees, snags, and wildlife cover.

- The soil section of the forest plan includes forest plan standards and guidelines associated with soil disturbance (FW-STD-SOIL-01 and FW-GDL-SOIL-01, 02, and 03). The infrastructure section includes plan components for road construction, reconstruction, and maintenance (FW-STD-IFS-06, 07 and FW-GDL-IFS-03 through 10 and 13, 14, and 16).
- The tree canopy would be retained due to the retention of live trees in harvest areas (e.g., no clearcutting) and the retention of forest cover to meet wildlife connectivity needs (FW-GDL-RMZ-08 and 09). In addition, all snags greater than or equal to 12 inches d.b.h. would be required to be left within treatment areas, with some exceptions (such as for safety in developed campgrounds, adjacent to landings, or in stand-replacement wildfire conditions). The use of prescribed fire, particularly underburning, may be desirable in riparian management zones to restore natural ecosystem function or to reduce forest density or fuel loadings. FW-GDL-RMZ-13 promotes the use of prescribed fire consistent with natural fire regimes.

The following protections on riparian management zones would largely not lead to different outcomes from current INFISH direction in alternative A. To limit impacts from fire suppression activities, riparian management zones would have limited exposure to fire retardant (FW-GDL-RMZ-02), and temporary fire facilities would rarely be allowed to be located within these zones (FW-GDL-RMZ-03). These protections carry forward existing protections under alternative A. Fire line construction and the use of heavy machinery would use methods that minimize impacts to riparian areas (FW-GDL-RMZ-05). The storage of fuels or other toxicants would not be allowed except in rare circumstances and would require the approval of an aquatic or other resource specialist (FW-STD-RMZ-03, FW-GDL-RMZ-04). For sand and gravel mining, the riparian management zones would carry forward existing direction; new sand or gravel mining would not be allowed, with the exception of disturbance for trail work (FW-GDL-RMZ-06).

For detailed discussion of riparian areas related to habitat for wildlife species and the effects of the forest plan direction for these species, refer to section 3.7.4, subsection “aquatic, wetland, and riparian habitat associates.”

Effects of recommended wilderness and inventoried roadless areas on riparian areas

The Forest has approximately 1,072,040 acres of existing wilderness (45 percent of NFS lands). Outside wilderness, there is approximately 478,758 acres of inventoried roadless areas (20 percent of NFS lands). These areas are largely undeveloped lands where relatively low amounts of human disturbance occur, including harvest or other vegetation management. Natural ecological processes and disturbances would be expected to be the primary factors influencing conditions within these riparian areas. Fire use, including prescribed fire, would be the primary vegetation treatment that might affect riparian areas.

Alternative A

The 1986 forest plan, as amended, proposes approximately 98,400 acres of recommended wilderness. The areas that are recommended for wilderness are mostly high elevation. Alternative A would continue to provide long-term protections to riparian areas in recommended wilderness areas, but not as much as alternative C. Natural disturbances such as fire, floods, blowdown, and avalanches would continue to be the main change agents to riparian zones in recommended wilderness areas.

Alternatives B modified, C, and D

Approximately 184,000 acres (about 45 percent) of the total estimated 410,863 acres of riparian management zones on the Forest (as mapped based on the definitions in FW-STD-RMZ-01) are within

existing wilderness. An additional approximately 58,300 acres (about 14 percent of the total) of riparian management zones are within inventoried roadless areas. Thus, 59 percent of all riparian management zones on the Forest are located on lands that are expected to be minimally impacted by human development and disturbance under all the action alternatives. Factoring in the different management area allocations that occur under the action alternatives further informs the conditions and potential impacts by alternative on the riparian areas of the Forest that are outside designated wilderness, as described below.

Recommended wilderness is expected to have very low levels of human impacts. Alternative B modified allocates approximately 190,403 acres of recommended wilderness, which includes approximately 25,000 acres of riparian management zones (or about 6 percent of the total area in riparian management zones on the Forest). Alternative C allocates approximately 506,919 acres to recommended wilderness, which includes approximately 64,000 acres of riparian management zones (or about 16 percent of the total area in riparian management zones on the Forest). Alternative D has no recommended wilderness.

Backcountry management areas 5a, 5b, 5c, or 5d represent another large area of land allocation that would be expected to have low levels of human disturbance. Alternative B modified allocates approximately 316,770 acres to management area 5a, 5b, 5c, or 5d (about 82 percent in inventoried roadless areas), alternative C approximately 134,919 acres (about 3 percent in inventoried roadless areas), and alternative D approximately 468,132 acres (about 91 percent in inventoried roadless areas).

When all NFS lands are factored in, the proportion of the Forest allocated to management areas that are expected to remain largely undeveloped and with minimal human disturbance (e.g., existing and recommended wilderness, backcountry, wild and scenic rivers, research natural areas) is relatively high, ranging from about 67 percent under alternative D to 73 percent under alternative C.

The number of acres within these relatively undeveloped, unroaded lands that occur within riparian management zones is approximately 265,000 acres (65 percent of the total acres within riparian management zones on the Forest) under alternative B modified, 289,000 acres (71 percent) under alternative C, and 261,000 acres (64 percent) under alternative D. This high forestwide proportion of riparian areas that are within management areas expected to have low to no harvest or other land management activities would provide a high degree of protection to riparian conditions and associated ecological values, including wildlife and aquatic habitat, under all the action alternatives. Existing and recommended wilderness would generally provide the highest degree of protection because human actions are the most restricted in these areas, and thus alternative C would be potentially more beneficial in regards to maintaining desired conditions within riparian areas, followed by alternative B modified and then alternative D. However, there is some uncertainty and complexities related to the potential impacts to riparian areas associated with natural disturbance processes and how they may function in the future in recommended wilderness and other undeveloped lands. Fire and other disturbances have played important roles historically in shaping the conditions within riparian areas (see section 3.2.5). The forest plan recognizes that fire use (both unplanned and planned ignitions) are important tools and would be applied to the landscape in order to maintain desired conditions and ecosystem integrity (FW-DC-FIRE-03), which would include the use of fire to influence riparian areas. The use of fire may pose greater difficulties in some portions of the Forest, such as location relatively close to communities or in areas where there is a desire to maintain specific wildlife habitat conditions. This may impact the ability to achieve desired conditions within riparian management zones in recommended wilderness and backcountry areas. These uncertainties would be similar under all action alternatives.

Effects on riparian areas from livestock grazing

Alternative A

There are nine active grazing allotments on the Forest, all with in management areas 6b and 6c (general forest medium- and high-intensity vegetation management). Seven of the nine allotments have been inactive for periods over the last five years, so their exposure to detrimental effects on riparian zones has been limited. Monitoring of allotments over the last decade has shown some streambank alteration and reduction in stubble height. In addition, there is elevated percent fines in allotment area streams as monitored at the PIBO locations, but this would have minimal impacts on riparian areas. Alternative A, would continue to have a minimal effect on riparian areas as a whole, but localized reduction in stubble height and shrub components may continue to occur unless stream sections within allotments are fenced. Incorporation of best management practices in the project-level analysis would minimize the effects of grazing on aquatic resources under the existing 1986 forest plan.

Alternatives B modified, C, and D

Incorporation of best management practices in the project-level analysis would minimize the effects of grazing on aquatic resources under all action alternatives.

The plan components for grazing that might affect aquatic resources are consistent under all the action alternatives. As mentioned under water quality, standards and guidelines specific to grazing (FW-STD-GR-07 and 08; FW-GDL-GR-01, 03 and 04) would help to reduce impacts on riparian conditions. These guidelines would reduce bank trampling and minimize livestock operations within riparian management zones, and thus there would be less compaction and loss of vegetation. Vegetation within riparian management zones is important for sediment filtering and shade. Watershed conservation practices and/or other requirements that would reduce the risk of impacts to native fish or riparian habitat are required to be incorporated into new or reauthorized livestock grazing permits.

Monitoring has shown that the proper implementation of livestock grazing standards leads to improved stream conditions. There would be no differences in effects between action alternatives except that alternative D might create more transient forage since more land would be in management areas 6a-6c (general forest), but this forage would tend to be located away from the creeks due to limited harvest within the riparian management zones.

Effects on riparian areas from minerals and oil and gas

Alternatives A, B modified, C, and D

There are no active leases on the Forest and there would be no effect on riparian areas under any of the alternatives. Generally, gravel pits are situated away from riparian areas and tend not to have watershed or riparian impacts. There would be no effects on riparian areas under any of the alternatives from free-use permits to the general public.

Effects on riparian areas from recreation

Alternative A

The Inland Native Fish Strategy amended the 1986 forest plan in 1995 and provided three standards and guidelines for recreation management, mainly related to relocating or constructing new developed and dispersed sites outside of riparian areas. No developed recreation sites have needed to be relocated due to adverse impacts to fish. This direction would be continued, and these standards and guidelines would be expected to continue to be effective at maintaining aquatic and riparian resources.

Many dispersed and developed recreation sites are located within riparian areas. Effects from this use are soil compaction and, frequently, the removal of ground vegetation. However, the Forest has not identified any areas where excessive sediment from these sites is a concern. Dispersed sites typically do not have toilet facilities, so they may have concentrations of human waste at some locations. Hazard trees have been felled for safety reasons in campgrounds and would continue to be felled for safety reasons. Once again, this impact would be limited in nature, and monitoring does not show that large wood would be limited in the Forest's streams.

Alternatives B modified, C, and D

Plan components provide guidance for managing recreation sites within riparian management zones. For example, guideline FW-GDL-REC-06 constrains new developed recreation sites from being built in the inner riparian management zone, with some exceptions, such as for water-related sites such as a boat ramp. However, it is assumed that minor, localized impacts to riparian vegetation, woody debris, and water quality would still occur where recreational use and activities are allowed. Existing recreational facilities and actions within or affecting riparian management zones might need to be modified, discontinued, or relocated if they are identified as not fully meeting functional aquatic and riparian conditions and processes or improving impaired conditions and processes.

Effects on riparian areas from motorized and nonmotorized winter recreation

Alternatives A, B modified, C, and D

The Forest has identified very few impacts from winter recreation on riparian areas over the years of implementing the 1986 forest plan, as amended. There would be no effects from any of the alternatives on riparian areas, largely because winter use does not result in ground-disturbing activities since it occurs over snow.

Effects on riparian areas from hiking and stock trails (nonmotorized trails)

Alternatives A, B modified, C, and D

Trails typically have very little impact on riparian resources. Trails commonly parallel streams and/or lakes and often are located within riparian areas. Although vegetation is removed along the trail itself, recreational use of the trails does not result in any effects to riparian function. Any impacts are localized, and riparian processes and function remain intact.

Effects on riparian areas from motorized trails, travel management and roads

Alternative A

Roads have had the greatest impact on riparian resources, especially roads that are within floodplains where riparian vegetation has been removed. Fortunately, the glaciated geology of the Forest has allowed roads to be located largely on old terraces rather than in constricted valley bottoms, as is seen in most of southwest Montana. Not very many roads parallel streams on the Forest; and most roads within riparian areas are stream crossings. Alternative A would continue to implement amendment 19 standards in those grizzly bear subunits that do not meet road standards. Riparian areas would benefit from the decommissioning of roads in riparian areas since vegetation would be reestablished. The removal of culverts at stream crossings would also reestablish riparian vegetation.

Alternatives B modified, C, and D

Adverse impacts to riparian vegetation from new road construction would be few due to limitations in the primary conservation area for grizzly bears and guidelines limiting roads in riparian management zones.

Maintenance, reconstruction, and decommissioning of roads would be done on the existing Forest transportation system and would be expected to influence riparian resources more than new road construction over the planning period. Plan components developed to minimize impacts from roads on riparian conditions are a central focus of the forest plan. Several key guidelines related to infrastructure (FW-GDL-IFS-03 through 10) are designed to control the methods and practices of activities associated with roads (construction, maintenance, decommissioning, etc.), trails, landings, and other actions within riparian management zones to reduce potential sediment inputs and compaction. Guidelines FW-GDL-RMZ-11 and 14 restrict the construction of new roads and landings and are designed to reduce the risk of sediment input and impacts on wildlife connectivity and protect the integrity of aquatic and riparian ecosystems.

The relocation of roads within riparian areas would be a priority for watershed restoration, which would greatly improve riparian conditions and floodplain processes. There would be no net increase in the road network and stream crossings inside of riparian management zones for watersheds within the conservation watershed network.

Refer to section 3.2.10, subsection "Effects of forestwide direction on riparian areas," for more detail on forest plan direction in riparian areas associated with roads.

Effects on riparian areas from lands and special uses

Alternatives A, B modified, C, and D

Land and special uses guidelines (FW-GDL-LSU 02 and 03) are similar for each alternative as they were modified from alternative A which adopted the INFISH guidelines in 1995 under amendment to the 1986 forest plan. These guidelines address permits for new facilities and their potential impacts on riparian management zones and strive to improve conditions or site them outside of riparian management zones. Some riparian vegetation could be removed or curtailed from re-establishing due to clearing of power lines, outfitter camps, etc., but that the overall effect is minor and would not affect riparian processes. Acquisition of areas along designated wild and scenic rivers would continue to be a priority for land exchanges.

Effects on riparian areas from restoration projects

Alternative A

The Inland Native Fish Strategy amended the 1986 forest plan to include four guidelines for restoration. Restoration actions since that time have primarily focused on culvert removal, road decommissioning, road relocation, and slump stabilization. Much of the restoration effort has been focused in riparian areas, and these activities have resulted in benefits to riparian areas functions and stream processes. Future benefits would be expected under alternative A.

Alternatives B modified, C, and D

Under the action alternatives, the highest priority for restoration actions would be projects within the conservation watershed network to benefit native fish. Riparian areas in these watersheds would receive the greatest benefits, and actions would focus on stream crossings. The benefit of reestablishing riparian vegetation at these sites would be the same under all the action alternatives.

Effects on riparian areas from timber and vegetation management

A number of standards and guidelines in the plan guide and restrict the implementation of timber harvest and other vegetation management activities within riparian management zones. Refer also to section 3.2.10, subsection “Effects of forestwide direction on riparian areas.”

Alternative A

The forest has had very limited timber harvest in riparian areas since 1995 when INFISH amended the 1986 forest plan. Riparian habitat conservation areas were established that limited timber harvest within riparian habitat conservation areas except for salvage or where silvicultural practices were needed to attain riparian management objectives. Generally, entry into riparian habitat conservation areas has occurred where a road bisected a riparian habitat conservation area, and harvest or salvage then occurred above the road but not below the road. The primary reason for this was to reduce impacts that would occur from firewood harvest from cutters winching trees to the road, which scours soil and plugs ditches. Entry into riparian habitat conservation areas has also occurred within the wildland-urban interface to reduce fuels. This resulted in thinning to protect structures and create defensible space. Lastly, entry has occurred to reduce hazard trees for safety reasons. Under alternative A, this direction would continue and riparian areas would be protected with the appropriate widths under INFISH. Monitoring data from PIBO demonstrates that stream habitat conditions (temperature, large woody debris, pool frequency, etc.) associated with riparian protection have generally trended in a positive direction on the Forest, with some exceptions (C. N. Kendall, 2014).

Alternatives B modified, C, and D

The action alternatives would provide a greater level of protection for aquatic and riparian resources than alternative A resulting from the increase of an estimated 96,940 acres forestwide within riparian management zones compared to the area within riparian habitat conservation areas on NFS lands in the existing 1986 forest plan. This increased area would be due to the increased width (compared to the1986 forest plan) of riparian management zones for some of the intermittent streams and some of the ponds, lakes, and wetland features (see section 3.2.10, subsection “Effects of forestwide direction on riparian areas” for details).

Riparian management zones are not exclusion zones; they are areas where vegetation management is allowed to occur, guided by the desired conditions for vegetation and aquatic resources associated with riparian management zones. The standards and guidelines in the forest plan were developed to reduce the risk of potential effects to riparian and aquatic resources. An inner riparian management zone area is defined where greater restrictions on treatments would occur under the plan, to provide a higher level of protection to the most critical areas closest to the stream or wetland. More management flexibility is provided in the outer riparian management zone, recognizing the role that active management (i.e., thinning, harvest, fuel treatments, prescribed fire) could play in some areas and landscapes in promoting desired conditions for riparian management zones. Vegetation management inside riparian management zones would consider the condition of the riparian vegetation as well as stream conditions. Site-specific, interdisciplinary analysis at multiple scales would occur before actions would proceed within riparian management zones.

Because riparian management zones are unsuitable for timber production and the purposes of harvest within the zones are limited to actions that are designed to achieve desired conditions for riparian-associated resources, the amount of harvest within riparian management zones is expected to be a minor amount compared to overall harvest levels (see section 3.21.2). The annual area forestwide of commercial timber harvest estimated to occur during the first decade of the forest plan period would be 3,138 acres under alternative B modified, 2,577 acres under alternative C, and 1,833 acres under alternative D. These

estimates are modeled and are best used for comparison rather than absolute values. Alternative D, which would have fewer acres treated, theoretically would reduce the intensity of soil disturbance due to less need for access, less equipment use, and fewer landings. Alternative B modified would have the most acres potentially treated and therefore the highest potential risk of impacts on riparian resources, which would be associated with more need for access, more equipment use, and more landings. However, the actual areas treated, their locations relative to riparian areas, and the acres that might actually be treated in riparian management zones are all site-specifically determined. In addition, the restrictions imposed on ground-disturbing activities within riparian management zones are designed to protect aquatic and riparian values. However, the potential risk of adverse impacts to riparian and aquatic resources may increase with higher numbers of acres treated due to activities such as road reconstruction, temporary road construction, use of skid trails, and other ground-disturbing activities.

One aspect of vegetation management is fuel reduction, which takes place primarily within the wildland-urban interface. Desired condition FW-DC-FIRE-05, “Fire management activities are designed to prevent spread of wildland fires to neighboring property where their objectives are inconsistent with wildland fire,” is designed to keep fire from threatening neighboring property and moving onto non-Forest Service system lands. To achieve this desired condition, it may be desirable to conduct fuel reduction activities in portions of the wildland-urban interface. Standard FW-STD-RMZ-06 is designed to protect riparian- and stream-related functions and processes by restricting vegetation management activities within the inner riparian management zone. However, exceptions are made for the nonmechanical treatments of prescribed fire and sapling thinning, which may be used as a tool to achieve desired ecological conditions. Exceptions are also provided for hand fuel reduction treatments and for mechanical fuel reduction treatments within 300 feet of non-NFS land. To assess the potential impacts of these mechanical treatments, an analysis was conducted that determined that approximately 10,500 acres on the Forest meet the criteria of being inside the riparian management zone and inside the wildland-urban interface 300 feet from non-NFS land. This amounts to about 3 percent of all riparian management zone acres on NFS land. In addition, guidelines FW-GDL-RMZ-8, 9, 10, 11, 12, 14, and 15 would apply to any treatments occurring within riparian management zones. These guidelines provide direction on the implementation of ground-disturbing management activities within riparian management zones. Based upon the very small proportion of the riparian management zones that might be affected by the exceptions that allow mechanical fuel treatments, and the direction within these guidelines, the potential impacts to riparian management zones under the action alternatives should be minimal from mechanical fuel treatments.

Guidelines for treatments in riparian management zones are designed to avoid ground-disturbing activities that might deliver sediment to streams and wetlands (FW-GDL-RMZ-11, 12, and 14). Construction of new roads, including temporary roads, is restricted in riparian management zone categories 1, 2, and 3 except where necessary to cross a stream. Log landings, designated skid trails, new roads (including new temporary roads), and new motorized trails would generally avoid riparian management zones unless they need to cross streams. To protect aquatic and riparian resources, exceptions may be considered during site-specific analysis only if the implementation of mitigation measures are determined to be appropriate by an aquatic resource specialist.

Forest plan direction in the soils section provides protection for soils that would also protect aquatic habitats and values associated with riparian areas. Refer to section 3.2.7 for additional discussion of effects on soils associated with timber harvesting. Under standard FW-STD-SOIL-02, project-specific best management practices design features should be incorporated into land management activities, which would protect riparian values.

Potential effects on riparian-associated wildlife species from vegetation management and timber harvest in riparian management zones are addressed in section 3.7.4.

Effects on riparian areas from timber harvest

As indicated by plan component FW-SUIT-RMZ 01, riparian management zones (or riparian habitat conservation areas in alternative A) are not suitable for timber production. Timber harvest is allowed for other multiple-use purposes.

The acres of riparian management zones on lands not suitable for timber production but where timber harvest is allowed varies by alternative. Alternative B modified has 157,066 acres, alternative C has 128,505 acres and alternative D has 169,143 acres of riparian management zones that may allow timber harvest. This is approximately one third of the acres that are not suitable for timber production but may allow timber harvest under each alternative. Alternative A has 124,609 acres of riparian habitat conservation areas on lands that are not suitable for timber production but may allow timber harvest, which is 28 percent of the total acres unsuitable for timber production that may allow timber harvest.

Timber harvest in the riparian management areas would be for the purpose of promoting desired conditions that maintain or improve ecosystem integrity and promote resilience of the vegetation, water, fish, wildlife, and soils resources. Timber harvest must also be consistent with desired conditions, standards, guidelines, management areas and laws (e.g., Montana streamside management zone law).

These areas are not expected to produce much timber volume. Table 153 displays the projected timber sale quantity that is expected from lands not suitable for timber production (the acres where timber harvest is allowed but is not suitable). Under all alternatives, the projected timber sale quantity from lands not suitable for timber production is less than 4.5 million board feet, with alternative C having the greatest volume at 4.2 million board feet and alternative D the least at 0.6 million board feet in the first decade. This volume is not scheduled and not managed on a rotation basis. The riparian management zones and riparian habitat conservation areas would comprise a portion of the acres managed to generate this volume.

For a description of the effects of riparian management zones or riparian habitat conservation areas on lands suitable for timber production, see section 3.21.2.

Effects on riparian areas from wildfire and burning for resource benefit

Alternatives A, B modified, C, and D

Fire is a natural disturbance process that has historically influenced forests within watersheds on the Flathead National Forest, including riparian areas and forests adjacent to water features (see section 3.2.5, subsection “Natural disturbance processes”). Fire is expected to continue to fulfill its function as a natural process across the Forest, with the use of both wildfire (unplanned ignitions) and prescribed fire (planned ignitions) available as management tools under all alternatives. Wildfire is primarily used within designated wilderness and relatively large areas of unroaded lands. Under all the alternatives, prescribed fire (planned ignitions) would be a potential tool available for use on all lands outside designated wilderness.

All the action alternatives include plan direction that supports the role of fire and its use across the Forest to a greater degree than the current 1986 forest plan direction (see section 3.8). Managing fire (both planned and unplanned ignitions) for resource benefit would promote ecological processes by allowing low- and moderate-severity fire to burn within riparian areas at a more natural rate, creating desired forest compositions and structures. Use of fire as a tool within riparian management zones would likely occur to a similar extent under all action alternatives because of the potential ecological benefits and ability to help maintain or achieve desired vegetation conditions within riparian management zones. However, alternative C could potentially have the highest amount of acres burned for resource benefit because this

alternative has the most acreage in management areas where mechanical treatments would likely not occur and fire would be the most commonly used forest management tool.

Effects on riparian areas from fire management

Alternatives A, B modified, C, and D

The forest has experienced an increase in large fires over the last two decades. Generally, riparian areas burn at a lower intensity than the surrounding uplands due to higher humidity next to streams.

Standards and guidelines would mitigate general fire management effects under all alternatives (FW-GDL-RMZ-02, 03, 04, and 05). There are no differences in effects between alternatives because it is nearly impossible to predict the extent and location of large wildfires. However, it is assumed that impacts to riparian areas would still occur where fire management activities, primarily suppression efforts, take place. Impacts to riparian management zones and habitat may still occur in certain circumstances when no other suitable locations exist for incident bases, camps, helibases, staging areas, etc. Delivery of chemical retardant, foam, and other additives near or on surface waters may occur when there is imminent threat to human safety and structures or when a fire may escape and cause more degradation to riparian management zones than would be caused by the delivery of chemicals, foam, or additives to surface waters in riparian management zones. Conversely, where management treatments are used to reduce wildfire hazard, positive long-term effects to riparian areas may be realized.

Effects on riparian areas from noxious weed treatments

Alternatives A, B modified, C, and D

Riparian vegetation, especially aspen stands, can be susceptible to mortality from herbicides, and therefore the use of chemicals would be discouraged within riparian management zones (FW-STD-RMZ-04). Effects to riparian areas from noxious weed treatments would be the same across all the alternatives because previous standards under alternative A would be carried forward and because the effects to riparian areas should be minimal due to the limited use of chemicals within riparian areas.

Effects on riparian areas from wildlife management

Alternatives A, B modified, C, and D

Riparian areas have benefited from wildlife management activities such as road decommissioning under alternative A and would continue to benefit as the Forest strives to achieve amendment 19. Benefits would be the same under all the action alternatives since plan components affecting wildlife and riparian areas are the same under all the alternatives.

3.2.11 Wetlands environmental consequences

Effects of forestwide direction on wetlands

Background

The first legal protection of wetlands came in 1977 when President Jimmy Carter signed Executive Order 11990 into law requiring Federal government agencies to take steps to avoid impacts to wetlands when possible. Then, in 1989 President George H. W. Bush established the national policy of "no net loss of wetlands." Section 404 of the Clean Water Act established a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands.

Alternatives A, B modified, C, and D

Refer to section 3.2.10, subsection "Effects of forestwide direction on riparian areas," where information on the effects of forestwide direction on wetlands by alternative is discussed. Also refer to section 3.7.4 for discussion of potential effects on wetland and riparian associated wildlife species.

Effects on wetlands from livestock grazing

Alternatives A, B modified, C, and D

Wetlands provide forage for cattle, and impacts can be seen from soil compaction and trampling on some wetlands. Noxious weeds are commonly transported by cattle and can be introduced into wetlands. The Forest has nine grazing allotments, which are located on the Swan Lake and Tally Lake Ranger Districts. There are forested wetlands and fens within these allotment area boundaries. Under Alternative A, three standards and guidelines under INFISH would require that grazing practices be modified if they retard the attainment of riparian management objectives.

Under the action alternatives, standards and guidelines specific to grazing (FW-STD-GR-07 and 08; FW-GDL-GR 01, 03 and 04) would help to reduce impacts on riparian conditions. These guidelines would reduce bank trampling and minimize livestock operations within riparian management zones, and thus there would be less compaction and loss of vegetation. Refer also to the section 3.2.10, subsection "Effects on riparian areas from livestock grazing."

Effects on wetlands from travel management and roads

Background

Construction of new roads accompanies many timber harvests. Depending on how roads are designed, constructed, and maintained, the effects of roads on wetlands and watershed hydrology can be undetectable or significant, and they can be either short term or long term. Roads can change the timing and volume and/or rate of runoff and the proportion of precipitation that infiltrates and becomes groundwater rather than runoff. These effects can rival or exceed those of the timber harvests themselves. Road-diverted flow paths often directly or indirectly lead runoff into wetlands or streams or onto downhill slopes.

Roads may alter the subsurface flow as well as the surface flow on wetland soils (Swanson, Kratz, Caine, & Woodmansee, 1988). Compacted saturated or nearly saturated soils have limited permeability and low drainage capacity. Wetland road crossings often block drainage passages and groundwater flows, effectively raising the upslope water table and killing vegetation by root inundation while lowering the downslope water table, with accompanying damage to downslope vegetation (Swanson et al., 1988).

The hydrologic effects of new roads are attributable to the following processes (NCASI, 2001):

- slowing and occasional impounding of runoff and channel flow;
- connecting, by means of excavated roadside ditches, of existing natural drainage ways that run perpendicular to the road;
- excavating into slopes and subsurface water flow paths, which causes more water to flow on the land surface; and
- removing vegetation, just as logging does, with consequent changes in water table height.

Essentially, roads can increase peak stream flows by replacing subsurface flow paths with surface flow paths, doing so by capturing subsurface water in road cuts and by reducing the rate of infiltration into compacted surfaces.

Runoff from roads generally follows one of four pathways: infiltration back into the hillslope below the road with no delivery to streams, direct delivery at channel crossings, direct delivery through gullies formed below cross drains, or indirect delivery via overland flow below the road. Direct delivery at channel crossings is the most common and most rapid form of delivery and occurs where roadside ditches and/or road tread runoff are directed to the stream-crossing structure, whether it is a culvert, bridge, or ford. Delivery at stream crossings is controlled partly by the spacing of cross drains. Direct impacts to wetlands occur if sediment is routed to them or if roads cross wetlands.

Alternative A

Under alternative A, the conservation strategy for *Howellia aquatilis* (USDA, 1997) prohibits ground-disturbing activities within 300 feet of occupied ponds. INFISH standard and guideline RF-2a requires a watershed analysis prior to construction of new roads in riparian habitat conservation areas, and RF-2b minimizes road and landing locations in riparian habitat conservation areas that have limited impacts on wetlands due to reduced potential sediment delivery, compaction, and vegetation removal. These standards and guidelines would continue to provide wetland protection under alternative A.

Alternatives B modified, C, and D

Under the action alternatives, riparian management zones would replace riparian habitat conservation areas and the conservation strategy for *Howellia aquatilis* would be retained. Riparian management zones would be increased to 300 feet for wetlands greater than 0.5 acre and for all sizes of howellia ponds, fens, and peatlands, and they would be increased to 100 feet for wetlands less than 0.5 acre to recognize the unique ecological value of wetlands. Numerous standards and guidelines in the forest plan associated with road management activities are designed to provide protection to streams, wetlands, and other water-based resources, and these are located mainly in the sections on riparian management zones and infrastructure sections. Refer to the subsections in section 3.2.10 on the effects on riparian areas from forestwide direction, travel management, and timber and vegetation management. The addition of these standards under all action alternatives and the increase in riparian management zone widths would provide greater protection to wetlands and wetland functions than alternative A. There is no difference between the action alternatives because the plan components are the same.

Effects on wetlands from timber and vegetation management

Background

Water regime is a key factor that determines wetland type and function. Water regime pertains to the depth, duration (hydroperiod), frequency, diurnal fluctuation, and seasonal timing of groundwater and surface water. A large number of variables—not just water yield, peak flow, and base flow—have been

used as “indicators” to describe hydrologic change in watersheds, streams, and rivers (Gao, Vogel, Kroll, Poff, & Olden, 2009; Konrad, Booth, & Burges, 2005; Merritt, Scott, Poff, Auble, & Lytle, 2010; N. L. Poff, 2009; N. L. Poff, Bledsoe, & Cuhaciyan, 2006; N. L. Poff & Zimmerman, 2010). A similarly large number could be used to characterize changes in wetlands. In general terms, some of the indicator variables that apply when estimating the hydrologic effects of vegetation management on wetlands are

- volume of water inputting to wetland (i.e., water yield of contributing area) and its timing;
- peak water level or flow within the wetland: magnitude (depth or rate) and timing;
- minimum water level or flow: magnitude (depth or rate) and timing;
- percentage of days annually with surface water or measurable flow (both continuous and total);
- fluctuation (variance) in water level or flow: daily or annual; and
- percent of wetland water budget derived from groundwater vs. surface runoff vs. direct precipitation (and snow vs. rain).

Small, isolated headwater wetlands are perhaps most at risk from hydrologic changes occurring in their catchments because their hydrologic inputs are usually the least. In glaciated landscapes such as the Flathead National Forest, some wetlands that comprise only one third of their catchment area can produce 50-70 percent of the annual streamflow because wetlands often occur where groundwater intercepts the land surface (Verry, Brooks, Nichols, Ferris, & Sebestyen, 2011).

Many but not all studies have shown that the removal of trees near a stream or in a wetland causes a mean annual rise in the local water table (A. E. Brown, Zhang, McMahon, Western, & Vertessy, 2005; Grant et al., 2008; Guillemette, Plamondon, Prevost, & Levesque, 2005; Mallik & Teichert, 2009; Miller, McQueen, & Chapman, 1997; R. D. Moore & Wondzell, 2005; NRC, 2008; Scherer & Pike, 2003; Smerdon, Redding, & Beckers, 2009; Stednick, 1996; Charles A. Troendle, MacDonald, Luce, & Larsen, 2010; Winkler et al., 2010). As regeneration occurs in cutover areas, the previous rates and amounts of water transfer between uplands and wetlands return. This usually begins within three to seven years post harvest (Beschta et al., 2000)—less if the area has not been clearcut (R. B. Thomas & Megahan, 1998). Hydrologic recovery to pre-harvest conditions takes 10 to 20 years in some coastal watersheds but may take many decades longer in mountainous, snow-dominated catchments (R. D. Moore & Wondzell, 2005; Whitaker, Alila, Beckers, & Toews, 2002).

The probability of a harvest operation having an effect on a wetland’s water regime is greatest if trees are removed directly from a wetland or, when removed from outside the wetland, if the removal occurs close to and upslope of the wetland. Several other factors influence the degree to which tree removal causes water tables to rise. Especially on windy south-facing forest edges during the summer, tree roots can transfer large amounts of soil moisture to foliage and then to the atmosphere via transpiration and evaporation (Keim & Skaugset, 2003). This effectively removes some of the water before it can reach wetlands and streams. Trees also intercept significant volumes of rain and especially snow, allowing some of that retained water to evaporate before it can reach wetlands and streams located farther downslope (C. A. Troendle & King, 1987; Winkler, Spittlehouse, & Golding, 2005). Thus, when trees are removed from within or above a wetland, that potential source of liquid water becomes available, the water table often rises, and the wetland may receive more water.

This has been suggested by the data from many studies of streams and watersheds in the Pacific Northwest, such as those by Hetherington (1987), Beschta et al. (2000), Jones & Grant (1996), Macdonald et al. (2003), Thomas & Megahan (1998), Troendle and Reuss (1997), Hudson (2001), and McFarlane (2001). If resulting increases in peak flows are great, the morphology of channels can be affected (Grant et al., 2008). This can create, expand, or shrink wetlands. Depending on the soils and

topography, the slash burning and soil compaction components of some harvest operations provide additional surface runoff to wetlands, at least for a few years post harvest (Lamontagne, Schiff, & Elgood, 2000). In addition, in snow-affected areas, clearcuts have sometimes been shown to cause greater runoff during rain-on-snow events (Berris & Harr, 1987) and earlier peaking of streamflow (or wetland water levels).

On the other hand, timber harvest might measurably reduce runoff to streams and wetlands in some parts of the Pacific Northwest during low runoff periods, partly by temporarily eliminating trees that otherwise contribute water by intercepting fog (Harr, 1982, 1983). During the autumn, streams in clearcut watersheds in the Pacific Northwest tend to have lower flows than in uncut watersheds (Harr, Harper, Krygier, & Hsieh, 1975). Also, cutting or windthrow of trees in or near wetlands can increase open-water evaporation sufficiently to reduce water persistence in late summer (Petrone, Silins, & Devito, 2007), especially in larger wetlands and/or in drier parts of the Pacific Northwest.

On the Flathead National Forest, forests adjacent to wetlands are not static and unchanging but, like all forests across this national forest, have historically been influenced by the natural disturbance processes characteristic of this ecosystem. These include fires, insects, disease, and weather events (e.g., windstorms). These disturbances have caused varying amounts of tree mortality, altering forest structures, species, and densities. Mixed or stand-replacement fire regimes, where greater than 75 percent mortality of trees occurs across portions or all of a burn area, are the most common natural fire regimes on the Forest, encompassing 90 percent of the area (USDA, 2014a). Forest lands adjacent to wetlands burned as well. Periodic high-severity fires would revert older forests to early-successional stages where grass, forbs, shrubs, tree seedlings, and snags dominated. Mixed-severity fires would have some areas burned at high severity, some burned at moderate severity, and some areas at low severity or unburned. All these fire severities may occur in the forested lands immediately adjacent to wetlands, depending upon forest conditions, moisture levels, weather, and chance. See also section 3.2.5, subsection "Natural disturbance processes," for a discussion of fire regimes. For information on historical fire patterns on the Forest, refer to section 3.8.2 and Trechsel (2017f).

Alternative A

Wetlands are protected under the conservation strategy for *Howellia aquatilis*, signed in 1994, which requires a minimum 300-foot buffer width around all ponds. Howellia can only be found in the Swan River drainage on the Forest. The Inland Native Fish Strategy amended the 1986 forest plan in 1995 and protects wetlands greater than 1 acre with 150-foot riparian habitat conservation areas and 50-foot riparian habitat conservation areas on wetlands less than 1 acre if howellia is not present. Standard and guideline TM-1 in INFISH allows salvage and fuelwood cutting as well as silvicultural practices in riparian habitat conservation areas if adverse effects to fish can be avoided. Ground-disturbing activities around howellia ponds are generally to be avoided. This direction would continue under alternative A.

Alternatives B modified, C, and D

Under the action alternatives, riparian management zones are established and would replace riparian habitat conservation areas. The conservation strategy for *Howellia aquatilis* would be retained. Wetlands would be included in riparian management zone categories 4a and 4b, as described above in section 3.2.10 on riparian areas. All ponds, lakes, and wetlands greater than 0.5 acre (and all sizes of howellia ponds, fens, and peatlands) would have a minimum 300-foot riparian management zone, an increase compared to the 50- or 100-foot width in the current 1986 forest plan. All ponds, lakes, and wetlands less than 0.5 acre would also be increased to a minimum width of 100 feet. Howellia ponds would have the same 300-foot width of riparian management zone as in the current plan. The width for fens and peatlands of all sizes would increase to 300 feet compared to the 50 to 100 feet under the current 1986 forest plan.

If entry into wetland riparian management zones for vegetation management occurs, it would be guided by forestwide plan components that describe desired forest conditions (FW-DC-RMZ-03 through 06). Standards and guidelines would provide direction for specific activities associated with vegetation management to reduce the risk of adverse effects to wetland resources, including guidelines that require retention of live reserve trees and snags (FW-GDL-RMZ-08, 10), retention of adequate forest cover for wildlife habitat needs (FW-GDL-RMZ-09), and limitations on ground disturbance from equipment (FW-GDL-RMZ-14 and 15).

For more detailed information, refer to section 3.2.10, subsection “Effects on riparian areas from timber and vegetation management.” Also refer to section 3.7.4, subsection “Aquatic, wetland, and riparian habitat associates,” for a discussion of the effects of vegetation management on wildlife associated with riparian areas.

Effects on wetlands from wildfire and burning for resource benefit

Alternatives A, B modified, C, and D

Fire is a natural disturbance process that has historically influenced the forests within watersheds, including forests adjacent to wetlands (see section 3.2.5, subsection “Natural disturbance processes”). Fire is expected to continue to fulfill its function as a natural process across the Forest, with the use of both wildfire (unplanned ignitions) and prescribed fire (planned ignitions) as management tools under all alternatives. All action alternatives include plan direction that supports the role of fire and its use across the Fore to a greater degree than under the current 1986 forest plan direction (see section 3.8). The riparian management zones associated with wetlands contain both riparian and terrestrial vegetative communities. Managing fire (both planned and unplanned ignitions) within riparian management zones for resource benefit would promote ecological processes and desired vegetation conditions within these zones by allowing fires to burn consistent with the natural range of variation. These may produce vegetation conditions (i.e., species compositions and forest structures) associated with low-, moderate-, or high-severity fire. Use of fire as a tool within riparian management zones would likely occur to a similar extent under all the action alternatives because of fire’s potential ecological benefits and its ability to help maintain or achieve desired vegetation conditions within riparian management zones. However, alternative C could potentially have the highest amount of acres burned for resource benefit because alternative C has the most area in management areas where mechanical treatments would likely not occur and where fire would be the most commonly used forest management tool.

Effects on wetlands from other resources

The effects on wetlands from other resources, such as wilderness and inventoried roadless areas, minerals and oil and gas, recreation uses, lands and special uses, restoration projects, noxious weed treatments, and wildlife management are the same as described in 3.2.10.

3.2.12 Cumulative effects

Cumulative effects common to all alternatives

Federal actions within the Flathead River Basin above Flathead Lake involve Glacier National Park and the Bureau of Reclamation. Glacier National Park manages headwater streams in the North and Middle Fork of the Flathead River. There would be little to no cumulative effects from park management actions as most areas in the park are managed to protect ecological values. The Bureau of Reclamation manages Hungry Horse Dam and operates a selective withdrawal system that helps warm the downstream water to its natural temperature. The dam also releases flows according to an integrated rule curve that provides for aquatic species downstream.

Non-Federal land management policies are likely to continue affecting riparian and aquatic resources. The cumulative effects in the Flathead River Basin are difficult to analyze considering the broad geographic landscape covered by the areas, the uncertainties associated with government and private actions, and ongoing changes to the region’s economy. Whether those effects will increase or decrease in the future is a matter of speculation; however, based on the growth trends and current uses identified in this section, cumulative effects are likely to increase.

State-owned school trust lands managed by the Montana Department of Natural Resources and Conservation in the Stillwater, Coal, and Swan State Forests will continue to support a variety of uses of their lands, from livestock grazing to mining, timber harvest, and recreational fishing and hunting. Montana law requires that school trust lands be managed to maximize income for the school trust. Management impacts may be greater on these lands than on other State or Federal lands but may not result in loss of fish populations.

For the most part, stream systems on the Forest originate on-Forest in protected headwaters and eventually flow downstream onto lands owned or administered by entities other than the Forest Service, ultimately flowing into Flathead Lake. Many fish populations, whether they move off-Forest as part of their life cycle or remain entirely within a localized area, require interconnectivity of these streams to survive as a population. For almost all species, genetic interchange between subpopulations is necessary to maintain healthy fish stocks. The more wide-ranging a species such as bull trout is, the more critical interconnectivity may be for the fish to be able to access important habitat components. Thus, activities off-Forest that disrupt fish migration corridors can have significant impacts to fish populations upstream.

A host of activities occur on private lands within the Flathead River Basin. These include water diversion, irrigation, livestock grazing, farming with varied cash crops, timber harvest, water-based hunting, outfitted and non-outfitted angling, construction of subdivisions, housing, and commercial development, building and stocking of private fish ponds, chemical treatment of noxious weeds, flood control and stream channel manipulation, and hydropower management.

The potential for the introduction of disease and aquatic nuisance species exists on all lands within the cumulative effects analysis area. The extent of the influence exerted by disease or exotic species is often determined by an area’s suitability. If conditions are favorable enough to promote and perpetuate them, then effects are determined by the fishery’s susceptibility to be influenced. The effects of these introductions could range from extreme to negligible, depending on the species. Quagga or zebra mussels introduced into Flathead Lake could have a devastating effect upon the entire ecosystem.

Montana Fish, Wildlife and Parks is the responsible agency for managing fish populations. Regulations will most likely continue to allow angling and harvest of fish, with variations on fishing limits and times when angling can occur and some gear restrictions. Flathead Lake and Swan Lake are critical to maintaining bull trout and westslope cutthroat trout populations in tributaries within the North and Middle Forks of the Flathead River and Swan River. Fish populations within the lakes are interconnected to upstream ecosystems. How non-native fish, i.e., lake trout, are managed within these lakes will largely determine the viability of migratory bull trout and westslope cutthroat trout populations (USFWS, 2015a).

The most complex cumulative effects relate to the restoration of bull trout and westslope cutthroat trout populations within the project area. The complexity of the life histories of these species exposes them to many factors affecting their abundance and viability. Cumulative effects to native fish include (1) predation, hybridization, and competition with non-native fish; (2) destruction or degradation of spawning and rearing habitat from logging, grazing, road construction/maintenance, and urban development on private and other non-Federal lands; (3) degraded water quality as a result of polluted runoff from urban and rural areas; and (4) migration barriers that result from roads on private or other non-Federal lands.

3.2.13 Aquatic species determinations associated with alternative B modified

The analysis in the final EIS of existing habitat conditions based upon PIBO monitoring form the basis of the desired conditions in the plan as well as of the effects that might occur with implementation of the plan. The forest plan includes plan components that would provide the ecological conditions necessary to maintain, improve, and restore ecological conditions within the plan area that maintain viable populations of at-risk aquatic species. Based on the analysis of alternatives, other interrelated and interconnected activities, and the cumulative effects of other Federal and non-Federal activities within the plan area, it has been determined by the fisheries biologist hat the implementation of the plan components would provide for ecological conditions that would support the recovery of bull trout.

The USFWS released the final Bull Trout Recovery Plan in September 2015 (USFWS, 2015b), which outlines the conservation actions needed to recover bull trout, a federally designated threatened species. The overarching goal of the recovery plan is to conserve bull trout so that the fish are geographically widespread, with stable populations in each of the six recovery units. Accordingly, the plan's recovery criteria focus on effective management of known threats to bull trout. The Coastal, Columbia Headwaters, Klamath, Mid-Columbia, Saint Mary, and Upper Snake are the six designated recovery units that are home to the threatened population in the lower 48 states. The Flathead National Forest is in the Columbia Headwaters recovery unit. The Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (USFWS, 2015a) has identified threats and recovery actions. It is important to note that the implementation plan did not identify any habitat threats to bull trout on the Forest, and the plan only recommends passive restoration as a recovery action with regards to habitat on the Forest. The Forest Service will work cooperatively with its partners to address the numerous actions that are identified related to fisheries management and non-native species.

A conservation watershed network helps conserve bull trout and genetically pure stocks of westslope cutthroat trout by identifying areas where cold water is modeled to occur into the future. A conservation watershed network is a collection of watersheds where management emphasizes habitat conservation and restoration to support native fish and other aquatic species. The goal of the network is to sustain the integrity of key aquatic habitats to maintain the long-term persistence of native aquatic species. Designation of conservation watershed networks, which include watersheds that are already in good condition or could be restored to good condition, are expected to protect native fish and help maintain healthy watersheds and river systems.

Coarse-filter plan components primarily related to watersheds, riparian management zones, the Forest's conservation watershed network, and road management would provide for ecological conditions for bull trout and other aquatic species and would maintain the persistence of the species across the planning area (USFWS, 2017a). The conservation watershed network protects a network of connected aquatic species populations in modeled cold-water refugia by reducing the effects associated with roads. The forest plan would add an active restoration component through desired conditions, objectives, guidelines, and standards that would supplement the retained passive components of INFISH. The forest plan would also help move projects and activities towards the desired conditions and improve aquatic habitats. Implementing any alternative, including the no-action alternative, "may impact individual westslope cutthroat trout but would not lead towards federal listing under the ESA [Endangered species Act]" (planning record exhibit #00631). This determination is based upon the provision of necessary ecological conditions, although individual fish may be negatively impacted during site-specific actions that are covered under the umbrella of this programmatic forest plan.

3.3 Vegetation–Terrestrial Ecosystems

Introduction

This section of the final EIS addresses the forested and non-forested vegetation component of the terrestrial ecosystems on the Flathead National Forest. A coarse-filter approach is used to discuss conditions and effects at the ecosystem or plant community level and how they provide for ecosystem integrity and diversity. These plant communities provide habitat for a host of wildlife species, as well as contributing benefits and services to people.

Regulatory framework

The following is a select set of statutory authorities that govern the management of vegetation on NFS lands. They are briefly identified and described below to provide context to the management and evaluation of the resource. Multiple other laws and regulations and policies not described below also guide the management of this resource.

Law and executive orders

Forest and Rangelands Renewable Resources Planning Act of 1974: This act provides for maintenance of land productivity and the need to protect and improve the soil and water resources.

National Forest Management Act of 1976: "It is the policy of the Congress that all forested lands in the National Forest System be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth, and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans. Accordingly, the Secretary is directed to identify and report to the Congress annually at the time of submission of the President's budget together with the annual report provided for under section 8 (c) of this Act, beginning with submission of the President's budget for fiscal year 1978, the amount and location by forests and States and by productivity class, where practicable, of all lands in the National Forest System where objectives of land management plans indicate the need to reforest areas that have been cut-over or otherwise denuded or deforested, and best potential rate of growth. All national forest lands treated from year to year shall be examined after the first and third growing seasons and certified by the Secretary in the report provided for under this subsection as to stocking rate, growth rate in relation to potential and other pertinent measures. Any lands not certified as satisfactory shall be returned to the backlog and scheduled for prompt treatment. The level and types of treatment shall be those which secure the most effective mix of multiple use benefits. . . . Plans developed . . . shall . . . provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet the overall multiple-use objectives, and within the multiple-use objectives of a land management plan . . . provide, where appropriate, to the degree practicable, for steps to be taken to preserve the diversity of tree species similar to that existing in the region controlled by the plan."

Other regulation, policy, and guidance

USDA Forest Service Position Statement on National Forest Old-Growth Values, Oct. 11, 1989: This position statement recognizes the many values associated with old-growth forests, such as biological diversity, wildlife and fisheries habitat, recreation, aesthetics, soil productivity, water quality, and industrial raw material. Old growth on the national forests will be managed to provide the foregoing values for present and future generations. Decisions on managing existing old-growth forest to provide these values will be made in the development and implementation of forest plans. These plans shall also provide for the succession of young forests into old-growth forests in light of their depletion due to natural events or timber harvest.

2012 Planning Rule (36 CFR § 219.9(a)): This section of the 2012 planning rule requires forest plans to include components that maintain or restore the ecological integrity of terrestrial ecosystems, including their structure, function, composition, and connectivity. A complementary ecosystem and species-specific approach is adopted to maintain the diversity of plant and animal communities.

2012 Planning Rule (36 CFR § 219.9(b)(1)): This section of the planning rule states that the responsible official will evaluate whether the plan components provide the ecological conditions necessary to contribute to the recovery of federally listed species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern. Evaluation would consider components that provide for ecosystem integrity and diversity (coarse-filter approach) and species-specific components (fine-filter approach).

Key ecosystem characteristics and indicators

Key ecosystem characteristics are defined in the 2012 planning rule as the dominant ecological components that describe ecosystems and that are relevant and meaningful for addressing ecosystem condition and integrity as well as important land management concerns. Ecosystem integrity related to vegetation is typically assessed by considering dominant ecosystem functions, composition, structure, and connectivity. Key ecosystem characteristics are also chosen because they are measurable (quantitatively or qualitatively) and because some type of data or means to distinguish and describe them is available.

Key ecosystem characteristics for the terrestrial vegetation on the Flathead National Forest have been identified and serve as the key indicators for describing the affected environment and evaluating differences among the alternatives. Differences among the alternatives may be expressed as both qualitative and quantitative, and the estimated changes in in the key ecosystem characteristics over time serve as the basis for evaluating ecological sustainability and forest resilience. The key indicators for vegetation discussed in this section of the final EIS are listed below. Descriptions of indicators and how they are measured are provided in the appropriate sections.

- Vegetation composition: vegetation dominance type (conifer and non-forested types) and tree species presence
- Forest size class and very large tree component: conifer tree d.b.h.[4]
- Old-growth forest: as defined by Green et al. (2011)
- Forest density: associated with coniferous tree canopy cover percent
- Snags and downed wood: snags density and distribution, and tons per acre for downed wood
- Landscape vegetation pattern: characteristics of forest patches (size classes or successional stages)

Additional key ecosystem characteristics related to vegetation conditions that are not included in this terrestrial vegetation section of the final EIS include those associated with riparian areas and wetlands and those associated with specific plant species that are considered at risk or of special concern. Riparian areas are covered in section 3.2; threatened, endangered, proposed, or candidate plant species and plant species of conservation concern are covered in section 3.5.

Information sources

A variety of well-documented and accepted vegetation data sources and analysis tools were used for the terrestrial vegetation analysis, collectively comprising the best available science for quantifying vegetation conditions. These sources are briefly described in this section of the final EIS; more detailed

[4] Diameter at base height (d.b.h.) is the diameter of a tree 4.5 feet from ground level on the uphill side of the tree.

descriptions and information are found in appendix 2 and in planning record exhibits (Trechsel, 2016c; USDA, 2015f).

The Northern Region's existing vegetation classification system (R1 VMap) (Barber, Bush, & Berglund, 2011) is the source for the classification and spatial mapping of existing vegetation attributes that are utilized in this EIS. The VMap product used for this EIS and for the development of plan components for the forest plan represents the Forest's best current spatial estimate for the various vegetation components, such as forest size classes and vegetation dominance types. These maps are not static. Vegetative succession and disturbances will change vegetation conditions over time. Newer maps using new methodology or technology may be utilized in the future for a variety of reasons, as determined appropriate, for the spatial portrayal of existing vegetation conditions across the Forest. As deemed appropriate, more detailed information may be incorporated into a map of existing vegetation at the project level of analysis, such as from information from field inventories.

R1 VMap is derived from national and regional remote-sensing protocols using a combination of satellite imagery and airborne acquired imagery, with refinement and verification through field sampling. The product has been assessed for accuracy and has a known and quantifiable level of uncertainty. Although the product is inherently less accurate and detailed than systematic plot sampling (e.g., Forest Inventory and Analysis), it provides valuable complementary information and allows for an analysis of the spatial distribution of vegetation. It is designed to allow consistent applications of vegetation classification and map products across all land ownerships (Barber, Berglund, & Bush, 2009; Barber et al., 2011; Berglund, Bush, Barber, & Manning, 2009). The primary vegetation classifications in R1 VMap are vegetation dominance types (composition), tree diameter class, and tree canopy cover class. R1 VMap used for this final EIS is based on 2009 imagery data that has Forest lands updated to the year 2013 to reflect vegetation-changing activities (fire and harvest) that occurred between 2009 and 2013. R1 VMap data is used in the Forest plan revision as the basis for the spatial representation and description of existing vegetation conditions and for the spatial modeling of vegetation conditions over time.

Unless indicated otherwise in this final EIS, the source of data for quantification of existing vegetation conditions is the R1 summary database, which is produced from the Forest Inventory and Analysis program using the Hybrid 2011 Forest Inventory and Analysis data set. It is not feasible to maintain an inventory of all vegetation on every acre of the 2.4 million acres Flathead National Forest for the purpose of assessing existing conditions and conducting analyses of forest attributes. Forest Inventory and Analysis is a national inventory of forest ecosystem data derived from field sample locations distributed systematically across the United States, regardless of ownership or management emphasis (Renate Bush, Berglund, Leach, Lundberg, & Zeiler, 2006). Data collection standards are strictly controlled, and the sample design and data collection methods are scientifically designed and repeatable. Forest Inventory and Analysis provides a statistically sound representative sample designed to provide unbiased estimates of forest conditions at the broad and mid levels. A statistical sample provides the means to observe a randomly selected subset of the entire population and make inferences about the entire population. Since variability exists across a landscape, statistical sampling provides methods for estimating population characteristics and evaluating the reliability of the estimates. The variability of the attribute of interest, number of plots analyzed, and the size of the plots affect the reliability of the estimate. It is particularly valuable for monitoring changes in forest and vegetation conditions over time, as plots have been permanently established and are remeasured on a regular basis (currently every 10 years). Forest Inventory and Analysis data used for the Flathead National Forest in this final EIS was collected from 1993 to 1994 (41 periodic plots) and from 2003 to 2011 (357 annual plots), for a total of 398 plots (almost 1,600 subplots) (see Trechsel, 2016c).

Quantification of existing vegetation composition (dominance types, species presence), forest size classes, forest density (canopy cover), old-growth forest, snags and downed woody material were derived from the Forest Inventory and Analysis Hybrid 2011 data set. Forest Inventory and Analysis data is also used in the forest plan to corroborate VMap data for vegetation modeling and to develop growth and yield tables for the model outputs. It is also the primary data source used for the monitoring and evaluation of vegetation conditions over time in the forest plan monitoring program.

The Forest Service Activity Tracking System is the source for information related to vegetation treatments (i.e., harvest, noncommercial thinning, planting, fuels reduction, invasive plant treatments, etc.) that have occurred on the forest in the past. The Forest Service Activity Tracking System stores information associated with these activities such as methods used, surveys conducted, and acres treated. When linked to spatial data sets, these activities can be spatially displayed across the Forest.

Analytical models were used to predict changes to vegetation over time and evaluate movement towards vegetation desired conditions. The Spectrum model was used to project alternative forest management scenerios, schedule vegetation treatments, and provide outcomes based upon a variety of input parameters such as management objectives and budget limitations. The SIMPPLLE model (SIMulating Patterns and Processes at Landscape scaLEs) was used to simulate fire, insect, and disease disturbances over time (historical and future) as well as the interaction of these disturbances with vegetative succession and treatment activities. The SIMPPLLE model provides spatial analysis of future management activities as scheduled through the Spectrum model. Spectrum also is used to project timber harvest acres and volumes over time under different management scenarios. Appendix 2 describes the Spectrum analysis process in detail and the modeled timber harvest outputs. Appendix 2 and the planning record contain additional information on the development and use of the SIMPPLLE model (Henderson, 2017; Trechsel, 2014), including the raw data outputs of the SIMPPLLE model (Trechsel, 2017g). Additional information on model outputs and the use of the model to develop the natural range of variation and future projected vegetation conditions for the Forest are also in planning record exhibits (Trechsel, 2017f, 2017g; USDA, 2017b).

Methodology and analysis process

The analysis approach for the forest plan was to seek to maintain and/or restore the full spectrum of ecosystem biodiversity within the planning area. Biodiversity conservation focuses on the need to conserve dynamic, multiscale ecological components, structures, and processes that sustain a full complement of native species and their supporting ecosystems. This general strategy is often called the “coarse-filter” approach to ecosystem management. This terrestrial vegetation section of the final EIS documents the coarse-filter analysis of the terrestrial ecosystems on the Forest. Analysis occurs at the broad, programmatic level, as is appropriate for developing forest plan direction and analyzing the effects of alternatives that are relevant at the scale of the Forest. Later sections in this final EIS focus on species-specific conditions and management strategies (for example, section 3.5.1), enabling a more “fine-filter” analysis of elements of the ecosystem that are not adequately covered under the coarse-filter approach.

Development of desired conditions and other plan components

As required by planning regulations (36 § CFR 219.1), forest plan direction must provide for ecological integrity while contributing to social and economic sustainability. Ecological integrity can be simply defined as the ability of the ecosystem to withstand and recover from most perturbations imposed by natural or human influences and to sustain natural ecological processes and biodiversity into the future. In response to this direction, desired conditions for vegetation were developed for the key ecosystem components identified for the Flathead National Forest. Standards and guidelines were developed if

necessary to move towards or maintain desired conditions. These plan components form the basis for the comparison of the alternatives.

The development of desired conditions was based on the Forest's best estimate of the historical, or natural, range of variation for key ecosystem components. The natural range of variation provides insight and a frame of reference for evaluation of ecological integrity and resilience. It reflects the ecosystem conditions that have sustained the current complement of wildlife and plant species on the Forest and provides context for understanding the natural diversity of the vegetation and which processes sustain vegetation productivity and diversity. Although humans have shaped the ecosystems of the Forest for thousands of years, since the mid-1800s human presence and activities have increased dramatically in the plan area, along with associated impacts to ecosystem conditions. Natural range of variation estimates provide a reference to conditions that might have occurred prior to this recent increase in human impacts. Additional factors considered in the development of desired conditions included the existing or anticipated human use patterns or desires for specific vegetation conditions and the ecosystem services desired and expected from Forest lands (such as reduction of fire hazard and production of forest products). More detailed documentation of development of the natural range of variation and development of desired conditions can be found in a planning record exhibit (Trechsel, 2016a).

Climate change, terrestrial ecosystems, and management strategies

This section briefly summarizes the possible influences of climate change on vegetation and the Forest's strategy to address the uncertainties associated with both climate change and its potential effects. Refer also to section 3.1.2 for additional information on the forest plan and climate change, to section 3.2 under the subsection on climate change and aquatic ecosystems, and to section 3.3.1 below for a summary of climate as a disturbance or stressor to vegetation.

Desired conditions describe specific ecological and vegetative conditions that portray the Forest's vision of what the Flathead National Forest should look like in the future. They describe, to the best of the planning team's ability, what is desired for maintain ecosystem integrity while contributing to social and economic sustainability. Although the forest plan provides direction for management of the Forest over a relatively short period of time (the next 15 years), the desired conditions were developed with the long-term view in mind as well. This is necessary because the concepts of ecological, social, and economic sustainability require a long-term perspective for appropriate interpretation and evaluation. This is also important because of the potential of changing climatic conditions that are likely to influence conditions of the forests and ecosystems on the Forest (refer to section 3.1.2 for a summary of potential changes). Compared to some other elements of change (such as fire), climate change is relatively slow, but it is inexorable. The future is inherently uncertain, and there is uncertainty about just how rapid and to what degree the climate will change. Specifically how, where, and in what ways climate change will affect the forests and ecosystems of the Forest cannot be known with certainty, especially given the diverse mountainous terrain of the region. What is generally accepted, however, is that climate change will impact the vegetation of the Forest in a myriad of ways, both directly through shifts in vegetation growth, mortality, and regeneration and indirectly through changes in disturbance regimes and the interaction of climate with hydrology, snow dynamics, and exotic invasions (Bonan, 2008; Hansen et al., 2001). Some species may decrease in abundance, and others may expand. The response and vulnerability of different plant species or communities to climate changes vary, depending upon their sensitivity or vulnerability to the direct and indirect impacts of the change. Complicating matters are the consequences of past activities and uses of the land, such as fire exclusion and conversion of forests to other vegetation types; these also impact forest and ecosystem conditions.

It is generally agreed that the impacts of climate change on forest vegetation will be primarily driven by vegetation responses to shifts in disturbance regimes and, secondarily, through shifts in regeneration,

growth, and mortality at individual plant and community scales (Dale et al., 2001; Flannigan, Krawchuk, de Groot, Wotton, & Gowman, 2009; Temperli, Bugmann, & Elkin, 2013). For the fire-prone, fire-adapted forest ecosystems of the Flathead, it is likely that the most visible and significant short-term effect of climate changes will be caused by altered disturbance regimes. Climate and fuels are the two most important factors controlling patterns of fire in forest ecosystems. Climate controls the frequency of weather conditions that promote fire, whereas the amount and arrangement of fuels influence fire intensity and spread. Climate changes may increase fire frequency, severity, and cumulative area burned as well as the frequency or magnitude of extreme weather events that affect fire behavior over the coming decades in the western United States (Flannigan et al., 2009; Kurz, Dymond, et al., 2008; Lubchenco & Karl, 2012; McKenzie et al., 2004). Climate influences fuels on longer time scales by shaping species composition and productivity (Dale et al., 2001; Marlon et al., 2008; Power et al., 2008). Current and past land use, including timber harvest, conversion of forests to non-forested lands, and fire suppression affect the amount and structure of fuels as well. Although fire is an integral part of the forests and ecosystems of the Flathead and the native plants and animals have evolved under its influence for millennia, changes in the fire regimes on the Forest (such as the frequency or severity of fire) as a consequence of climatic change could have substantial impacts on species and communities in both the short and long term by introducing a rate of change that is more rapid than they have historically evolved and adapted to.

The forest plan direction incorporates strategies and concepts that address the uncertainties associated with climate change and its potential impacts on vegetation. The concept of managing for sustainable forests has always been an underlying premise in the science of forestry, but integrating management concepts related to future uncertainties associate with climate change, altered disturbance regimes, and changing societal demands is relatively recent. The forest plan utilized the best available scientific information, as cited throughout this document, to analyze past, present, and future vegetation conditions, which was used to inform the development of forest plan direction for vegetation.

The forest plan direction applies a forest and ecosystem management approach that recognizes the importance of applying an ecological understanding, as well as an understanding of societal needs, to the management of the forest and ecosystems (Brang et al., 2014; Millar, Stephenson, & Stephens, 2007; O'Hara, 2016; Schutz, 1999). The plan direction emphasizes ecosystem processes and the natural dynamics of ecological systems, particularly the role of disturbances such as fire. It includes multiple strategies with the underlying concept of providing flexibility where possible, and it incorporates the capacity to change and be adaptive to new information as it becomes available. The plan direction recognizes the importance of a sustainable forest ecosystem in providing for the sustainability of social and economic resources.

Three management approaches commonly published in the literature that apply these ecological concepts are promoting resilience to change, creating resistance to change, and enabling forests to respond to change (Holling, 1973; Janowiak et al., 2014; Robert E. Keane et al., in press; Millar et al., 2007). *Resilience* is defined as the degree to which forests and ecosystems can recover from one or more disturbances without a major shift in composition or function and is the most commonly suggested adaptation option discussed in the context of climate change (Millar et al., 2007). Resilient forests accommodate gradual changes related to climate and are able to cope with disturbances. *Resistance* is the ability of the forest or ecosystem to withstand disturbances without significant loss of structure or function—in other words, to remain unchanged. From a management perspective, resistance includes both the degree to which communities are able to resist change, such as from a warming climate, and the manipulation of the physical environment to counteract and resist physical or biological change, such as through burning or harvest treatments (Robert E. Keane et al., in press). The *response* approach intentionally accommodates change rather than resists it, with the goal of enabling or facilitating forest ecosystems to respond adaptively as environmental changes accrue. Treatments would mimic, assist, or

enable ongoing natural adaptive processes, anticipating events outside the historical conditions such as extended fire seasons or summer water deficits. Response tactics may include such practices as shifting desired species to new, potentially more favorable sites through planting, managing early-successional forests to "re-set" normal successional trajectories to create desired future patterns and structures, and promoting connected landscapes (Millar et al., 2007). Although it is important to understand the concepts and purpose behind these three adaptive approaches (resilience, resistance, and response), it is more important to understand that they all have the same goal of helping the forest and ecosystem adapt to inevitable future changes related to climate while maintaining ecological integrity and continuing to provide desired ecosystem services. No single approach will fit all situations, and the integration of various adaptive approaches and management practices is the best strategy (Millar et al., 2007; Spittlehouse & Stewart, 2003). A particular tactic or action may be consistent with two or three of the adaptive approaches.

At the broad conceptual level, in developing the programmatic management direction in the forest plan, all approaches have been integrated to one degree or another, although promoting resilience and resistance are the primary approaches. Promoting the establishment and growth of native fire-resistant species, such as planting or thinning western larch and ponderosa pine, are examples of creating resistant or resilient forests and ecosystems. Protecting existing highly valued habitats, such as old-growth forest in the warm-dry potential vegetation type, by treating the stand to increase its resistance to high severity fire is another example. An approach that could be considered a response option is the promotion of landscape connectivity and treatments in young sapling stands to develop desired future forest patterns and structures. Appendix 7 provides a summary table outlining the climate change adaptation strategies that were the focus in the development of forest plan direction and the ways they were addressed in the forest plan.

Another key plan component that is critical in the context of future climate change is the establishment of a monitoring plan under an adaptive management approach. This enables the intentional use of monitoring to evaluate the effectiveness of the forest plan direction and the resulting management actions. The Forest explicitly acknowledges that it has an incomplete understanding of both climate change and its potential impact on the Forest and its ecosystems. The planning team has done the best it can with the best available information to integrate adaptation strategies into the design of the desired conditions and other plan components, but the team also understands that an iterative learning process is important in order for the Forest to be adaptive in its approach to management in the face of future uncertainties.

Discussion of modeling and evaluation of vegetation change

Vegetation across the Forest will change over time in response to both natural ecological disturbances (such as fire and insects), human elements (such as timber harvest and prescribed burning), and the interaction of these factors with vegetation succession and climate. The desired condition is to maintain vegetation conditions within the desired ranges over time to contribute to forest and ecosystem resilience and sustainability. A simulation of potential vegetation change was projected across five decades into the future using the SIMPPLLE model. Fifty years is considered a reasonable time period over which to model potential disturbances and succession and to capture trends in vegetation condition, considering that some drivers of change occur very quickly (such as fire) and others are much more gradual (such as vegetative succession and climate). However, it should be noted that 50 years is also considered a relatively short time period to adequately portray some of the shifts in conditions that may occur for species that are as long-lived and persistent as conifer trees. There is an increasing level of uncertainty associated with ecological and social change the further into the future the model extends, especially when linked to climate change. Thirty model simulations were run to better capture the variability and uncertainties associated with disturbance events and resulting vegetation change. Therefore, model results

provide not a single value but a range of values for vegetation condition by the end of the modeling period (decade 5).

Changes in the model inputs occurred between the draft EIS and the final EIS to incorporate new and more accurate information and interpretation. Additional correlation was completed of the modeled vegetation input layer with the existing vegetation conditions as estimated using current Forest Inventory and Analysis data (see "Information sources" section above) for species presence and the large and very large forest size classes. Corrections to the logic associated with certain disturbance processes were also completed to more accurately portray expected Douglas-fir and spruce beetle activity in the future. These changes improved the comparison and interpretation of both the natural range of variation and future vegetation projections against current conditions. Also, assumptions related to future fire were adjusted to reflect what is considered a more realistic range of possible future fire conditions. These updates to SIMPPLLE resulted in some differences in the future vegetation condition estimates (50 years into the future) in the final EIS compared to the draft EIS. Refer to planning record exhibits (Henderson, 2017; Trechsel, 2017a) for detailed information on these changes to the modeling process. Also refer to Trechsel (2017b) for information on how these model refinements resulted in some adjustments to desired conditions in the forest plan for some of the vegetation components. This was necessary so the desired conditions would continue to appropriately correlate to the estimated natural range of variation but does not result in a change in the intent behind the design of the desired condition.

As discussed in the "Information Sources" above, the Forest used the Spectrum and SIMPPLLE analytical models to evaluate vegetation conditions and changes over time. In the Spectrum model, vegetation management activities expected to occur over time under each alternative were formulated by considering the management areas, land suitability, other resource limitations on treatments (such as restrictions within Canada lynx habitat and grizzly bear security core), and budget limitations. The Spectrum model was run for each alternative with an objective that was in keeping with the theme of the alternative. For alternatives B modified and C, the objective was to maintain or trend towards the desired conditions for vegetation composition (dominance types) and structure (forest size classes). For alternative D, the objective was to maximize timber in the first decade and then maintain or trend towards vegetation desired conditions for the succeeding four decades. For alternative A, the model was run with the objective of maximizing timber production over all five decades because there are no quantitative desired conditions for vegetation in the existing 1986 forest plan. The timber product outputs resulting from the Spectrum model analysis are displayed and compared in section 3.21, and the timber and vegetation analysis process is described in detail in appendix 2.

The treatment acres (harvest and prescribed fire) resulting from the Spectrum model are not spatially explicit. Projected treatments were integrated into the SIMPPLLE model to allow for a spatial analysis of vegetation change over time and to interact with vegetation succession pathways and the fire, insect, and disease assumptions within the SIMPPLLE model. The attributes modeled quantitatively for the analysis of vegetation changes over time include vegetation composition, forest size classes, and forest density (canopy cover). All model outputs assume a reasonably foreseeable future budget, similar to current budgets.

It is important to understand the strengths and limitations of the analytical models to appropriately interpret the results. Out of necessity, the models simplify a very complex and dynamic relationship between ecosystem processes and drivers (such as climate, fire, and succession) and vegetation, over time and space. The models use a given set of assumptions, including the amount of stand-replacing fire, insect or disease activity, and rate of tree growth and stand structure change over time (succession). These assumptions are based on analysis and corroboration of actual data (such as fire history and historical vegetation information) and review of the scientific literature, as well as professional judgment and the

experience of resource specialists familiar with the ecosystems and forest types of the Flathead. Although best available information and knowledge is used to build these models, there is a high degree of variability and uncertainty associated with the results because of the ecological complexity and the inability to accurately predict the timing and location of future events. The timing, magnitude, and/or location of disturbances, such as fire or bark beetle activity, may differ from that modeled, resulting in different effects to vegetation. In addition, the task of modeling potential treatments accurately to represent the impacts of numerous limitations on treatments (i.e., lynx habitat, grizzly bear security) and then integrating these treatments with multiple ecological processes and disturbances is very complex.

Model results are not objectives for plan implementation but are merely a useful indicator of how vegetation may change over time. Models are but one tool to help inform the analysis of effects in this EIS, useful for understanding relative differences between alternatives and general trends in vegetation. These models are for comparative value and are not intended to be predictive or to produce precise values for vegetation conditions. Model outputs augment other sources of information, including research and professional knowledge of how ecosystem processes (such as succession) and disturbances and stressors (such as fire, insects, harvest, and climate) might influence changes in vegetation conditions over time, especially at the scale of the Forest. All these sources of information were used in the evaluation of the environmental consequences of the alternatives.

Appendix 2 and exhibits in the planning record provide additional and more comprehensive information on and discussion of the process and quantitative results of the modeled vegetation changes over the five-decade modeling period. Key results from modeling are summarized in this EIS where central to the discussion of environmental consequences and comparison of alternatives.

Potential vegetation types and analysis scale

Habitat types are an aggregation of ecological sites of like biophysical environments (such as climate, aspect, soil characteristics) that produce plant communities of similar composition, structure, and function. The designation of habitat types is based on the potential climax plant community of the site (Pfister, Kovalchik, Amo, & Presby, 1977). Climax conditions represent the culmination of the plant community conditions that would occur through natural succession in the absence of stand-replacing disturbances such as fire. Although the general characteristics of the climax plant community may be the same on sites of the same habitat type, at any one point in time the existing plant communities and conditions on areas of the same habitat type could be very different. Conditions vary due to factors unique to each site, such as the history, pattern, and frequency of the disturbance and its influence on tree regeneration, species, density, and other characteristics.

Habitat typing is a fine-scale classification of lands, and there are nearly 50 forest habitat types present on the Forest. For purposes of analysis at broader scales, habitat types are typically assembled into groups based on similarities of climatic and physical factors. These groups are called potential vegetation groups, or types, consisting of a coarse grouping of the USDA Forest Service Northern Region habitat types (Pfister et al., 1977). The baseline classification and methodology used for this grouping and their spatial mapping on the Forest is the Region 1 potential vegetation type classification for western Montana and northern Idaho (J. Jones, 2004). This layer provides a consistently derived and contiguous mapping of potential vegetation types across the region on all ownerships. The mapping was completed by the Northern Region of the Forest Service in 2004, using as data sources field plots, remote sensing, modeling, and extrapolation of plot data. Although this map represents a broad grouping of habitat types, it is still a relatively fine-scale land classification. The Jones (2004) map has 18 forested potential vegetation types, and there are seven grass/shrub/hardwood types on the Forest.

For purposes of analysis and development of plan components in the Flathead forest plan, the Jones potential vegetation types and the underlying habitat types have been further aggregated into four main forest groups that are consistent with the Northern Region's broad-level potential vegetation type groupings (Milburn, Bollenbacher, Manning, & Bush, 2015). In the forest plan and this EIS, these groups are also referred to as *potential vegetation types*, although they are a substantially coarser grouping than the Jones (2004) potential vegetation type classification described in the previous paragraph. These coarse groups are applicable for broad-level analysis and monitoring.

The terminology applied to these groups changed over the course of the planning period, although the concept has remained the same. In the assessment, the term "potential vegetation type" was used, but this term changed to "biophysical settings" in the proposed action and the draft EIS. In this final EIS and forest plan, the term "potential vegetation type" is again used. All refer to the same groupings of habitat types (with some slight variation). Refer to appendix D of the forest plan for a table showing the habitat types and potential vegetation type groupings used through the revision process. Also refer to Trechsel (2017b) for additional information on the changes that occurred from the assessment to the final EIS.

Four coniferous potential vegetation types and two non-coniferous potential vegetation types have been identified for the Forest, and these serve as the basis for the description and analysis of certain ecological conditions at the forestwide scale. Areas within each of the potential vegetation types have similarities in patterns of potential natural plant communities, potential productivity, natural biodiversity, and the types of ecological processes that sustain these conditions. The potential vegetation types provide information on the inherent capability of the land to support certain types of vegetative communities and the nature of change in those plant communities over time through succession and in response to disturbances.

Table 17 provides the acres and proportion of each potential vegetation type within the geographic areas on the Forest. Non-forest vegetation types are grass/forb/shrub hardwood and non-forested. Appendix D of the forest plan provides a table displaying the grouping of habitat types into the potential vegetation types. Appendix B contains maps displaying potential vegetation types forestwide and for each geographic area. These maps may be updated and improved over time as new information, methodology, or technology becomes available to inform the identification and mapping of potential vegetation types.

Table 17. Estimated percentages and acreages[a] of each potential vegetation type on NFS lands within each geographic area (GA) on the Flathead National Forest and forestwide[b]

Potential vegetation type	Hungry Horse GA	Middle Fork GA	North Fork GA	Salish Mountains GA	South Fork GA	Swan Valley GA	Total percent and acres forestwide
Warm-Dry	13,100 (5%)	17,600 (5%)	6,200 (2%)	48,400 (18%)	109,100 (14%)	28,000 (8%)	222,400 (9%)
Warm-Moist	6,200 (2%)	800 (<1%)	12,900 (4%)	13,000 (5%)	600 (<1%)	72,700 (20%)	106,200 (4%)
Cool-Moist	242,700 (85%)	275,300 (75%)	228,100 (72%)	198,900 (76%)	459,700 (58%)	207,300 (57%)	1,612,000 (68%)
Cold	17,000 (6%)	53,000 (14%)	67,400 (21%)	1,800 (1%)	163,600 (21%)	32,600 (9%)	335,400 (14%)
Non-forest vegetation types	5,900 (2%)	21,900 (6%)	4,300 (1%)	300 (< 1%)	54,300 (7%)	22,000 (6%)	108,700 (5%)
Total acres	284,900	368,600	318,900	262,400	787,300	362,600	2,385,200

a. All acreage figures in the table are estimates and are rounded to the nearest 100 acres. Water is excluded.

b. Data source: Flathead National Forest GIS Library, R1 VMap layer (2009, updated through 2012 for changes due to disturbances), joined with the potential vegetation types GIS layer (J. Jones, 2004). Potential vegetation type groups are consistent with USFS Region 1 broad potential vegetation types defined in Milburn et al. (2015).

The warm-dry potential vegetation type occupies the warmest and driest sites on the Forest that support forest vegetation. All sites supporting ponderosa pine and Douglas-fir climax forest communities fall within this type, as well as the driest of the grand fir habitat types. Douglas-fir habitat types dominate by far, covering over 90 percent of the lands within this potential vegetation type. The warm-dry types mainly occur at the lower elevations or warmer southerly aspects across the Forest or on droughty soils. Warm-dry types occur most commonly within the South Fork and the Salish Mountains geographic areas.

The warm-moist potential vegetation type includes moist sites that are relatively warm and are largely limited to lower-elevation sites and wider valley bottoms with relatively productive, deep ash-capped soils. All western red cedar and western hemlock habitat types are within this type, as well as the moist grand fir habitat types. The majority of this type occurs within the Swan Valley geographic area. This potential vegetation type is the least common one on the Forest. The Flathead is at the far eastern edge of the range for western red cedar and hemlock forest types characteristic of the moist, maritime-influenced ecosystems. Site and soil conditions (e.g., depth of ash cap) that best support these warm-moist forest communities are more fragmented and limited in distribution compared to areas to the west.

The cool-moist potential vegetation type comprises the majority of the lands on the Forest and is well distributed across all geographic areas. Subalpine fir habitat types dominate by far, comprising over 95 percent of the lands in this type. Spruce habitat types make up most of the remainder. This type occurs on low- to mid-elevation sites across all aspects. Most sites fall within the moist end of the spectrum (about 75 percent), with somewhat drier sites within this type limited largely to southerly or westerly aspects dispersed within the larger matrix of moist areas.

The cold potential vegetation type occupies the higher-elevation areas on the Forest. Most sites are cold, moist subalpine fir habitat types that support moderately dense forest cover. Remaining areas are cold, drier subalpine fir and whitebark pine types where growing conditions are harsher and tree density more open.

Non-forest potential vegetation types consist of the persistent non-coniferous vegetation types and areas of very sparse or no vegetation, such as scree or barren areas. For purposes of this analysis, persistent hardwood tree and grass/forb/shrub communities are defined as dominating the site for at least a 50-year period. They occur on sites where establishment and growth of conifers is severely impeded, for example, in areas of shallow or very droughty soils; very wet soils and high water tables; or very frequent disturbance, such as by avalanche or flood. The persistent grass/forb/shrub types range from alpine meadows to dry grassland types to moist shrub-dominated riparian areas. Persistent hardwood types are usually cottonwood groves in floodplains and areas of high water tables.

Incomplete and unavailable information

Terrestrial ecosystems are highly complex and contain an enormous number of known and unknown living and non-living factors that interact with each other, often in unpredictable ways. For this reason, the Forest acknowledges that there are gaps in the available information and in the knowledge about ecological functioning, as well as an inability to even evaluate what those gaps may be. This gap in information may lessen over time as new information or methodologies are devised.

Vegetation is very dynamic, changing constantly due to succession and in response to disturbances and stressors. Descriptions of vegetation represent only one point in time. The Forest’s ability to predict changes in vegetation into the future is limited and is subject to uncertainty. The level of uncertainty depends on the predictability of such factors as natural disturbances, climate change, or human-caused disturbances.

Analysis area

The affected area for effects to terrestrial vegetation is the lands administered by the Forest. This area represents the NFS lands where changes may occur to vegetation as a result of management activities or natural events.

The affected area for cumulative effects to terrestrial vegetation includes the lands administered by the Forest as well as the lands under other ownership, both within and immediately adjacent to the Forest boundaries.

Notable changes between draft and final EIS

In addition to general reworking of some sections of the EIS to improve organization and clarity and to respond to public comments, there were key changes in the vegetation analysis that occurred between the draft and final EIS that are summarized in this section. One notable change was the updating and refining of the SIMPPLLE modeling, which is used to estimate future vegetation conditions. Further correlation of the model vegetation input layer (VMap) with the Forest Inventory and Analysis database for current conditions was conducted for the large and very large forest size classes and for species presence. Changes were made to model assumptions to address issues that were discovered related to patterns of future insect, disease, and fire disturbances. These changes to the model improved the comparison and interpretation of both the natural range of variation and future vegetation conditions compared to the current vegetation conditions. Some minor changes to desired conditions for vegetation resulted as well. Refer to Trechsel (2017a) for details of the model changes.

New information on the existing condition for snags and downed wood, as well as large and very large live trees, became available between the draft and final EIS. The analysis for these key ecosystem components was updated and expanded in the final EIS to incorporate this new information as well as to respond to some public comments that believed the analysis of these components to be insufficient. In addition to the analysis in section 3.3.7, refer to Trechsel (2017i) for further discussion of the new information and analysis.

Some minor changes in terminology occurred, specifically in the term used for potential vegetation types, in order to be fully consistent with the terminology recommended by the regional office for use at the broad-scale level of analysis (Milburn et al., 2015).The term “biophysical setting” was replaced with the term “potential vegetation type” to refer to the grouping of habitat types based on biophysical similarities. Only the *term* used to identify the underlying groupings of habitat types has changed, not the groupings themselves. Refer to appendix D of the forest plan for a table showing the habitat types and potential vegetation type groupings used during the plan revision process.

Potential management approaches and strategies in appendix C of the forest plan relative to vegetation plan components were clarified and expanded upon for the final EIS.

3.3.1 Vegetation affected environment and environmental consequences

Introduction

A primary goal of forest plan direction related to the vegetation component is to provide for ecological integrity and sustainability, supporting a full range of native plant and animal species while providing for the social and economic needs of human communities. As discussed at length earlier in this section, ecosystem and forest integrity and sustainability may be adversely affected by the potential impacts associated with climate change. Adaptation strategies to address this potentiality the resilience, resistance,

and response options (see the “Climate change, terrestrial ecosystems, and management strategies” section above).

Ecosystem integrity as related to vegetation is typically assessed by considering dominant ecosystem functions, composition, structure, and connectivity. The key ecosystem characteristics listed earlier are the identified indicators that will be used to describe ecosystem conditions and integrity and, considered as a whole, will provide a means to address forest resilience and compare effects between alternatives. The forest plan components for the vegetation resource (see the “Methodology and analysis process” section above) and the relationship of the desired conditions to the projected future conditions with the implementation of forest plan direction form the basis for the evaluation of environmental consequences and comparison of alternatives in this section.

This section begins by describing the primary ecosystem processes and disturbances (e.g., the dominant ecosystem functions) that affect vegetation composition and structure. Composition can be described as the types and variety of the vegetation, which in the case of the Flathead National Forest is overwhelmingly dominated by coniferous forest types. Structure can be described as the physical form of the forest stand, i.e., the vertical and horizontal arrangement of plants, dead and alive. Forest structure is a complex construct, which may include number of tree canopy layers, tree density, dead wood components, and tree sizes. At the forestwide scale of this analysis, consideration of forest structure is necessarily coarse. Indicators of forest structural diversity across the forest landscape analyzed in this EIS are forest size class, very large live trees, snags and downed wood, old-growth structures, and forest density.

The remainder of this chapter describes the affected environment and the environmental consequences of the alternatives for each key vegetation indicator. The “Environmental consequences” section includes a summary and comparison of model results for certain indicators, disclosing trends or future conditions that are considered important and relevant to the comparison of alternatives. Documentation of the modeling process and detailed tables and figures displaying outputs over time from this modeling process are found in appendix 2 and in planning record exhibits (Henderson, 2017; USDA, 2017b).

Summary of ecosystem processes and disturbances

The vegetation conditions on the Forest are not static but are constantly changing across space and time. The primary causes of vegetation change that are integrated into this analysis are climate, vegetation succession, fire, forest insects and disease, and treatments (i.e., timber harvest). The complex interactions between these ecosystem processes and disturbances over past centuries have resulted in the vegetation composition and structure that currently exists, and these interactions will be responsible for the changes to vegetation into the future that are evaluated in this EIS. Each of these causes of vegetation change is briefly discussed below. Additional detail can also be found in the assessment (USDA, 2014a).

Climate

Climate strongly influences vegetation conditions and ecosystem processes. Temperature and moisture patterns dictate which trees and other plant species are able to establish and grow on a site as well as such factors as growth rates and plant density. Periodic drought can alter forest conditions through direct mortality of trees or, indirectly, by increasing the frequency and/or severity of fire, for example, or by rendering trees more susceptible to mortality due to insects and disease.

Considerable natural variation in climate conditions has occurred historically, both over the long time frame (e.g., many centuries) and the shorter time frame (e.g., the past 100 to 200 years). The future climate change projections summarized in section 3.1.2 and in the assessment (USDA, 2014a) suggest that temperature increases in future decades will exceed the historical variation and average monthly

maximum temperature. Specific changes in ecosystem components due to expected climate change are difficult to predict and are highly uncertain, especially in the mountainous, diverse terrain of the northern Rocky Mountain region. Given the high level of uncertainty, the authors of the Northern Rockies Adaptation Partnership climate change assessment for vegetation (Robert E. Keane et al., in press) concluded that “assessing vegetation change and vulnerabilities is currently more of an educated guess based on inconsistent and contradictory studies rather than a highly confident evaluation of comprehensive scientific investigation.” Therefore, taking a relatively broad approach to management of the ecosystems of the Flathead is prudent, focusing on strategies that increase the overall resilience and resistance of the forests to allow adaption to whatever changes the future may bring. This translates to concepts that include maintaining or increasing biodiversity (species, forest structures, pattern complexity, etc.), featuring species and forest conditions that are more resistant and resilient to fire and insects and disease, and maintaining healthy, vigorous forest conditions. The forest plan has taken this approach to addressing potential climate change and associated change in ecosystem function in the management direction for vegetation. Refer to the section “Development of desired conditions and other plan components” above and to appendix 7 for more details on the approaches the Forest has taken to address climate change in the context of the forest plan revision.

Some possible effects to vegetation from increasing temperatures are as follows. For the forests of the western United States, it is likely that water balance and disturbance dynamics will be more important than actual increased temperature in affecting vegetation conditions. Longer, warmer growing seasons may increase growth rates; however, greater soil water deficits and increased evapotranspiration in the summer may offset this effect and increase plant stress. This latter result is more likely on the Forest, where water is currently a limiting factor on many sites. Stress can lead to higher mortality rates, either directly caused by water stress or indirectly by insects or disease. Increasing soil water deficits can also cause eventual shifts in species presence across the landscape as they become less able to successfully regenerate or survive under changing site conditions. Species located on sites at the margin of their optimal range would be most vulnerable, such as ponderosa pine on the driest sites, western larch on south aspects, whitebark pine in mid elevations, and western white pine on the drier sites.

Because of changing water balances, climate changes are expected to affect disturbance processes within forested ecosystems of the western United States. On the Flathead, fire, insects, and disease would potentially experience the most notable changes. There is a high degree of variability and uncertainties associated with extrapolation of these kinds of effects to more local sites, such as the Forest. As summarized in the Northern Rockies Adaptation Partnership report (Rachel A. Loehman et al., in press), studies of potential effects of climate change on fire and insects and disease suggest the following may occur across the western United States and Canada (refer also to section 3.8):

- There may be longer fire seasons, more days of high fire danger, increased frequency of ignitions, more frequent large fires, more episodes of extreme fire behavior, and increased average annual area burned.
- Given the availability and spatial distribution of host species, there may be elevated levels of native insects and disease, with bark beetles (mountain pine beetle, Douglas-fir beetle) and western spruce budworm notable examples for the Flathead. These increases are closely tied to increased stress of trees due to changing water balances. The effects of climate changes on forest diseases are difficult to predict, but predicted increases in temperature and drought will probably serve to increase pathogen populations in the future. The roles of pathogens as important disturbance agents will likely increase in the future because they are able to migrate to new environments at a faster rate than trees.

Vegetative succession

Vegetative succession is the sequential process of long-term plant community change and development. Succession entails the change in the composition, structure and function of plant communities over time following a disturbance (such as fire) and is based on the concept that every plant species has a particular set of environmental conditions under which it will reproduce and grow optimally. Successional pathways are complex and varied, reflecting the tangled web of interrelationships between site conditions, vegetation, and multiple ecosystem processes and disturbances, as well as weather and climate. The rate of successional change can also be highly variable.

Simplification of the complex successional process for integration at the scale of this forestwide analysis is necessary. For purposes of the analysis for this EIS, evaluation of forest size classes (see descriptions of forest size classes in section 3.3.4) provides the means to evaluate successional change of forests over time and their contribution to the biodiversity across the Forest. The early-successional stage is characterized by domination of seedling/sapling trees. This successional stage creates a forest opening because the much shorter trees and other vegetation create a distinct boundary and noticeably different condition to adjacent stands that are dominated by larger trees. As trees grow, they would be expected to transition through vegetative succession from smaller size classes into larger size classes. Mid-successional forests are associated primarily with the small and medium forest size classes, but in some cases forests in the large size class would also be considered mid-successional, depending on tree ages and species. Late-successional forests are associated mainly with the very large forest size class, although stands in the large size class may be late successional, again depending on tree ages and species.

Wildfire

Wildland fire is arguably the most dominant landscape disturbance on the Flathead National Forest. Wildfire emerged as a dominant process in North America after the end of the last glacial period, about 16,500 to 13,000 years before present, commensurate with rapid climate changes and increased tree cover (Marlon et al., 2009). Fire is an integral part of the creation, maintenance, and renewal of forests on the Forest and part of the ecological history of the forest ecosystems. Fire has influenced vegetation ages, structure, plant species composition, productivity, carbon storage, water yield, nutrient retention, and wildlife habitat.

Climate and fuels are the two most important factors controlling patterns of fire in forest ecosystems. Climate controls the frequency of weather conditions that promote fire, whereas the amount and arrangement of fuels influence fire intensity and spread. Climate influences fuels on longer time scales by shaping species composition and productivity (Dale et al., 2001; Marlon et al., 2008; Power et al., 2008). Current and past land use, including timber harvest, conversion of forest to non-forest lands, and fire suppression affect the amount and structure of fuels as well.

A fire regime is a generalized description of the role fire plays in an ecosystem, and for this analysis it is defined in terms of the effects of fire on the dominant vegetation in the system (James K. Agee, 1993, pp. 19-24). Fire regimes are defined by fire frequency (mean number of fires per time period), extent, intensity (measure of heat energy released), severity (net ecological effect), and seasonal timing. These characteristics vary across vegetation types and depend on the amount and configuration of live and dead fuel present on a site (such as forest densities, tree sizes, dead wood amounts), environmental conditions that favor combustion (such as drought), and ignition sources (such as lightning). The type of fire regimes characteristic of the Flathead are described in detail in the assessment (USDA, 2014a). Historical fire patterns are described in section 3.8 and are briefly summarized here.

The most common fire regimes on the Forest feature moderate- and high-severity fire, where most or all trees are killed across both small (e.g., less than 100 acres) and very large (e.g., tens of thousands of

acres) areas. Fire frequency, depending on the site, ranges from 35 to 100+ years. Climatic conditions feature largely in both the size, extent, and severity of fires. Historically, extended periods of warm and/or dry climatic conditions tended to be associated with larger, higher-severity, and more widespread fire events. Periods of more cool and/or moist climatic conditions tended to be associated with smaller and less severe fires. Long time intervals (e.g., 100 years or more) between major fire events in a particular area were common, particularly during cool and/or moist climatic periods. These long time periods allowed forest lands to once again develop into the mid and later stages of succession, including old-growth forest. Wildfire is typically a very dramatic event; in a matter of hours, thousands of acres of mid- or late-successional forest can be converted to an open, early-successional forest.

Fire on the landscape comes from natural ignitions and human-caused starts. Fire management strategies recognize the important ecological role of fire. Wildfire suppression strategies consider such factors as fire location, time of season, fuel conditions, and resource availability. Wildfires on the Flathead National Forest started by any source that threatens identified values are suppressed as soon as possible.

Use of wildfire to deliberately achieve desired vegetation objectives is a management action that may be used on the Flathead, particularly within wilderness. Within wilderness areas, wildfire is allowed to occur as a natural disturbance process. From 2001 to 2013, approximately 131,900 acres of wildland fire managed to meet resource objectives occurred on the Forest, all within wilderness areas. These wildfires are largely higher-severity stand-replacement burns that create large areas of early-successional forest openings. Some areas burn at more moderate severity, where 40 to 70 percent of the trees survive the fire.

Refer to section 3.8 for additional information on fire.

Forest insects and disease

Many insects and diseases affect vegetation in the forests of the Forest. Most are native and usually exist at relatively low population or intensity levels that do not cause notable large-scale or long-term impacts to forests. The actions of insects and disease are natural ecological processes that have played a major role in the past and will continue to do so in the future as drivers of vegetative change. The effects may be rather dramatic, such as when epidemic conditions for mountain pine beetle causes high mortality over the span of one year in lodgepole pine forests. More often, effects due to insects and disease occur more gradually, but they still can cause major changes to vegetation conditions. In the absence of fire, insects and disease account for an estimated 75 percent of change in vegetation over time (Byler & Hagle, 2000).

Insects and diseases that are considered to have the most notable impacts on forest conditions at the landscape scale and/or over time are included in this analysis and briefly summarized in this section. Refer to the assessment (USDA, 2014a) for additional information. There may be other insects or diseases that become more important in the future relative to impacts on forest conditions if warming climatic conditions occur, especially with an increase in disturbances such as fire.

Mountain pine beetle

Mountain pine beetle is the most aggressive and persistent bark beetle. Host species are lodgepole pine, ponderosa pine, western white pine, and whitebark pine. Lodgepole pine is its most abundant and widespread host species, and it tends to grow in large, often nearly pure stands of trees of similar size. This contributes to the periodic development of epidemic population levels of mountain pine beetle across this ecosystem, killing large numbers of lodgepole as well as spreading into the surrounding areas and killing trees of other pine species. Generally, the larger a tree’s diameter, the more susceptible it is to mountain pine beetle attack. During an infestation, all or nearly all trees can be killed in some susceptible stands over a relatively short time period (e.g., a few years), opening forest canopies enough to return them to the early stage of succession and thus providing regeneration opportunities for shade-intolerant

tree species. A more open canopy also allows the growth release of understory shade-tolerant tree species that are already present on the site. Tree mortality also increases the amount of snags and dead, downed woody material. This can influence the probability of large stand-replacing fires, which in turn can return the stand to the early-successional stage.

Figure 9 displays the mountain pine beetle hazard (primarily for lodgepole pine) across the Forest. Hazard is defined as the likelihood of an outbreak within a specific time period and is a function of forest conditions and susceptibility to mountain pine beetle. Elevation, age, size, and the proportion and density of lodgepole pine are factors used in the hazard rating. The majority (more than 80 percent) of the acres at low, moderate, or high hazard lies within the cool-moist potential vegetation type.

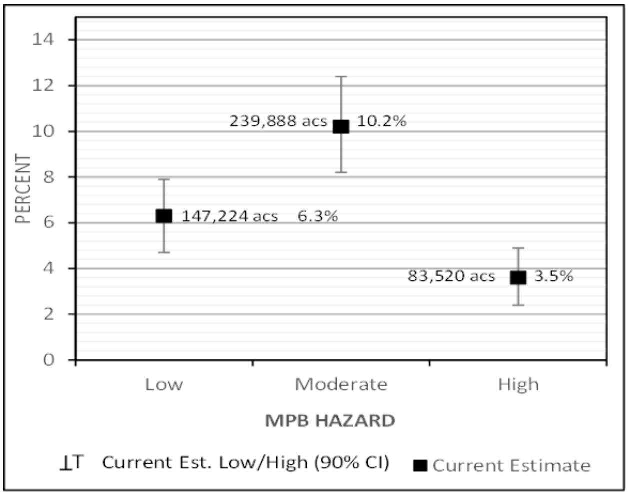

Figure 9. Forestwide percent and acres of low, moderate, and high hazard for mountain pine beetle in lodgepole pine. Data source: Forest Inventory and Analysis data using the R1 summary database (Hybrid 2011) analysis tools.

Recent review of aerial detection survey data indicates that the mountain pine beetle was present at mostly elevated levels every year on the Flathead National Forest during the 36-year time period from 1979 to 2015. Acres of tree mortality attributed to mountain pine beetle ranged between 100 and 308,000 acres, with an average of 66,408 acres. The most recent outbreak began in 2002, when beetle populations began to build and mountain pine beetle mortality, primarily of lodgepole was noted on about 21,000 acres across the Forest. Between 2002 and 2010, from 22,000 to 78,000 acres each year on the Forest have experienced notable levels of mortality from mountain pine beetle, peaking in 2010. Beetle populations subsided in 2012, with fewer than 7,000 acres of mortality across the Forest, dropping to approximately 2,000 acres in 2013.

As summarized in chapter 8 of the Northern Rockies Adaptation Partnership report (Rachel A. Loehman et al., in press), potential climate changes in the future are likely to have an effect on bark beetle activity. Many bark beetle life history traits that influence beetle population success are temperature dependent. The stress of host trees due to changing water balance increases vulnerability of trees to bark beetle attack and mortality. Warming temperatures associated with climate change have directly influenced tree mortality caused by bark beetle in some areas of western North America. Future bark beetle-caused mortality will depend not only on the spatial distribution of host trees and pattern across the landscape, but also the ability and capability of beetle populations to adapt to changing conditions. Beetle populations may be favored by warming temperatures due to the potential for the increased survival of beetles and to increased stress of the host species.

Douglas-fir beetle

Douglas-fir is one of the most dominant and widespread species on the Forest, and Douglas-fir beetle is a chronic mortality agent within Douglas-fir stands, killing or injuring individuals and small groups of Douglas-fir across the Forest every year. Beetle outbreaks and widespread mortality of trees occur periodically in this ecosystem, typically following stand disturbances such as fire, severe drought, or windthrow, where large areas of weakened trees exist. Persistent root disease provides habitat for the maintenance of endemic levels of Douglas-fir bark beetle. Larger-diameter trees (greater than 15 inches d.b.h.) are most vulnerable to beetle attack. Figure 10 displays estimated Douglas-fir beetle hazard across the forest. Although most of these low-, moderate-, and high-hazard acres occur on the cool-moist potential vegetation type, a disproportionate amount of the forests within the warm-dry and warm-moist types have hazard to Douglas-fir beetles. Low-, moderate-, or high hazard Douglas-fir beetle forests occur across an estimated 119,000 acres (55 percent) of the warm-dry type and an estimated 69,237 acres (65 percent) of the warm-moist type.

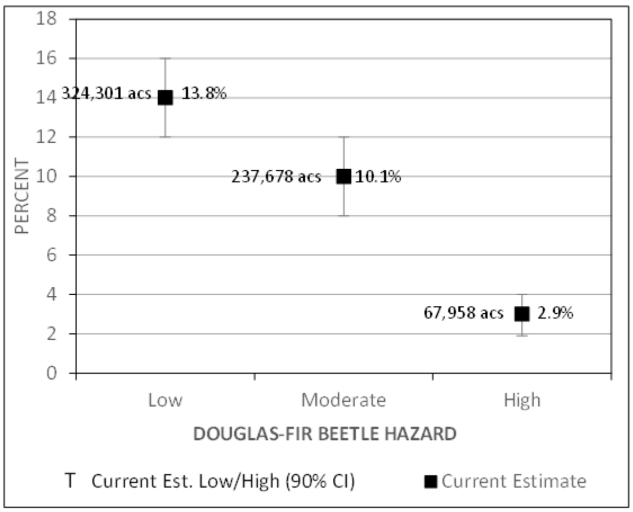

Figure 10. Forestwide percent and acres of high, moderate, and low hazard for Douglas-fir beetle. Data source: Forest Inventory and Analysis data using the R1 summary database (Hybrid 2011) analysis tools.

Recent review of aerial detection survey data indicates that the Douglas-fir beetle was present every year on the Forest at some level during the 36-year time period from 1979 to 2015. Annual acres of tree mortality attributed to Douglas-fir beetle ranged between 3 and 14,000. The average was 2,873 acres per year.

Douglas-fir beetle activity would likely be influenced by the expected warming future climate in similar ways to mountain pine beetle activity. Not only would beetle survival be enhanced by warming temperature, but the stress levels of host species would make them more vulnerable to beetle attack.

Spruce beetle

Spruce beetle is the most significant natural mortality agent of mature spruce, and its host on the Flathead is Engelmann spruce. Outbreaks of this beetle have caused extensive spruce mortality from Alaska to Arizona and have occurred in every forest with substantial spruce stands. Spruce beetle outbreaks cause extensive tree mortality and modify stand structure by reducing the average tree diameter, height, and stand density. Residual trees are often slow-growing small and intermediate-sized trees that eventually become dominant.

Endemic spruce beetle populations usually live in windthrown trees, and most outbreaks in standing trees originate in windthrown trees. When populations increase to high levels in downed trees, beetles may enter susceptible large-diameter standing trees. Spruce beetle also attacks trees that are weakened by fire, root disease, or other stress agents. Beetle outbreaks can occur following stand disturbances, such as fire or widespread blowdown of trees after a high-wind event.

As with the Douglas-fir beetle, larger-diameter trees are more susceptible to beetle attack. In the Rocky Mountain area, the susceptibility, or hazard, of a stand to spruce beetle attack is based on the physiographic location, tree diameter, basal area, and percentage of spruce in the canopy. Spruce stands are highly susceptible if they grow on well-drained sites in creek bottoms, have an average d.b.h. of 16 inches or more, have a basal area greater than 150 square feet per acre, and have more than 65 percent spruce in the canopy.

Spruce beetle is currently at endemic levels on the Forest, primarily due to the lack of widespread availability of stands containing larger spruce. Areas where large-diameter-spruce-dominated forests develop are commonly associated with the moist areas and riparian zones, which tend to form a relatively narrow linear or discontinuous pattern across the landscape. Large outbreaks of spruce beetle in the 1950s and 1960s resulted in high mortality of large-diameter spruce in portions of the Forest. This event, and subsequent salvage and sanitation harvesting, removed many larger-diameter spruce, and the current forests in these areas are still young and are not yet susceptible to spruce beetle.

Western spruce budworm

This is a widely distributed native insect that historically has caused widespread damage and tree mortality in drier forests east of the Continental Divide. It is a defoliator, feeding on the flowers, cones, and foliage of trees. The most common and severely affected host trees on the Forest are Douglas-fir, subalpine fir, grand fir, and Engelmann spruce. Damage includes top-killing of the trees, severe growth reduction, and some tree mortality, mostly in sapling-sized and smaller trees. Newly established seedlings are particularly vulnerable to being seriously damaged or killed by larvae. Seedling damage or mortality, coupled with the impact of larvae feeding on seeds and cones, can significantly delay the establishment of natural regeneration of host-tree species. Young trees are particularly vulnerable when growing beneath a canopy of overstory trees, where larvae falling from the overstory canopy layers find an abundant food source in the understory trees. In mature stands, trees severely defoliated by the western spruce budworm may be predisposed to one or more species of tree-killing bark beetles, mainly the Douglas-fir beetle and the fir engraver beetle.

Outbreaks of spruce budworm often follow periods of drought. Similar to bark beetles, warmer climatic conditions tend to provide favorable conditions for budworms, especially if they are associated with increased stress in the host species. There is an ongoing outbreak of the western spruce budworm in the northern Rocky Mountains that began in 2008 and is still continuing into 2015. Aerial detection surveys recorded 375,000 acres defoliated in 2014. Over the past 70 years, the Forest has experienced four major budworm outbreaks including the current one. Outbreaks appear to be very cyclical. During an outbreak in the early 1970s, the number of acres defoliated by budworm peaked at 383,500 in 1972. There was a 15-year break from budworm defoliation on the Flathead and most of the other national forests between 1993 and 2009. The only other sustained period of time when budworm was nonexistent on the Forest was from 1959 to 1966.

Root disease

Root diseases are the most damaging group of tree diseases (S. Hagle, 2004). Root diseases are caused by fungi that spread from the roots of diseased trees to the roots of healthy ones. Root disease fungi are widely distributed across the forested sites of the Forest. The main root pathogens known to occur on the

Forest are heterobasidion root disease, armillaria root disease, tomentosus root disease, and schweinitzii root and butt rot. All tree species on the Forest are affected by one or more of these fungal diseases, with varying degrees of tolerance among tree species and differing intensity of infection among sites. Douglas-fir, subalpine fir, and grand fir tend to be the most susceptible to these pathogens; ponderosa pine and western larch are the least susceptible.

At high infection levels, in trees stressed by other factors, or simply over time, these root diseases are capable of killing trees outright. Other stress or mortality agents, such as bark beetles, drought, or windthrow, often contribute either directly or indirectly to the death of trees. Sometimes large numbers of trees in an area may be killed within a period of a few years, but in most cases root diseases kill individuals and groups (large or small) of trees more gradually over time. Because of this, they usually act as thinning agents in the forest, killing the individuals and species that are more susceptible to root disease. This favors more resistant species and has the potential to cause major shifts in species composition and changes in forest structure over time. Once established on a site, root disease fungi can be persistent to essentially permanent, living for decades in the roots and stumps and killing new trees that seed into the site (S. K. Hagle, 2006).

New information on root disease severity and hazard across the Flathead National Forest became available after publication of the draft EIS, and this new information has been used to update this analysis (Lockman, Bush, & Barber, 2016). Figure 11 displays the acres of varying levels of root disease severity on the Forest as published in Lockman et al. (2016).

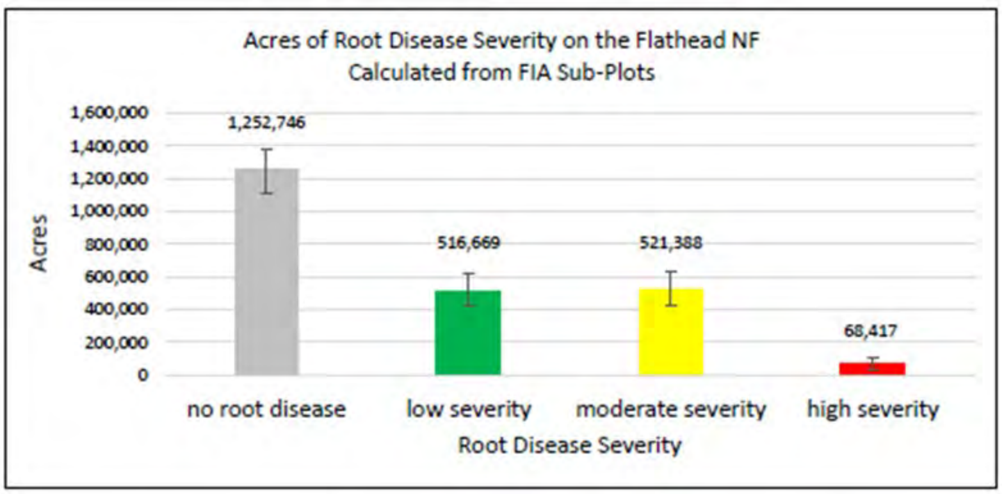

Figure 11. Acres of no, low-, moderate-, and high-severity root disease on the Forest.

Root disease severity is tied to aboveground symptoms of root disease and based on the amount of canopy loss due to root diseases and/or the ground occupied by root disease pathogens. A rating of low indicates up to 10 percent canopy loss; a rating of moderate indicates 10 to 50 percent canopy loss; and a rating of high indicates 50 percent or greater canopy loss. Of the eight national forests in the Northern Region west of the Continental Divide, the Flathead National Forest has the highest proportion of area rated at high severity (2.9 percent) and moderate severity (22.1 percent) (Lockman et al., 2016). This is largely attributable to the high proportion of this Forest in the cool-moist potential vegetation types that are particularly favorable for development of root disease (e.g., subalpine fir habitat types). Figure 12 displays the proportion of root disease severity for the Flathead potential vegetation types, as calculated from Forest Inventory and Analysis plot data (Lockman et al., 2016).

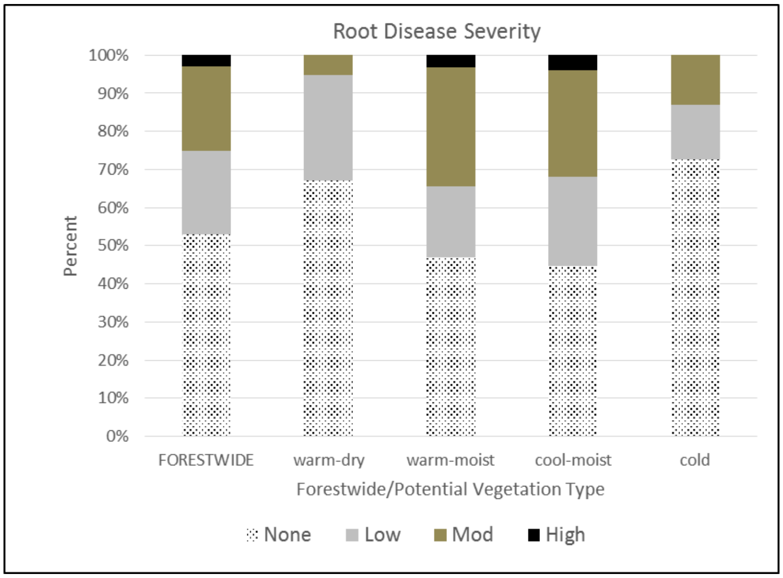

Figure 12. Percent of high, moderate, low, and no severity for root disease by potential vegetation type on the Forest.

Root disease hazard is defined as the probability of root disease existing within a defined vegetation class. Using the results of the root disease severity analysis, Lockman et al. (2016) applied a rule set to determine root disease hazard that also incorporated dominance types and potential vegetation types and then mapped the hazard using R1 VMap for the existing vegetation. Areas were assigned a low, moderate or high root disease hazard rating, as displayed in figure 13.

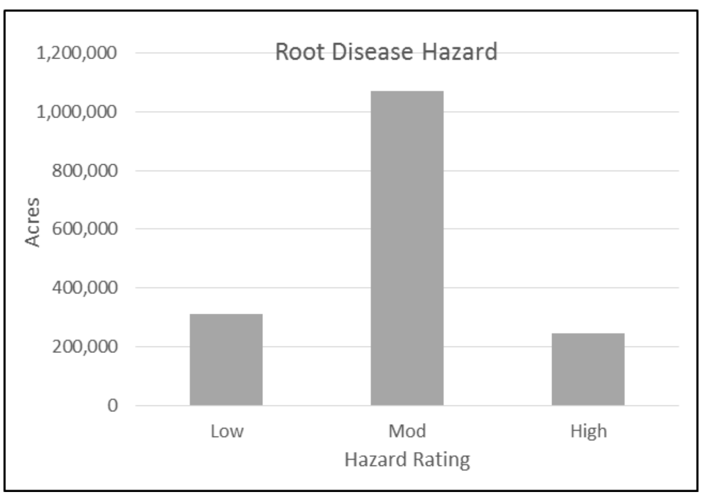

Figure 13. Acres of high, moderate, and low hazard for root disease on all ownerships within the administrative boundaries of the Flathead National Forest.

Over 1.6 million acres of the Forest have some level of root disease hazard. About 245,000 acres have high hazard, with most occurring on grand fir, subalpine fir, Douglas-fir, and western red cedar potential vegetation types, especially where these species dominate the forest composition. Although not all acres within the high hazard class have root disease, this class has the greatest potential for severe root disease to occur and to have significant impacts where it does occur. Low root disease hazard occurs on

approximately 313,000 acres, indicating root disease may occur in these areas but would likely be at the low-severity level and with less impact.

Clearly, root disease currently is a primary factor causing change in forest conditions of the Flathead and has the potential to continue to do so into the future. Root disease expresses itself in a variety of ways, depending on the pathogen species and degree of infection as well as on forest conditions. It may affect patches of trees or individuals. It usually weakens and kills trees gradually over a period of years or decades, with secondary agents (such as bark beetles) often striking the final blow to the weakened tree. Once established, root disease pathogens persist for decades in the roots of stumps and dead trees. The pathogen is very persistent and not eliminated by fire. It can infect newly regenerated trees of the host species if present.

There is great capacity for root disease to move from a moderate level of severity to high severity on the Flathead National Forest (Lockman et al., 2016). Hagle et al. (2016) completed an analysis of root disease plots monitored over 22 years on the Clearwater National Forest and found that root disease severity class increased "roughly one severity class . . . per decade." This study found that root disease-caused mortality tended to be greater on the wetter habitat types. Since the Flathead National Forest has a greater proportion of drier potential vegetation types, a slower transition to higher levels of root disease severity may be expected, but data has not been analyzed to date to validate this assumption. Root disease and other pathogens commonly respond to weakened or less vigorous host tree conditions, so their importance could increase if climatic conditions less favorable to tree vigor and growth become more frequent or widespread in the future.

White pine blister rust

Unlike the insects and diseases discussed above, white pine blister rust is a non-native, introduced disease that entered the United States from Europe at the turn of the 20th century. It infects all five-needled pines, and its primary host species on the Forest are western white pine and whitebark pine. The pathogen kills trees of all ages and sizes. It also infects leaves of *Ribes* species (currants and gooseberries), which are alternative hosts that are required for blister rust to complete its life cycle. Other possible but as yet undetermined alternative species include louseworts and Indian paintbrush.

Both western white pine and whitebark pine are important contributors to the ecosystem diversity, structure, and resilience of forests in the planning area. Both are very long-lived species and are well adapted to both survive and regenerate in the mixed and stand-replacement historical fire regimes of this ecosystem. However, these tree species have little natural resistance to this introduced disease, and vast numbers of western white pine and whitebark pine trees have been killed across their ranges, which includes the Forest. The loss of these species has impacted forest resilience in the face of potential future disturbances and wildlife habitat values. Refer to section 3.3.3 for further discussion of the existing condition of western white pine and whitebark pine, and the effects of this exotic disease on these species.

Vegetation treatments

Two broad categories of active vegetation treatments were evaluated and incorporated into the modeling for this EIS: timber harvest and prescribed fire. These treatments change forest conditions in both the short term (i.e., one year) and the long term. Timber harvest removes commercial timber products and consists of three general types: even-aged regeneration, group selection, and commercial thinning. Timber harvest prescriptions in this analysis also incorporate noncommercial thinning of young sapling stands and tree planting, both key treatments that influence stand composition and structure in the short and long term. Prescribed fires are planned ignitions where fire is deliberately applied to the landscape. For purposes of this analysis, this term refers to planned ignitions that are not associated with timber harvest areas (i.e., it does not include the burning of harvest slash). A description of each of these treatments and

how they affect vegetation conditions, plus a summary of past acres of treatments across the Forest, follow. Refer also to the assessment (USDA, 2014a) for more detailed information on past harvest and prescribed burn treatments and to section 3.21, which provides information on past commercial timber harvest activities.

Regeneration harvest (even-aged)

Regeneration harvest includes clearcuts and seedtree and shelterwood cuts with reserves, all of which remove the majority of the trees, opening up the forest canopy sufficiently to allow new tree seedlings to establish and grow. After regeneration harvest, forest size class changes to seedling/sapling, an early-successional forest condition. Forest dominance types and species presence may also change, depending upon the composition of the regenerated forest. Forest densities and forest fuels (i.e., downed wood, snags) may decrease or increase depending upon the preharvest forest conditions.

Noncommercial thinning (sometimes called precommercial thinning) is not directly modeled and analyzed in this EIS but is incorporated into the even-aged regeneration harvest prescriptions. This thinning occurs in stands of sapling size (1 to 5 inches d.b.h.) and reduces tree densities. Species composition may change due to targeting different species to leave or remove. Maintenance or improvement of tree growth may occur. Forest structure may be affected over the long term (e.g., tree sizes, forest density).

Similar to noncommercial thinning, tree planting is also incorporated into the even-aged regeneration harvest prescriptions. Tree planting primarily influences species compositions and, in some situations, forest density.

Group selection (uneven-aged regeneration)

Group selection harvest is a type of uneven-aged regeneration harvest, converting the forest to a seedling/sapling size class and potentially changing species composition. However, this conversion occurs gradually over a period of many decades, creating a multi-age and multi-size stand. Openings are created (typically less than one or two acres) over a portion of the stand in each harvest entry. For example, a particular stand may have a treatment entry every 10 to 15 years, treating 20 percent of the stand each entry by creating small openings, resulting in the entire stand being treated over a 50- to 75-year period.

Commercial thinning

Commercial thinning is an intermediate harvest type that removes fewer trees than in a regeneration harvest, leaving a forest that is less densely stocked but still dominated by trees larger than seedling/sapling size class. The focus is not on regenerating a new forest stand but on changing the condition of the current one. Not only is forest density reduced, but species compositions and forest size class may change due to the unequal removal of trees of different species or size. Tree growth is typically accelerated. Reduction of downed wood may occur.

Prescribed fire

Prescribed fire treatments are planned fire ignitions used to meet a variety of vegetation-related resource objectives, including the improvement of wildlife habitat, stimulation of shrub sprouting, reduction of stand densities, reduction of forest fuels (downed wood), creation of openings of early-successional habitat, and restoration of natural disturbance processes. Prescribed fires may be designed to be of low severity (less than 40 percent tree mortality) or high severity (greater than 70 percent tree mortality), depending on the desired post-fire vegetation conditions.

Past vegetation treatment acres

Harvesting has been a tool used on the Forest to achieve a variety of resource objectives, including but not limited to lowering fuels and fire risk, establishing desired tree species, improving tree growth, reducing impacts of insects or disease, contributing wood products to the local economy, improving wildlife habitat, and salvaging the economic value of trees killed by fire or other factors. Reliable records of timber harvest on Forest Service lands extend back to about the mid-1940s. Since that time, an estimated 16 percent (approximately 400,000 acres) of the total NFS lands on the Forest have experienced some type of timber harvest (1940s to 2013). Looking at a more recent time period, in the period 1990 to 2013, an estimated 97,000 acres, or about 4 percent, of NFS lands have been harvested. Table 18 displays the estimated acres of past commercial timber harvest on the Flathead. These acres include salvage harvest, which is considered an intermediate harvest treatment and focuses on removal of dead or dying trees, most commonly due to fire, insect (bark beetle) infestation, or windthrow.

Table 18. Estimated acres of past commercial timber harvest on the Flathead National Forest as recorded in the Forest Activity Tracking System database

Decade of Harvest	Acres of Intermediate Harvest	Acres of Regeneration Harvest	Total Acres
prior to 1950	854	4,721	5,575
1950-1959	6,567	21,626	28,193
1960-1969	15,943	63,162	79,105
1970-1979	32,530	67,729	100,259
1980-1989	19,538	64,296	83,834
1990-1999	10,318	33,107	43,425
2000-2012	28,176	25,679	53,855
Total	113,927	280,320	394,247

Noncommercial treatments are also used to achieve resource objectives. Since 1950, approximately 119,000 acres (about 5 percent of Flathead National Forest lands) have been non-commercially thinned (i.e., thinning in sapling stands), with nearly 40 percent (approximately 44,000) of those acres occurring from 1990 to 2013. Prescribed fire has been used across an average of 2,500 acres per year over the past decade.

Planting of tree seedlings within areas disturbed by fire or within regeneration harvest units has occurred across approximately 136,000 acres (about 5.6 percent) of Forest lands since 1950. About 61,000 of these planted acres were accomplished from 1990 to 2013. Planting is usually conducted for the purpose of establishing desired tree species on a site where natural regeneration is not expected to be sufficient.

Modeled disturbance processes and treatments

As described in the methodology section earlier, analytical modeling was used to assist in the evaluation of trends in vegetation characteristics over time. Fire, insects, disease, and timber harvest are the disturbances that impact vegetation change in the model, interacting with climate and vegetative succession, over the five-decade modeling period. This section briefly describes the modeled disturbance and treatment outputs over the next five decades, which is the modeling period used for describing effects to vegetation in this section. Relevant results in vegetation changes from the modeling are described later in the “Environmental consequences” sections for each key ecosystem characteristic. This section also describes some of the particulars of the modeling to be aware of when interpreting these results. More detailed information on the modeling process and outputs is found in appendix 2 and the planning record

exhibits (Henderson, 2017; Trechsel, 2017g). Figure 14 displays the proportion of the Forest affected by the various modeled processes and activities over the five-decade future model period. The source of data is the Spectrum model for the prescribed burns and timber harvests and the SIMPPLLE model for the natural disturbances.

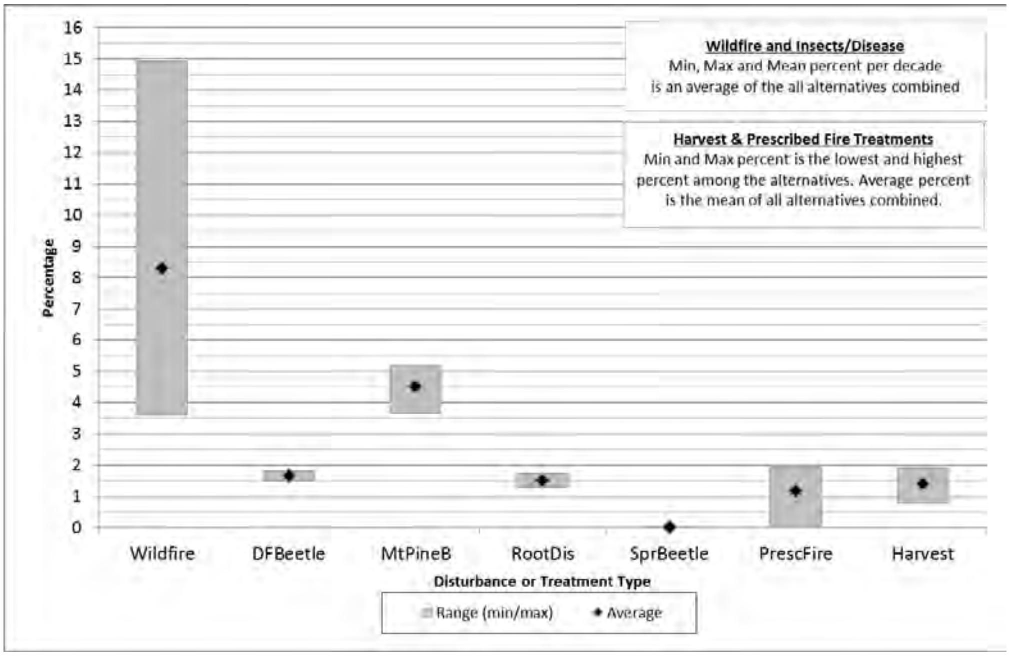

Figure 14. The average mean, minimum, and maximum percent per decade of Forest area affected by different disturbances and treatments, as modeled over a five-decade future period.

Wildfire

As in the past, wildfires are expected to continue to have one of the most substantial influences on vegetation conditions in the future. Figure 14 displays estimated modeled range in fire acres into the future, as an average of all the alternatives. Figure 14 displays the amount of wildfire as a minimum, maximum, and average across the five decades and by alternative. The acres of wildfire in that figure are unplanned ignitions that include both fires that will be allowed to burn to achieve desired vegetation conditions and fires that will be actively suppressed but have a probability of growing to moderate or large size under certain climatic and vegetation conditions. Updates to the modeling occurred between the draft EIS and the final EIS to address what was felt to be an underestimation of the potential amount of future fire in light of expected climate changes and potential effects on fire disturbance processes (Henderson, 2017; Trechsel, 2017a).

Although the best understanding of how fire behaves across the Forest and the effects fire has on vegetation was used to inform the model, there is an inherent degree of uncertainty. The Forest cannot predict with high accuracy where and when fires will occur. There is also an inherently high degree of variability, both spatially and over time, in the amount and location of wildfire. The average wildfire acres displayed in figure 14 do not imply an “even flow” of acres burned over time. The acres burned vary by decade between the simulations, from a low of about 50,000 acres to a high of about 450,000 acres within a decade (Trechsel, 2017g). The model simulations reflect the reasonable assumption that under warmer climate periods, drier conditions would occur and a higher amount of fire could therefore be expected across the landscape. For additional discussion of fire, both historical and future, refer to section 3.8 and to the assessment (USDA, 2014a).

Prescribed fire

The Spectrum model applies prescribed fire across the Forest over the modeling period under all the action alternatives. No prescribed fire is modeled to occur in designated wilderness, but it may occur in other management area allocations and within all potential vegetation types and forest dominance types (except for the grand fir/cedar dominance type, which has no prescribed fire modeled). The amount of prescribed fire as averaged over the next five decades is very similar between the action alternatives, ranging from an estimated average of 4,100 acres annually (alternative D) up to and estimated 4,900 acres annually (alternative B modified). Lower-severity underburns are applied in the warm-dry potential vegetation types where early-successional fire-resistant species occur. About one quarter of the estimated prescribed burn acres are estimated to be low-severity fire. The remainder are mostly anticipated to be moderate severity, with some high-severity burns (i.e., in lodgepole pine or subalpine fir forest types), and would largely occur in the cool-moist and cold potential vegetation types. The specific desired vegetation conditions most likely to result from the modeled prescribed burning include the creation of seedling/sapling-dominated forest size class, reduced forest densities, and increased forest size classes by the removal of smaller-diameter understory trees and the altering of species compositions to favor the fire-resistant species (especially western larch and ponderosa pine). Refer to appendix 2 of the final EIS for more information on prescribed fire as modeled into the future.

No prescribed fire is modeled to occur under alternative A because the existing 1986 forest plan has no specific objectives or direction related to the implementation of prescribed fire. However, in reality, prescribed fire is and will be used as a tool to achieve desired vegetation and fuel conditions under the current 1986 forest plan, similar to what might occur under the action alternatives.

The model applies prescribed fire within recommended wilderness areas under all alternatives, as allowed by the plan. However prescribed fire use would be much more limited in these areas once they become designated wilderness, and this potential future change in the extent of prescribed fire that may be able to be applied in recommended wilderness is not reflected in this modeling process. The use of wildland fire (management of unplanned fire ignitions) to meet management objectives may continue in newly designated wildernesses; however, the ability to use this tool in many of the recommended wilderness areas is limited due to their location relative to values at risk (i.e., communities). Refer to sections 3.3.10 and 3.5.1 for additional discussion of effects to vegetation, especially to whitebark pine restoration objectives, from the allocation of recommended wilderness.

Prescribed fire is limited not only by budget but also by weather- and climate-related factors and logistical factors. In addition, management direction in the current and forest plan related to the threatened Canada lynx, and the resulting restrictions on vegetation treatments, is expected to limit prescribed burning opportunities substantially (refer to section 3.3.10, subsection “Effects from wildlife management”). These factors are difficult to reflect in the modeling, but it is reasonable to assume that the amount of prescribed burning portrayed into the future by the model is a generous amount relative to what might actually be possible to achieve. Refer also to section 3.8 for more detail on prescribed fire.

Timber harvest

Timber harvest as modeled in Spectrum is of three general types: regeneration, commercial thinning, and group selection. Refer to the discussion earlier under vegetation treatments for a description of these types of harvest and the types of vegetation change that they typically would achieve. Table 19 displays the annual average acres of commercial timber harvest as modeled in Spectrum for the next two decades, representing the life of the plan. For comparison, over the decade 2000 to 2009, an estimated average of 3,400 acres annually of commercial harvest occurred (excluding salvage) (see USDA, 2014a). The timber section of this EIS (section 3.21) provides information on the estimated outputs in timber volume from

these harvested acres. Additional information on the estimated acres of harvest over five decades, which is the time period modeled in SIMPPLLE to assess vegetation changes, may be found in appendix 2.

Table 19. Average annual acres of commercial timber harvest by alternative for decades 1 and 2, under reasonably forseeable budget levels

Type of Harvest	Decade	Alternative A	Alternative B Modified	Alternative C	Alternative D
Even-aged regeneration	1	1,199	2,138	77	1,833
	2	1,081	2,045	411	908
Commercial thinning	1	-	1,000	1,500	-
	2	-	1,000	1,499	1,000
Uneven-aged management	1	500	-	1,000	-
	2	500	-	1,328	500
Total	1	1,699	3,138	2,577	1,833
	2	1,581	3,045	3,238	2,408
Average annual acres, all harvest types	two-decade period	1,640	3,092	2,908	2,121

It is important to realize that the acres and proportions of timber harvest by different treatment prescriptions in these tables and exhibits are a product of a modeling process. The different objective functions applied in the model influence the mix of treatment types that result by alternative (refer to the discussion of modeling in appendix 2). By necessity, the models simplify treatment implementation, applying harvest treatments using very general and limited guidance, both spatially and temporally. The focus should be less on the precision or accuracy of these acre estimates and more on the relative difference between alternatives. The vegetation change resulting from the treatments is also by necessity broad and generalized. In reality, silvicultural prescriptions for harvest treatments are applied site-specifically, are designed to address forest conditions unique to the site, and are far more variable in application and resulting vegetation conditions than can be depicted by the model. As required by plan direction, each prescription would be designed to meet desired vegetation conditions, and each would contribute to achieving more resilient forest conditions across the Forest. This is an underlying assumption common to all the alternatives, although it may not be well illustrated through the modeling process.

Regeneration harvest alters forest size classes and may alter forest densities and forest composition. Subsequent reforestation (planting or natural regeneration) occurs in regeneration-harvested stands. Noncommercial thinning may occur in some stands, although its use is highly restricted across most of the Forest due to management direction within Canada lynx habitat (refer to section 3.3.10, subsection “Effects from wildlife management”). Commercial thinning and group selection are the two types of non-even-aged harvest in the model. Commercial thinning mainly reduces forest density but also could result in an increase in size class (by removing smaller trees and leaving larger trees) and a change in forest composition. Group selection harvest may or may not alter the current forest condition, depending on pre-harvest species composition and structure of the stand. It tends to maintain or increase the shade-tolerant tree species (e.g., grand fir, subalpine fir) compared to shade-intolerant species because of the small openings and denser forest canopy conditions.

Insects and disease

Modeling suggests that insects and disease, particularly the bark beetles, will play an important role in vegetation change over the next five decades (Trechsel, 2017g). The amount of insect and disease

disturbance is linked to the abundance of the host species, vegetative succession of these forests into more susceptible conditions (i.e., larger trees, higher densities), and the warmer climatic scenario that is modeled in the latter decades of the model period. These are modeled estimates, based on the best available information but still associated with a high level of uncertainty.

There were updates to the SIMPPLLE model related to insect and disease processes between the draft EIS and the final EIS. As disclosed in the draft EIS, it was believed the model substantially overestimated the amount of acres infested by Douglas-fir and spruce beetle and the length of infestation that would be expected on the Forest for these bark beetles. The Forest Service regional entomologist reviewed the data and adjusted the model assumptions. See Henderson (2017) and Trechsel (2017a) for details and documentation of the model changes.

The model expresses impacts from insects and disease that reflect the changes that would occur in forest composition and structure under a moderate to high level of insect and disease activity. Forests impacted by Douglas-fir and spruce beetles would generally show a decrease in large and very large trees of those species and a reduction in forest densities. The mountain pine beetle would mainly impact lodgepole pine stands and, to a lesser degree, ponderosa pine. They too would show decreased density and reduced size classes. Root disease would generally reduce size classes as well, with the removal of the more susceptible, larger-diameter, older trees. Species composition might also change as more susceptible species were killed (such as Douglas-fir) and other species gained dominance (such as western larch).

The model indicates root disease and western spruce budworm would also affect forests over the five-decade model period, although impacts on vegetation is generally expected to be less than that of the bark beetles (refer to appendix 2). Root disease primarily impacts forests dominated by Douglas-fir, grand fir, and subalpine fir, potentially decreasing forest densities and shifting species composition. Western spruce budworm primarily impacts these same species and also spruce.

3.3.2 Forest plan management direction

Forest plans provide direction designed to achieve the overall goal of maintaining or moving towards resilient and sustainable vegetation conditions on the Flathead. This section describes and compares forest plan direction between the alternatives.

Desired conditions, objectives, standards, and guidelines

Effects of alternative A

The existing forest plan incorporates strategies to maintain resilient forests in the goals, standards, and objectives for vegetation management and wildlife habitat. Most of this direction originates from amendment 21 to the forest plan, management direction related to old-growth forest, which was adopted and integrated into the existing forest plan in 1999. In addition to revising old-growth management direction, amendment 21 provided broad direction related to other forest structures designed to maintain forest and ecosystem resilience. The 1986 forest plan does not contain explicit or quantitative desired conditions for vegetation components but provides more general direction for management. This includes direction to manage for vegetation composition, structures, and patterns that would be expected to occur under natural succession and disturbance regimes; use historical vegetation conditions and knowledge of natural disturbance regimes to guide development of desired conditions at the project level; reduce the risk of undesirable fire and insect and disease disturbances; and provide for the long-term recruitment of forest structural elements such as snags and downed wood. Most of this direction is located in the forestwide objectives under section A(6)—Vegetation (USDA, 1986, p. II-8) and in the forestwide standards under (H)—Vegetation (USDA, 1986, p. II-47). This direction is designed to maintain or trend the Forest towards greater resilience at both the stand and landscape scales. Specific information related

to direction provided for the different key ecosystem characteristics is provided within the sections for each characteristic that comprise the rest of this vegetation section of the EIS.

Effects common to alternatives B modified, C, and D

All action alternatives employ a similar framework and emphasis related to maintaining or achieving forest resilience and resistance to future disturbances and climates. The forest plan for all action alternatives includes specific plan components related to key ecosystem characteristics for vegetation. Desired conditions FW-DC-TE&V-03 and 04 highlight the overriding ecological vision for the forests of the Flathead National Forest, which includes having "vegetation conditions and patterns contribute to resistant (the capacity to remain relatively unchanged following disturbance) and/or resilient (the capacity to regain normal functioning following disturbance) forest conditions at both the stand and landscape level" and having habitat conditions across the Forest that "contribute to long-term persistence and diversity of native plant and animal species."

Specific desired conditions, both qualitative and quantitative and based on the natural range of variation, are provided for the key vegetation characteristics. The desired conditions provide substantially more detail and clarity regarding the vegetation conditions and species compositions to strive for across the Forest as compared to the existing 1986 forest plan. The desired conditions describe, as well as possible based on current knowledge, what will maintain or trend the Forest towards resilience and sustainability. A planning record exhibit (Trechsel, 2016a) provides details on how desired conditions for vegetation were developed. The forest plan contains many plan components that contribute to the maintenance or achievement of a diverse, resistant, and resilient forest. These include the following:

- desired conditions for vegetation composition (FW-DC-TE&V-07, 08, 09)
- desired conditions for vegetation structure—forest size classes and very large trees (FW-DC-TE&V-10, 11, 12)
- desired conditions for forest density (FW-DC-TE&V-13)
- desired conditions for old-growth forest (FW-DC-TE&V-14)
- desired conditions for forest structural components of snags and downed woody material (FW-DC-TE&V-15, 16, 17)
- desired conditions for landscape patterns (FW-DC-TE&V-18, 19)
- desired conditions for ecosystem processes (FW-DC-TE&V-24), including insect and disease (FW-DC-TE&V-20, 21, 22) and fire (FW-DC-TE&V-23), including recently burned forest conditions (FW-DC-TE&V-25)
- desired conditions for vegetation in riparian management zones (FW-DC-RMZ-01, 03, 04, 05, 06) (see also section 3.2.10 of the final EIS)
- objectives (FW-OBJ-TE&V-01 through 04; FW-OBJ-RMZ-01) specifying acres of vegetation treatments to implement over the plan period to achieve desired conditions for coniferous forest types and associated wildlife species; to contribute to the restoration of resistant western white pine and achieve desired conditions for this species; to contribute to the restoration of diverse native hardwood forest types; to promote the persistence of grass/forb/shrub plant communities; and to improve riparian habitat
- guidelines and standards for vegetation management that provide direction to help achieve desired conditions and avoid or mitigate for undesirable effects. These include snag, downed wood, and large live tree retention (FW-STD-TE&V-03 and associated snag retention standards within each geographic area; FW-GDL-TE&V-08, 09, 10); protection of and provision for future old growth

(FW-STD-TE&V-01, FW-GDL-TE&V-06, 07); and guidance and direction for vegetation management activities within riparian management zones (FW-STD-RMZ-05, 06; FW-GDL-RMZ-08, 09, 10, 12, 13)

Individually, these vegetation components and desired conditions are important for their role in contributing to the overall goal of maintaining the resilience and sustainability of forest resources. Later sections in this chapter describe existing conditions and effects of the alternatives related to each individual vegetation key ecosystem characteristic (composition, size class, old-growth forest, etc.). Integration of the key characteristics into a whole for purposes of evaluation of forest resilience and sustainability and the difference between alternatives occurs in a summary section on modeling results (section 3.3.9).

The design of the components in the forest plan facilitates reliable and repeatable monitoring of existing conditions and trends over time, and the monitoring plan reflects this (see chapter 5 of the forest plan). Measurable monitoring components are important for determining how management activities and ecological processes, including climate change, may be influencing vegetation conditions and the achievement of desired conditions over time.

Forest plan management areas and management approaches

Management areas represent different management emphases on a landscape basis. In general, they reflect the degree and type of both natural and human influences (i.e., vegetation treatments) that are allowed, expected, or desired to occur across the Forest. Because it is the disturbances and vegetation treatments described in the previous section (interacting with climate and successional processes) that will change vegetation over time, management areas are important to the discussion of how the alternatives differ in achieving desired vegetation conditions. This section of the final EIS describes how the management area direction affects potential vegetation conditions in the future and the opportunity to move towards or maintain desired vegetation conditions.

The complexity of ecosystem characteristics and the diverse ecological, social, and economic values that characterize the Flathead are reflected in the integrated nature of the direction in the forest plan. Single or narrowly focused management approaches are generally ill suited to this situation. Direction in the forest plan can be best described as employing an “intentional management” approach, emphasizing a full range of both active and passive management techniques to manage the forests and ecosystems of the Flathead National Forest, with the purpose of producing multiple ecosystem services and values (from wood to wilderness) and of promoting ecological, social, and economic sustainability (Carey, 2006; Carey, Lippke, & Sessions, 1999). Passive management is defined as an approach with minimal human intervention, relying on natural disturbances (such as fire) and processes (such as natural succession) to maintain or develop desired forest conditions (Duncker et al., 2012). It also includes actions designed to remove existing stressors or other factors that are preventing desired conditions from being maintained or achieved (E. B. Allen, 1995). Active management is defined as the deliberate application of forest practices and tools to maintain or move towards achieving desired forest conditions (Helms, 1998). These management tools include prescribed fire (planned ignitions), and mechanical treatments (commercial harvest, noncommercial thinning, fuels reduction treatments). Each approach has its supporters and detractors in the literature on the subject, as well as recommendations on its applicability to particular situations (James K. Agee, 2002a; Holl & Aide, 2011; McIver & Starr, 2001; Society of American Foresters, 2003), and the forest plan incorporates elements of both passive and active management approaches.

Management area allocations and associated management emphases, as well as the physical and ecological conditions of the Forest, influence the management approach and types of management tools available for use in a particular area to achieve desired vegetation conditions. To analyze and display forest management differences between alternatives, the management areas have been grouped into "management emphasis groups." Table 20 provides information on the acres and percent within five management emphasis groups for each alternative. A description of the management emphasis groups is provided below.

Management emphasis groups 1 and 2

For management emphasis groups 1 and 2, the intentional passive management approach would be the primary means of maintaining vegetation and moving it towards desired conditions. Allowing fire, as well as other disturbance processes, to function as naturally as possible is the guiding principle behind management approaches for the management areas in these groups. The management of wildfires to meet management objectives is by far the primary tool used in designated wilderness and segments of the designated and eligible wild and scenic rivers classified as 'wild' (management areas 1a, 2a, and 2b). The use of wildland fire with multiple objectives would also play a role in larger unroaded portions or areas contiguous to designated wilderness, within recommended wilderness areas (management area 1b), and in backcountry designations (management areas 5a-5d).

In some portions of management emphasis group 2, a more active management approach with the use of prescribed fire (planned, human-ignited fire) could occur, particularly in management areas 5a-5d but also in limited portions of management area 1b. The use of prescribed fire would be most prevalent in areas where wildland fire use is constrained due to other values that might be at risk (such as nearby communities). In limited situations, primarily within segments of designated and eligible wild and scenic rivers classified as 'recreational' (in management areas 2a-2b) and in parts of management areas 5a-5c, active management in the form of controlled use of mechanical vegetation treatments (such as thinning, fuels reduction, or planting whitebark pine seedlings within fire areas in higher elevations) could occur to bring about desired vegetation conditions. None of the land within management emphasis groups 1 and 2 is designated as suitable for timber production, although timber harvest is allowable in some areas in limited circumstances (refer to the suitability sections for each management area in the plan).

Management emphasis groups 3, 4, and 5

A more active management approach would be applied in forests within the management areas in these groups for the purpose of maintaining or moving towards desired vegetation conditions. The use of mechanical vegetation treatments would be a primary tool, with various types of timber harvesting (i.e., regeneration, thinning), tree or shrub planting, and noncommercial treatments (i.e., sapling thinning, understory removal for fuels reduction). Chemical methods for control of invasive plant species would occur in some areas. Prescribed fire would also be a primary tool, especially within management area 6a, both to restore fire as a natural ecosystem process and to treat fuels created by harvest or other factors. Use of prescribed fire is particularly key in areas that have been adversely impacted by past fire suppression, such as some forests within the warm-dry potential vegetation type. Active management approaches also include the managing of ecosystem components such as decayed trees and snags and very large live trees.

The intensity (i.e., regularity, extent, rate over time) of active vegetation management, particularly timber harvest, would vary across the management areas in these emphasis groups, based on the influence of other resource values and plan direction. For example, the presence of lynx habitat and grizzly bear security core might limit the extent or rate of harvest over time in order to maintain desired conditions for these species. Important wildlife habitat connectivity or secure areas, winter range, very high scenic values, and areas of lower site productivity are other factors that would influence the intensity of active

vegetation management. Most of the lands within these management emphasis groups are identified as suitable for timber production, where a regular supply of timber products can be expected to be produced, and this would contribute to desired conditions related to social and economic values and sustainability.

Though less so than for management emphasis groups 1 and 2, an intentional passive management approach would also be applied within portions of these emphasis groups, particularly on lands identified as unsuitable for timber production, such as riparian management zones. Although active management might also occur within portions of the riparian management zones, treatments would be limited and would be designed to meet or move towards desired conditions associated with riparian and aquatic resources (see section 3.2.10). Management emphasis group 3 would tend to be managed more passively than groups 4 and 5. Wildland fire might be used as a tool within these management areas although, because of other values and risks, its use would be restricted to controlled and site-specific situations (see section 3.8).

Natural disturbances, ecological processes, and management tools

The basic ecological processes of natural succession and nutrient cycling are continually at work, changing forest structures and compositions at the stand and landscape scales. Although these agents of vegetation change may not be as obvious as fire or timber harvest, they are no less influential and are primary drivers of change in the ecosystem, although typically at a slower and more gradual pace.

The natural disturbance processes of wildfire, insects, and disease will continue to affect vegetation on the Flathead National Forest to a substantial degree. These processes know no boundaries and are expected to occur to some degree across all 2.4 million acres of the Forest. Fire suppression strategies provide some control over fire extent and severity (see section 3.8), and vegetation conditions (such as forest densities and landscape patterns) may influence the intensity and extent of the area affected by both fire and insects or disease. However, in a broad sense (forestwide) and based on past experience, it can be expected that there will be situations where control measures and management approaches will not be successful at excluding wildfire or insects and disease from areas where they are not desired. The Forest's ability to control the location, extent, and severity of these types of disturbances and the resulting changes in vegetation is limited.

In contrast to wildfire and other natural disturbances, the use of vegetation treatments such as timber harvest, noncommercial thinning, and prescribed burning (planned ignitions) provide increased flexibility and control over vegetation change at the site-specific level, in the context of maintaining or moving towards certain desired conditions. There is greater opportunity to influence the type and rate of vegetation change because treatment location, extent, and implementation is more precise and controlled. Where fire is desired, use of planned ignitions can be conducted under weather and fuel conditions that are more likely than wildland fire to achieve the desired intensity and extent of fire. There is still the element of uncertainty as to the outcome when using prescribed fire, and favorable weather and fuel conditions can occur infrequently. Overall, fire is a less precise tool than mechanical treatments for achieving desired vegetation conditions.

Mechanical treatments generally provide the greatest control over outcomes. For example, mechanical treatments are not indiscriminately applied; specific stands or forest conditions can be targeted for treatment or no treatment depending on well they currently meet the desired condition. Specific trees can be selected to leave and to remove, allowing the retention of desired forest structural components (such as large snags, very large live trees) and valued individual trees (such as desirable seed trees). Planting desired species after fire or harvest will affect species composition across stands and landscapes both in the present and into the future. Thinning in young stands can facilitate the development of desired stand structures far into the future. Thinning increases growth rates and facilitates the more rapid development

of large trees. Thinning also influences species composition by removing less desired species in favor of more desired species. Thinning can promote the development of multistoried stand structures. Treatments such as these can help increase resilience by developing the stand structures and compositions that are more able to withstand or recover from future disturbances such as fire, for example, by establishing fire-resistant species and size classes.

All this is not to imply that the changes in forest and vegetation conditions resulting from mechanical treatments are equivalent to those resulting from natural disturbances such as fire or insect mortality. Obviously, forest structures would be different because harvest removes trees and biomass from the site, whereas fire might kill them but they would remain as dead standing and down trees. Impacts to understory vegetation and soil conditions may occur with mechanical treatments. Fire also impacts these components, but in different ways. Road construction or reconstruction to access areas for treatments can impact forest resources in ways fire or natural disturbances do not. Both active and passive forest management approaches have a place in the overall management of the Forest, as guided by forest plan direction and site-specific analysis of local conditions and needs for treatments. Landscapes with minimal human interference that appear “natural” and landscapes that are intensively managed and have roads and harvest activities that are clearly evident are both expected and desired to provide the full suite of ecosystem services and multiple uses that the Forest is capable of. Forest plan direction is designed to provide for ecological sustainability, meeting the requirements of the National Forest Management Act of 1976 to provide for diversity of plant and animal communities in order to meet overall multiple-use objectives. Forest plan direction recognizes and provides direction to achieve the requirement in the 2012 planning rule to contribute to social and economic sustainability, which in part includes the active management of forests to provide wood products to the local and national economy.

Environmental Consequences

All action alternatives have the same forest plan direction (e.g., desired conditions, standards) related to vegetation. However, acres within the different management areas, and thus within each of the five management emphasis groups described above, vary among the alternatives. Therefore, the alternatives vary in the degree to which certain types of management tools may be used across the landscape to achieve desired vegetation conditions. Table 20 summarizes these differences by alternative. Refer to figures 1-01 through figure 1-04 for maps that display the location of management areas under each alternative.

Effects common to all alternatives

As is clear from table 20, under all alternatives the majority (over 65 percent) of vegetation change across the Forest would be the result of natural disturbance processes and intentional passive management approaches, the dominant approach within management emphasis groups 1 and 2. The ability to directly influence forest and landscape conditions in these areas is limited, resulting in a higher level of uncertainty associated with future vegetation conditions as compared to management emphasis groups 3, 4 and 5. Active vegetation management, and in particular mechanical vegetation treatments (on lands suitable for timber production, management emphasis groups 4 and 5) would be the primary approach across 17 to 30 percent of the Forest, depending on the alternative. Natural disturbances such as fire and disease are also expected to influence vegetation in management emphasis groups 4 and 5, although to a lesser degree than in groups 1, 2 and 3. Vegetation treatments would be equally limited by budget constraints under all alternatives, with acres treated by timber harvest (excluding salvage) modeled at about 3,000 or less acres annually on average over the next two decades (Table 19). This is a very small portion of the total acres in groups 4 and 5, and this factor masks some of the distinctive differences in management emphases among the alternatives and how those differences might affect harvest amounts and types if there were no budget constraints.

Table 20. Acres and percent of management areas (MAs) within the five management emphasis groups by alternative

	Management Emphasis Groups	Alternative A	Alternative B modified	Alternative C	Alternative D
1.	Designated wilderness (MA 1a)	1,072,040 (44.8%)	1,072,040 (44.8%)	1,072,040 (44.8%)	1,072,040 (44.8%)
2.	Recommended wilderness, wild and scenic rivers, special areas, research natural areas, and backcountry (MAs 1b, 2a-2b, 3a-3b, 4a, 5a-5d)	509,692 (21.3%)	555,073 (23.2%)	679,591 (28.4%)	541,695 (22.6%)
3.	General forest low-intensity vegetation management, Coram Experimental Forest, focused recreation areas (not suitable for timber production) (MAs 4b, 6a, 7)	105,873 (4.4%)	145,050 (6.1%)	228,427 (9.5%)	137,596 (5.8%)
4.	General forest medium-intensity vegetation management, focused recreation areas (suitable for timber production) (MAs 6b, MA 7)[a]	705,202[b] (29.5%)	343,807 (14.4%)	281,861 (11.8%)	339,438 (14.2%)
5.	General forest high-intensity vegetation management, Miller Creek Demonstration Forest (suitable for timber production) (MAs 6c and 4b)[a]	—	276,837 (11.6%)	130,888 (5.5%)	302,037 (12.6%)

a. The acres displayed in this table of lands suitable for timber production are greater than the acres used for calculation of projected timber outputs (see section 3.21.2, table 157). This is because non-mapped unsuitable areas (such as non-forested types and riparian management zones) are included in table 20 calculations but are not included in the modeling to calculate projected timber volumes.

b. The management areas for alternative A (existing 1986 forest plan) do not identify a level of expected timber management intensity. For analysis purposes, in this table all acres suitable for timber production under alternative A are included in management emphasis group 4.

Alternative A

Alternative A reflects the 1986 forest plan, as amended. It serves as the baseline for comparison with the action alternatives. The management area allocations in the current 1986 forest plan differ from those in the action alternatives. These are cross-referenced to the management areas in the forest plan for comparison purposes (refer to table 3). Alternative A has the greatest number acres in management emphasis groups 4 and 5. On these lands, it can be expected that this alternative could apply active management approaches across more area to achieve desired conditions. This might better facilitate the achievement of conditions most benefited by timber harvest and planting (i.e., altering species composition, particularly increasing ponderosa pine and western white pine). However, the use of naturally ignited fire (wildfire) as a potential tool to manage vegetation outside wilderness is limited under the current 1986 forest plan. And, fuel reduction objectives to protect values on private lands are not provided in the 1986 forest plan. Refer to figure 1-01 for a display of management areas in alternative A and figure 1-09 for timber suitability maps prepared for the purpose of projecting future timber volume.

Alternatives B modified and D

The acres within the different management emphasis groups are very similar under alternatives B modified and D. In comparison to alternatives A and C, these alternatives have slightly less area than alternative A but quite a bit more area than alternative C in management emphasis groups 4 and 5, where the greatest diversity of active management approaches could be utilized to maintain or achieve desired conditions. This might better facilitate the achievement of conditions most benefited by timber harvest and planting (i.e., altering species compositions, particularly increasing ponderosa pine and western white

pine). Refer to figures 1-02 and 1-04 for maps that display the location of management areas and figures 1-10 and 1-12 for timber suitability maps prepared for the purpose of projecting future timber volume.

Alternative C

Alternative C has the fewest acres in management emphasis groups 4 and 5 and the most acres within management emphasis groups 1 and 2. Intentional passive management approaches would be most utilized under this alternative, and the use of active vegetation management techniques would be least utilized. Refer to figure 1-03 for display of management areas and figure 1-11 for timber suitability maps as calculated for purposes of projecting future timber volume.

3.3.3 Vegetation composition

Affected environment

Vegetation composition is an important component contributing to the biodiversity of forests across the Flathead National Forest. The Forest is overwhelmingly characterized by vegetation types dominated by coniferous trees (see table 17). Vegetation composition is portrayed by two indicators: vegetation dominance types and tree species presence. When considered together, these two attributes provide a clearer picture of the overall forest composition, diversity, and species distribution than either would alone.

Dominance types describe the most common plant species in a forest and give an indication of the abundance of the species on the site. This indicator is used to portray the relative abundance of the different species across the forest. Detailed information on how dominance types were determined and assigned can be found in the publications by Barber et al. (2011) and in exhibits within the planning record (Trechsel, 2016c; USDA, 2015f).

Tree species presence indicates whether a tree species exists in the stand, meaning there is at least one live tree per acre of any d.b.h. Since most forest stands are composed or more than one tree species, a stand can have numerous individual species present. This indicator provides information on of how widely distributed a species is across the landscape, and what types of site conditions (i.e., potential vegetation types) these species most commonly occur.

There are 13 native coniferous tree species on the Forest, and 10 of these are analyzed in this EIS. Seven coniferous forest dominance types have been identified, as well as a hardwood and a grass/forb/shrub dominance type. The vegetation dominance types “subalpine fir/spruce” and “grand fir/cedar” represent areas that are dominated by one or both of those species. A few other conifer species are so limited in extent forestwide that they have not been listed as a separate species in the analysis, although effects to these species can be determined by their association with other analyzed types. These very uncommon species are mountain hemlock and alpine larch, which are high-elevation species and most closely associated with the whitebark pine forest types, and western hemlock, which is a species found in warm, moist, low-elevation sites, most commonly in association with western red cedar.

Figure 15 displays the current and desired range for vegetation dominance type forestwide, and figure 16 to figure 20 display the current and desired range of conifer tree species presence forestwide and by each potential vegetation type. Refer to the methodology and analysis process discussion under section 3.3 and to Trechsel (2016a) for information on the development of the desired ranges. Based on current knowledge, the desired condition reflects sustainable and resilient forest conditions relative to vegetation

composition. For all the figures and tables in this section, the source of the data for existing vegetation is Forest Inventory and Analysis (FIA) data using the R1 summary database (Hybrid 2011) analysis tools (Trechsel, 2016b; USDA, 2015f). The current proportion from this data set is expressed as an estimated mean percentage, with a lower and upper bound estimate provided at a 90 percent confidence interval (abbreviated as CI in the figures below). The abbreviations for the species in the figures in this section are as follows:

PP = ponderosa pine	WP = western white pine	GF = grand fir	LP = lodgepole pine
DF = Douglas-fir	AF = subalpine fir	C or WRC = western red cedar	WB = whitebark pine
WL = western larch	ES = Engelmann spruce	GFS = grass/forb/shrub	HRDWD = hardwoods

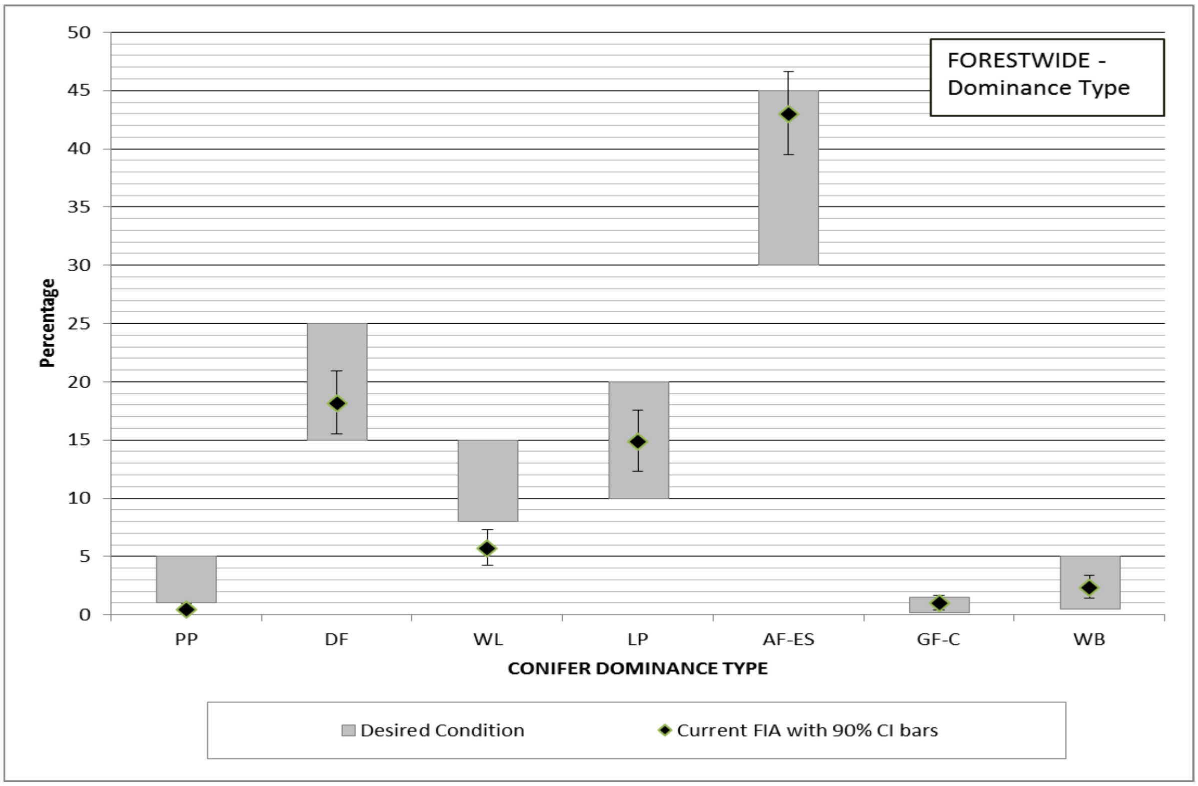

Figure 15. Current and desired condition for conifer dominance types forestwide

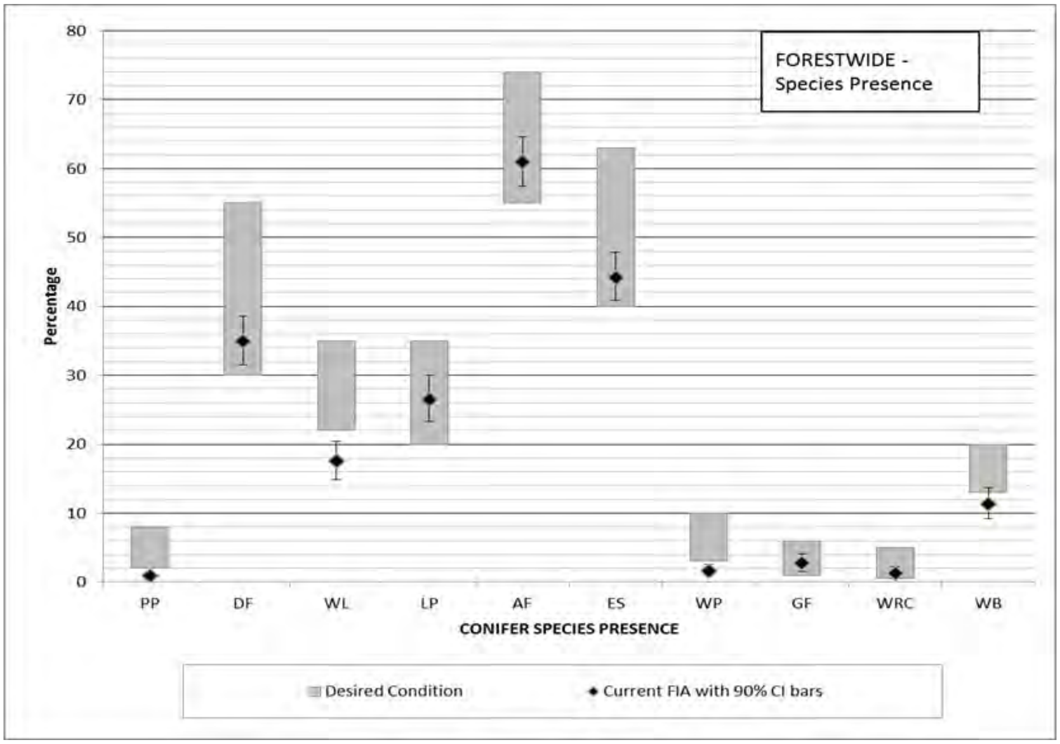

Figure 16. Current and desired conditions for conifer tree species presence forestwide.

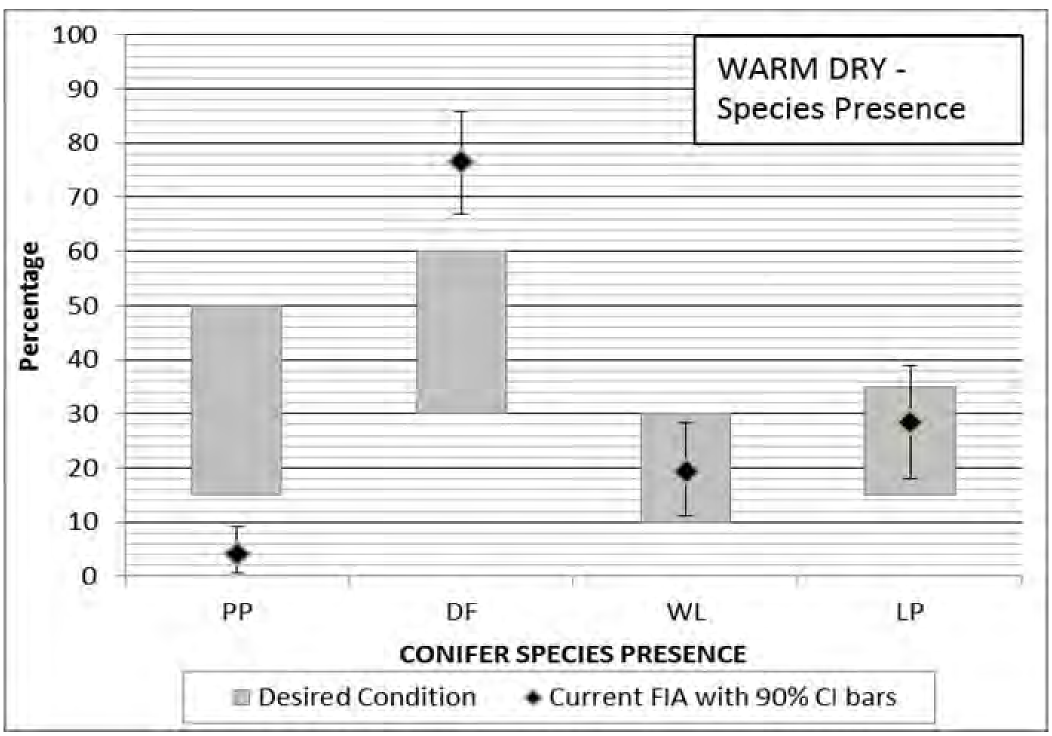

Figure 17. Current and desired conditions for conifer tree species presence on the warm-dry potential vegetation type.

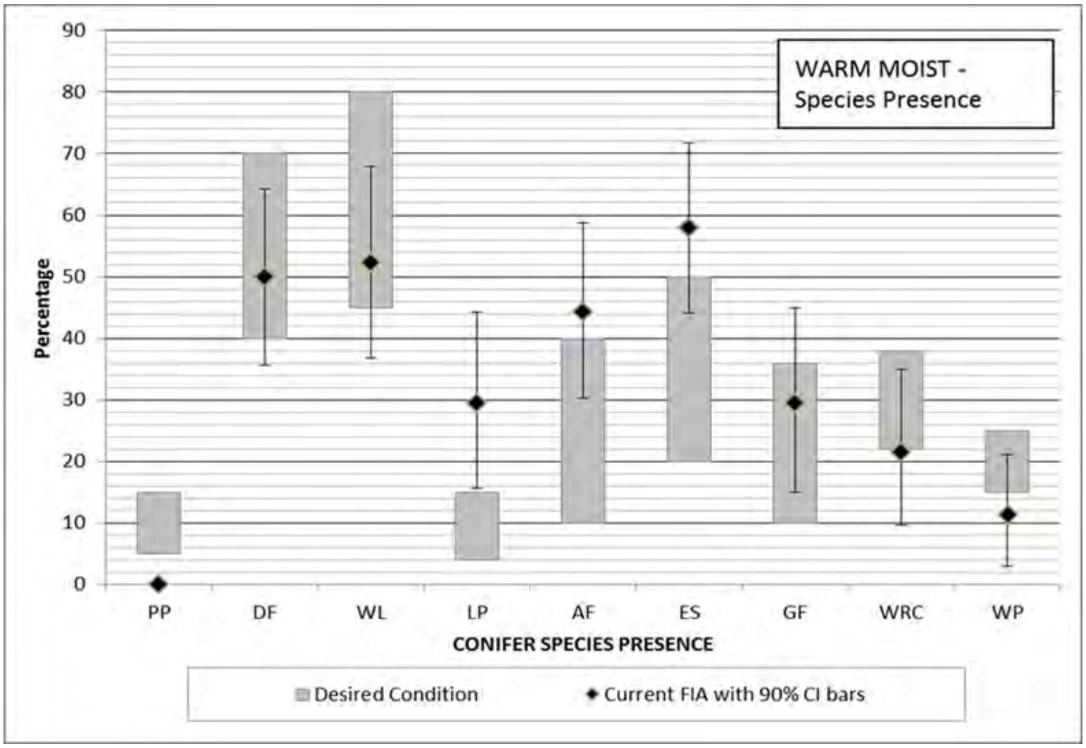

Figure 18. Current and desired conditions for conifer tree species presence on the warm-moist potential vegetation type

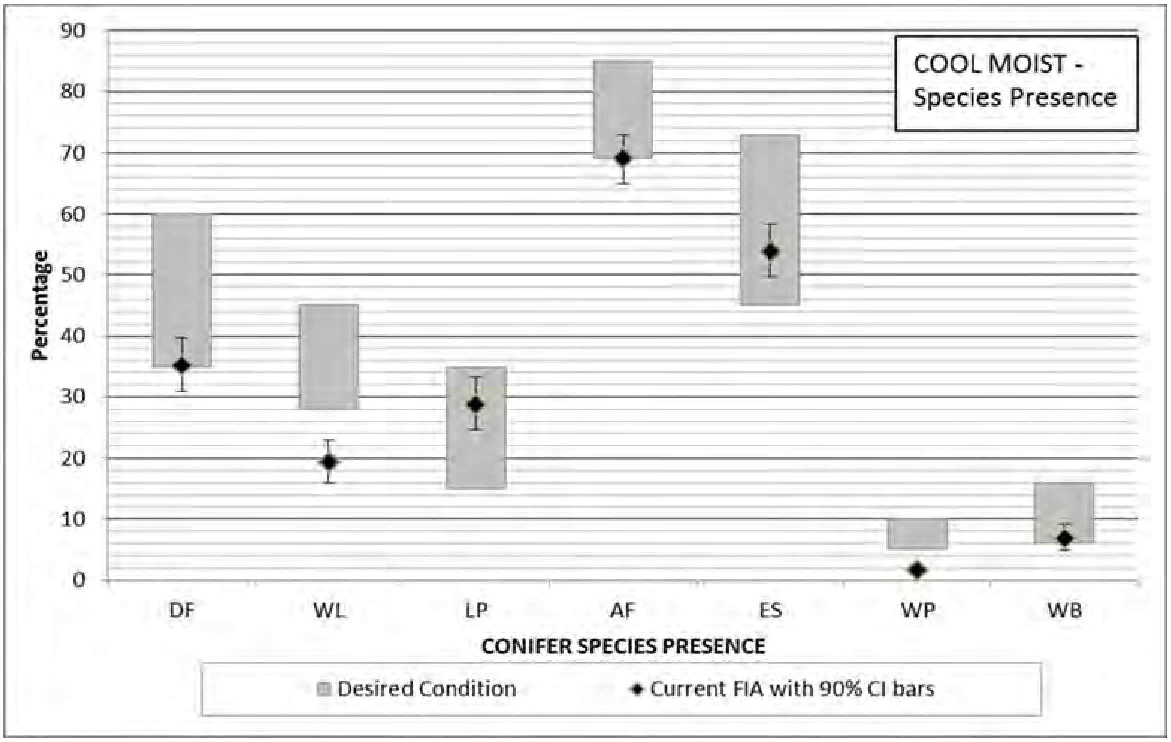

Figure 19. Current and desired conditions for conifer tree species presence on the cool-moist potential vegetation type

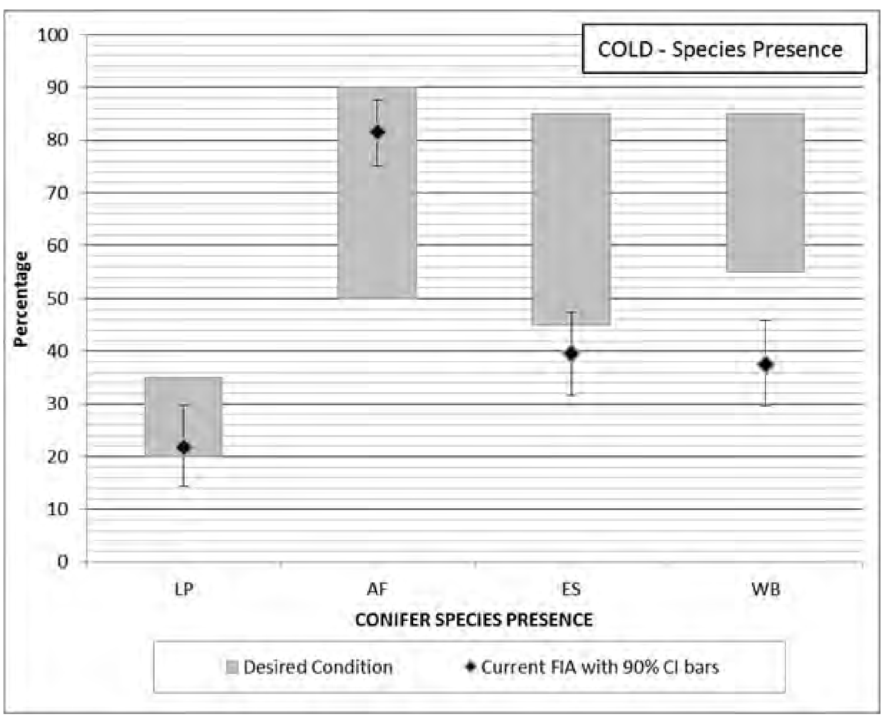

Figure 20. Current and desired conditions for conifer tree species presence on the cold potential vegetation type.

Table 21 provides a narrative description of desired conditions for forest composition by each potential vegetation type. Following the table is a short summary of the characteristics of each species evaluated in this EIS and its ecological role in the forests of the Flathead National Forest.

Table 21. Qualitative desired conditions for coniferous tree species by potential vegetation type

Potential vegetation type	Desired conditions
Warm-dry	Ponderosa pine is very common, and all sizes are represented. Douglas-fir is common but usually in mixed stands with ponderosa pine, western larch, or lodgepole. Western larch is present on the more moist sites within this type, most often in mixed stands with ponderosa pine and Douglas-fir. Grand fir and subalpine fir may be present on some of the moister sites, usually in understory canopy layers. In areas determined to be big game winter habitat (determined in cooperation with MFWP), species with full crowns in winter (e.g., Douglas-fir and ponderosa pine) are well represented in all size classes, whereas western larch and to a lesser extent lodgepole pine occur as minor or codominant species.
Warm-moist	Species composition is very diverse, both across the landscape and within stands. Western larch and Douglas-fir are the most common shade-intolerant species observed, especially in overstory tree layers and larger size classes. Western white pine is present on many sites, achieving codominance with other shade-intolerant species. Lodgepole pine is less common than other shade-intolerant species, usually present as a codominant or minor species. Ponderosa pine is uncommon but is present in some stands within this potential vegetation type. Western red cedar, grand fir, subalpine fir, and Engelmann spruce are commonly present in understory tree layers but are less common in overstory tree layers, except in riparian areas and lands immediately adjacent to streams, ponds, or wetlands. Groves of large, old western red cedar are present in portions of the most sheltered sites and wet areas. Areas in this type with presence of ponderosa pine contribute to flammulated owl habitat. Areas in this type with presence of western red cedar, western hemlock, western white pine, and western larch contribute to fisher habitat. In areas determined to be big game winter habitat (determined in cooperation with MFWP), species with full crowns in winter (e.g., Douglas-fir, ponderosa pine, western white pine) are well represented in all size classes, and western larch and to a lesser extent lodgepole pine occur as co-dominant or minor species.
Cool-moist	Species composition is diverse across the landscape, with stands commonly containing more than one tree species. Some pure or nearly pure stands of subalpine fir and Engelmann spruce as well as lodgepole pine occur. Subalpine fir and spruce are commonly present in understory tree layers. Douglas-fir and western larch trees are widespread across the landscape, contributing to species diversity, forest resilience, and recovery after fire events. These conditions contribute to habitat for key species such as Canada lynx and provide high-quality habitat for cavity nesting and denning species.
Cold	Subalpine fir and Engelmann spruce are common in the cold type, particularly in basins and moist slopes. Lodgepole pine is also widely present, contributing to species diversity and recovery of forested conditions after fire. Whitebark pine is common, particularly on more exposed sites and other areas where this species has competitive advantage and is most likely to persist. Douglas-fir and western larch are uncommon but occasionally occur on some of the warmer sites within this potential vegetation type. Groves of alpine larch are rare but present and persistent over time on suitable sites throughout this type. These conditions contribute to habitat for key species such as Canada lynx and Clark's nutcracker.

Ponderosa pine (PP)

This species most often dominates on the driest and warmest sites on the Forest, and it usually grows in association with Douglas-fir. It is of particularly high value for its contribution to species diversity, forest structure, and ecosystem resilience in the drier ecosystems. The ponderosa pine dominance type provides important wildlife habitat, particularly as late-successional or old-growth forest on the warm-dry potential

vegetation type. It can live for many centuries and grow to very large diameter. It is one of the most drought- and fire-tolerant species in this ecosystem. Trees are capable of surviving low- to moderate-severity fire even at younger age classes and can regenerate on bare soils of high temperatures. As a large tree, ponderosa pine provides important wildlife nesting and feeding habitat, both when live and dead. Also, as a large, stately tree with distinctive bark color and texture that stands out visually, its presence contributes to the scenic value of sites. Compared to associated species such as Douglas-fir, it is less vulnerable to root disease and other pathogens. However, it is shade intolerant, and without disturbance that opens the forest canopy, it is gradually replaced by Douglas-fir over time on most sites.

Current conditions for the ponderosa pine dominance type and species presence are below desired conditions forestwide and within the warm-dry and warm-moist potential vegetation type, and an increase in this species in all size classes is desired. Ponderosa pine decline is likely due to a combination of factors, including fire suppression and exclusion and the resulting vegetation succession, past logging, and residential and agricultural development in the lower elevations. Historically, wildfires were relatively frequent and of low to moderate severity on the lower-elevation, drier sites where ponderosa pine dominated. Frequent fires maintained more open forest conditions with a higher proportion of ponderosa pine, which is more resistant to fire than its common associate Douglas-fir. Douglas-fir is also able to tolerate and survive under the more densely forested shaded environments resulting from succession in forests where fire has been excluded, as compared to ponderosa pine. The lower elevation sites favored by ponderosa pine are also where access for logging and development activities is readily available. The majority of the greater Flathead Valley was historically a ponderosa pine-dominated forest. The vast majority has been converted to agriculture and other human development.

Western larch (WL)

This species grows on a relatively wide range of site conditions but competes best on the cool, moist sites. Similar to ponderosa pine, it is of high value for its contribution to species diversity, forest structure, and ecosystem resilience. It also provides important wildlife habitat components in the form of very large, old live trees and snags, particularly in the late-successional and old-growth forest structures. Larch is of relatively high economic value for commercial wood products and is the preferred conifer species for firewood. It has high resistance to many forest insects and pathogens. As a mature tree, it is one of the most fire-tolerant species, and it can survive low- to moderate-severity fire once it reaches medium d.b.h. It is well adapted to survival and regeneration under the mixed and high-severity fire regimes typical of the Forest’s ecosystem largely because it has relatively thick bark and an open crown structure, a light seed that can spread far into a burned area, is able to establish on bare soil of high temperatures, and its seedlings and saplings have very fast early growth rates. Western larch is highly intolerant of shade and requires open, sunny conditions to grow and compete well against other species, as provided by high- and moderate-severity fire. It is not capable of regenerating and surviving in understory tree layers within denser stands. Thus, unless a disturbance occurs that opens up the forest canopy, it is typically replaced over time by more shade-tolerant species. Western larch may live for several centuries and grow to very large diameter. These larger trees provide important wildlife nesting and feeding habitat, both when live and dead. The large, stately trees stand out in the forest, and their presence contribute to the scenic values of the forest. Also, in the autumn the foliage turns golden before falling, providing an opportunity for recreational viewing.

Current conditions for western larch are below desired conditions as a dominance type and species presence forestwide and below desired conditions for species presence in the cool-moist potential vegetation type. On the warm-dry and warm-moist types, it is within desired conditions. An increasing trend in western larch is desired in all areas, although in the warm-dry type, maintaining current levels is desirable as well. In the warm-dry type, with a warming climate, the conditions for western larch establishment and growth may become less suitable.

Western larch is very closely linked to fire as a means of sustaining and perpetuating its presence across the landscape, and its decline on portions of the Forest is likely associated with fire exclusion and suppression over the past 70+ years, followed by vegetation succession that would favor more shade-tolerant species such as subalpine fir, Engelmann spruce, and grand fir. Timber harvest practices probably contributed to its decline by removing larch in some areas without ensuring its reestablishment.

The recent increased amount of fire across the Forest may favor this species; however, in some of the fire areas, seed sources for larch are unavailable. Western larch may be vulnerable to decline with warming climatic conditions, as it is less drought tolerant than some of its associates, such as Douglas-fir. Even with increases in fire and the presence of a seed source, warmer conditions may make some sites too harsh for larch seedlings to survive. However, larch is less vulnerable than Douglas-fir or subalpine fir to many of the insects and diseases that may increase with warming conditions.

Potential future fire severity is likely to increase, and the loss of older fire-resistant western larch and the increase in subalpine fir and Douglas-fir will be proportional to fire severity. Fewer large western larch also means the loss of their presence as a potential seed source for regeneration after future disturbances such as fire. This will accentuate the decline in this species over time.

Douglas-fir (DF)

Douglas-fir is one of the more common species on the Forest, largely due to the wide range of site and forest conditions under which it is able to grow and compete successfully. It is of relatively high economic value for wood products. Similar to ponderosa pine, it is highly tolerant of drought. It is moderately tolerant of shade, and unlike ponderosa pine or western larch, it is capable of establishing and persisting in the more dense forest conditions that develop over time. Older, larger Douglas-fir trees are tolerant of fire, although less so than ponderosa pine or western larch. Trees can live for many centuries and grow to large diameters. These larger old trees provide wildlife habitat values, although as snags they typically have less longevity than larch. Douglas-fir is one of the most susceptible conifer species on the Forest to serious damage from a variety of insect and diseases, which are expected to increase under a warming climate. These include Douglas-fir bark beetle, western spruce budworm, and several root diseases and heart rot pathogens. Insect and disease impacts may alter forest structures and forest fuels, increasing susceptibility to high-severity fire.

Forestwide, Douglas-fir is within desired range as both a dominance type and species presence, although at the low end of the range in distribution (presence). It is within the desired range on the warm-moist potential vegetation type, but it is barely at the minimum point of the desired range in the cool-moist potential vegetation type. Its low amount on this type is probably associated to some degree with lack of fire and advancing succession, although Douglas-fir would be more able to sustain itself in these kind of conditions compared to western larch. High mortality due to the Douglas-fir beetle and root disease in the recent past may have contributed to this low current amount. Forestwide and in the cool-moist and warm-moist types, it would be desirable to maintain, and in some areas increase, the amount of Douglas-fir. Douglas-fir is a species that can grow and thrive under a wide range of conditions, and maintaining its presence across the landscape may be an advantage in light of future changes in the climate.

On the warm-dry potential vegetation type, Douglas-fir is well above the desired range for species presence, and a decrease of this species would be desired. As described under the section on ponderosa pine above, fire suppression and exclusion favors the expansion of Douglas-fir, particularly on these drier forest types. The higher stand densities increases tree stress, which contributes to even greater susceptibility and mortality of Douglas-fir from various insects and diseases. As a result, forest resilience is reduced overall and forest conditions would tend to support higher-severity fires in the future, due to

the higher tree densities, multiple canopy layers, greater fuels from tree mortality, and loss of the more fire-resistant tree species.

Lodgepole pine (LP)

Lodgepole pine is capable of growing under a wide range of site conditions, from warm to cold frost pockets or higher elevations, and under a relatively broad range of moisture conditions. The species is well adapted to the moderate- and high-severity fires that are common in this ecosystem, and it rapidly reforests even the largest burned areas. Although these trees have thin bark and are easily killed by fire, their abundant seed production and the presence of cones that are "sealed" for decades until opened by the heat of the fire allows for very rapid recolonization of a burned area by lodgepole seedlings. It has one of the most rapid early growth rates of all tree species on the Forest and is capable of surviving in very dense forest conditions, outcompeting other early-successional species such as western larch and creating the nearly pure lodgepole stands that are common across portions of the landscape. It is very shade intolerant and relatively short lived, so over time lodgepole pine is typically replaced by other more shade-tolerant species, such as subalpine fir, unless a fire disturbance occurs.

Lodgepole pine is within desired conditions across most of the Forest, except in the warm-moist type where it is well above desired levels. Maintaining the presence of lodgepole pine near current levels would be desired across most of the Forest, although an increase on the cold type would also be acceptable. A decrease of the currently high levels on the warm-moist type is the desired trend. The reason for the high amount of lodgepole pine in the warm-moist type is not certain, other than the fact that as a seed source it is widespread across this type and may have benefited from the types of timber harvest practices and other disturbances that have occurred over the past 60 years or so.

Subalpine fir (AF) and Engelmann spruce (ES)

Subalpine fir is the most common species present across the Flathead National Forest, followed closely by Engelmann spruce. These species occur on all but the driest sites on the Forest. They fulfill similar ecological roles, require similar site conditions, and often co-exist on a site, so they are combined into a single vegetation dominance type.

Both subalpine fir and Engelmann spruce are very shade-tolerant species, and they commonly are most abundant in the mid- and understory tree canopy layers. Subalpine fir is the indicated climax species across most of the Forest (refer to the above discussion of potential vegetation types). Both species are intolerant of drought. They are also very intolerant of fire, with shallow roots, thin bark, and tree crowns that extend to the ground. They are easily killed by fire, even low-severity fire. Although they may regenerate into the opening created by the fire, they have comparably slow growth rates and are soon overtopped by other early-successional species such as lodgepole pine or western larch. However, their shade tolerance allows them to persist on the site indefinitely, and eventually, over many decades to centuries, they will dominate the site unless there is a fire event or other stand-replacing disturbance.

The subalpine fir/spruce dominance type is within desired conditions forestwide, although at the upper end of the range. Maintenance of this dominance type is desired within lynx habitat (refer to section 3.7), with the focus on maintaining the mid- and understory tree layers but with a decreasing trend in the overstory canopy, associated with an increase in western larch and Douglas-fir. Decreasing the dominance type outside lynx habitat is desired. The large amount of subalpine fir/spruce dominance type correlates with the low amount of western larch dominance type, again likely due to fire exclusion and suppression activities, advancing succession, and past harvest practices, which have increased the density and abundance of subalpine fir and spruce compared to shade-intolerant species.

Subalpine fir and Engelmann spruce meet desired conditions for species presence forestwide and within the cool-moist potential vegetation type, although subalpine fir is at the low point of the desired range on the cool-moist type, probably influenced by the high amount of recent fire. Maintaining these species would be desired in the cool-moist type, especially in the mid- and understory layers, to provide habitat for Canada lynx (see section 3.7 for details). In the warm-moist potential vegetation type, subalpine fir and Engelmann spruce are above desired range, and a decrease in these species' presence would be desired. Subalpine fir is within the desired range on the cold potential vegetation type, and Engelmann spruce is below desired range. It would be desired to generally decrease the presence of subalpine fir in areas best suited for whitebark pine and lodgepole pine and to maintain or increase Engelmann spruce in the basins and moist areas, especially in the mid- and understory canopy layers.

The prevalence of forests dominated by subalpine fir and spruce is tied to the frequency of fire. More frequent fires will reduce the presence and dominance of these species; long fire-free intervals and/or the lack of seed source for other species will favor their dominance. Species diversity and forest resilience are dependent upon a mix of species across the Forest that includes early-successional fire-resistant species. Forests dominated by subalpine fir and Engelmann spruce tend to support higher-severity fires due to the low fire tolerance of the species, higher tree densities, multiple canopy layers, and greater litter depths and fuel loads typical in these stands. The multistory forest conditions that typically develop in subalpine fir and spruce-dominated forests are highly susceptible to damage from the western spruce budworm.

Grand fir (GF) and western red cedar (WRC)

The Flathead National Forest is on the far eastern side of the geographic range for grand fir and western red cedar. Sites suitable for their growth are limited, and thus they are a relatively uncommon species forestwide. Their distribution is limited to the warm-moist potential vegetation type. They occupy similar site conditions and fulfill similar ecological roles, so they are combined into a single vegetation dominance type.

Grand fir and western red cedar are the indicated climax species on sites within the warm-moist potential vegetation type. Although they may occupy the same sites, grand fir tends to dominate on the somewhat cooler, drier sites within the warm-moist potential vegetation type and western red cedar on the warmer, moister sites. They are very shade tolerant, and in most stands they are most abundant in the mid and lower canopy layers, with other species, such as western larch, lodgepole pine, and Douglas-fir, more common in the overstory canopy layer.

Grand fir has a relatively short life span, is intolerant of fire and easily killed by it, and is highly susceptible to various root diseases, stem decays, and other pathogens. Western red cedar is capable of living for many centuries and growing to very large diameters, is moderately tolerant of lower-severity fire when mature, and is more resistant to insects and disease than grand fir.

Cedars, particularly the larger-diameter trees, are prized for their timber value. Groves of very large, very old western redcedar trees are prized for their aesthetic and wildlife habitat values. This condition is rare on the Forest, partly due to the limited area where these species are able to grow and partly due to the disturbance history of the Forest's ecosystem (fire and past harvest practices). Western hemlock is present on the Forest but is rare, and it is associated mainly with western red cedar in very limited locations. Both species have a high tolerance of shade, which allows them to persist in the stand. Over time, without disturbance, western red cedar may grow into and dominate the main canopy layers.

The current condition of the grand fir/cedar dominance type and the species distribution (presence) of both grand fir and cedar meets desired conditions forestwide, although cedar presence is at the low end of the desired forestwide range. On the warm-moist potential vegetation type, cedar presence is also at the

very low end of the range, although grand fir is within and at the upper end of the range. This low amount of cedar may be tied most closely to past harvest practices that removed cedar and regenerated to other species, such as western larch and Douglas-fir. Cedar is slower to regenerate, and when young it grows more slowly than many other species. Because the cedar types typically occur in the lower elevations and the relatively accessible portions of the Forest, they are more vulnerable to human influences. Timber harvest has removed the large, old cedar trees, which often had high economic value. Harvest practices that selectively removed associated shade-intolerant species, such as western white pine and western larch, have favored grand fir or cedar in some areas but have reduced the overall species diversity of the stand and lowered the forest's resilience. Forests dominated by grand fir or cedar have the potential to burn at higher severity for reason similar to those described above for the subalpine fir/spruce dominated forests. Also, similarly to subalpine fir/spruce, the dominance of grand fir and cedar is tied to the frequency of fire. More frequent fires will reduce the presence and dominance of these species; long fire-free intervals will favor their dominance. The desired trend would generally be to increase cedar, especially where it has the potential to persist and grow into large diameters, and to maintain current levels of grand fir.

Western white pine (WP)

The natural range of western white pine extends from the Cascade and Sierra Mountains through the interior section of the northern Rocky Mountains and up into southern British Columbia. A key ecosystem component of forests throughout its range, the species is valued for its contribution to ecosystem diversity, structure, and resilience. It is a long-lived species; individual trees 300 to 400 years old are common. Western white pine has relatively fast growth rages on productive sites and can achieve great heights (140 or more feet) and diameters (40 or more inches d.b.h.) compared to associated species on the Forest. Because of its ability to grow tall, straight, and fast, it can achieve dominance in the overstory tree layers of a forest, adding considerably to the forest's structural diversity. Because of this, it contributes to wildlife feeding and nesting habitat and complements scenic values. It also provides a high-value commercial forest product.

Western white pine is moderately tolerant of shade, particularly when a sapling, but it requires full or nearly full sunlight to grow well. Its shade tolerance gives it a bit of an advantage over less shade-tolerant species, such as western larch, in maintaining its presence on a site, even if it is in the mid- or understory tree layers. With its thin bark at young ages, it is vulnerable to fire damage or mortality but becomes moderately tolerant of fire as it matures, as the bark thickens and lower branches self-prune. The prolific seeding habits and fast early growth of this species allow it to regenerate rapidly into burned areas.

As with grand fir and western red cedar, the Flathead is at the far eastern side of the geographic range of western white pine, in the ecotone between the moist, productive ecosystems and forest types to the west and the drier, less maritime-influenced ecosystems to the east and south. Optimum climate and site conditions for western white pine are limited on the Flathead. This restricts its presence, extent, and abundance, and the species is largely limited to sites within the warm-moist potential vegetation type and on the low- to mid-elevation, warmer, more productive sites in the cool-moist potential vegetation type. An analysis of the natural range of variation and of the presence of sites on the Forest that are suited to the establishment and growth of western white pine indicates that approximately 8 to 10 percent of the Forest area (up to about 200,000 acres) could support the successful establishment and growth of western white pine (USDA, 2016a). However, it currently occurs on far fewer acres and is below the desired conditions forestwide and on the warm-moist and cool-moist potential vegetation types, for reasons described below.

Conditions and trends

Western white pine has experienced a severe decline throughout its range due to the impacts of the exotic disease white pine blister rust (see section 3.3.1, subsection “Forest insects and disease”). The population size of western white pine in the Interior Northwest is now estimated to be less than 5 percent of what it was at the turn of the 20th century (Neuenschwander et al., 1999). Similarly, populations have been severely reduced on the Flathead National Forest over the past 50 years. Historically, western white pine was common on the Forest where the species was capable of growing, often occurring as a dominant overstory tree in mixed species stands with western larch, Douglas-fir, and other species and adding important structural features to the stand and across the landscape. As recently as 30 or 40 years ago, many of these large old trees were still present, but they have succumbed to blister rust or, in some cases, to mountain pine beetle.

Currently, there are very few acres on the Forest where western white pine is a dominant or even a major species in the stand. The species persists, however, as a minor mature stand component or as young understory trees. Western white pine is a prolific species, and the scattered survivors continue to produce frequent and abundant cone crops, which contributes to its continued persistence across the Forest even though it continues to have high mortality rates due to blister rust.

Western white pine presence is most suited to sites in the warm-moist potential vegetation type. The loss of overstory tree canopy layers, exacerbated by factors such as fire suppression and timber harvest, contributes to increases in the proportion of subalpine fir, Engelmann spruce, and grand fir and to multicanopy forest structures on some sites. This can result in increased vulnerability to high-severity fire and to insects and disease. As already mentioned, these changes tend to reduce the overall resilience of the forest.

An upward trend in western white pine is desired to restore this species to its former role in the forests of the Flathead, contributing to the diversity of species and forest structures as well as providing economic value as a timber product. Where a seed source exists, western white pine continues to naturally regenerate within forest openings. These remaining survivors and seed producers appear to have some level of natural blister rust resistance. Natural selection has and will continue to occur, gradually increasing resistance to the disease within the population. Early studies indicate that on some sites, 19 percent of the healthy western white pine seedlings were produced from blister-rust survivors, an 18 percent increase over the original population (R. J. Hoff, McDonald, & Bingham, 1976).

A program to develop genetic resistance in western white pine seedling stock began in the 1950s, and resistant seedlings have been available for planting on the Forest since the 1970s. Planting of these trees forms the basis for programs aimed at restoring the species across its range and returning it to at least a portion of its former role. The Forest has been planting rust-resistant western white pine since the late 1970s, with approximately 22,000 acres planted from 1978 to 2013.

A study that modeled potential effects of climate change on western white pine in a drainage within Glacier National Park suggests that warming temperatures favor increased abundance of the species over existing climax and shade-tolerant species, mainly because warming temperatures increase fire frequency and extent, which facilitates the regeneration of western white pine (R. A. Loehman, Clark, & Keane, 2011). This species could be an increasingly important component of the biodiversity of the Flathead National Forest in the future. The planting of rust-resistant seedlings in openings created by both harvest and fire will be key to ensuring its expansion across the landscape and its survival to cone-producing age.

Focal species determination

Western white pine has been identified by the Flathead as a focal species. Focal species are defined as species whose status provides meaningful information regarding the effectiveness of the plan components in maintaining or restoring the desired ecological conditions and species diversity within the plan area. They are selected on the basis of their functional role in ecosystems (36 CFR § 219.19). Forest Service Handbook 1909.12 chapter 30 (Monitoring) provides detailed information on the identification of indicators that could be used for focal species. Every plan monitoring program must identify at least one focal species and one or more monitoring questions and associated indicators to track the status of the identified focal species.

Western white pine is a key ecosystem component of forests throughout its range, and it is valued for its contribution to ecosystem diversity, structure, and resilience. The primary concern associated with western white pine on the Flathead National Forest centers on its dramatic population decline, in particular of mature individuals, due to the exotic disease blister rust. The loss of western white pine has altered the structure, composition, and productivity of forests on the Flathead, particularly the lower-elevation forests on warm-moist potential vegetation type, which are uncommon but highly diverse and productive sites on the Flathead. Monitoring of the status and condition of this species will provide insight into the integrity and diversity of these forested ecosystems. It will help inform the Forest as to the effectiveness of plan components at maintaining or restoring desired ecological conditions on these sites and the potential effects of future disturbances and climate change on forests and ecosystems within the planning area. Refer to Trechsel (2017l) for additional information on the characteristics and selection of western white pine as a focal species.

Whitebark pine (WB)

Whitebark pine is listed as a candidate species by the USFWS, and this species is discussed in detail in section 3.5.1. A brief summary will be provided here.

Whitebark pine is most common on sites in the cold potential vegetation type. It competes best and most often achieves dominance on harsher, exposed sites. It usually occurs in association with subalpine fir, Engelmann spruce, and sometimes lodgepole pine. It occurs as a minor species in some stands at mid elevations (i.e., down to about 5,500 feet elevation), where it is typically associated with lodgepole pine and subalpine fir. The species is a key ecosystem component of high-elevations forests, where it was historically a dominant and widespread species at all stages of forest succession. As the most fire-resistant and long-lived species in these forests, it plays an important role in the stability of these high-elevation ecosystems and in the quality of wildlife habitat, as discussed in detail in section 3.51.

Forestwide, whitebark pine is within the desired range for dominance type but below the range for species presence both forestwide and on the cold potential vegetation type where this species plays the most important ecological role. Maintaining or increasing the presence of whitebark pine would be desired. The species has experienced extensive mortality over the past few decades due to the exotic disease white pine blister rust as well as other factors such as mountain pine beetle. Although whitebark pine still occurs across the landscape, most trees are in the small size classes (seedling/sapling or small size class), and larger trees are very scarce across much of its range. This has greatly reduced its regeneration potential. Subalpine fir has increased in abundance with the loss of whitebark pine and the lack of fire and regeneration of whitebark pine.

Hardwood trees

The primary hardwood species on the Forest are quaking aspen, paper birch, and black cottonwood. Persistent hardwood-dominated plant communities are rare on the Forest (see table 17 and discussion above under “Potential vegetation types) and consist mostly of cottonwood stands in river bottoms and

floodplains (see discussion in section 3.2.5). More commonly, hardwood-dominated communities occur as a transitional vegetation type in the earlier stages of conifer forest succession, immediately after a stand-replacing disturbance such as fire or harvest. Because the hardwood species on the Forest are relatively shade intolerant, they grow best in the openings created by disturbance. The current condition of broadleaf hardwood tree species is displayed in figure 21. The source of the data for existing hardwood presence is Forest Inventory and Analysis data using the R1 summary database (Hybrid 2011) analysis tools (Trechsel, 2016b; USDA, 2015f). The current proportion from this data set is expressed as an estimated mean percentage, with a lower and upper bound estimate provided at a 90 percent confidence interval (abbreviated as CI in the figures).

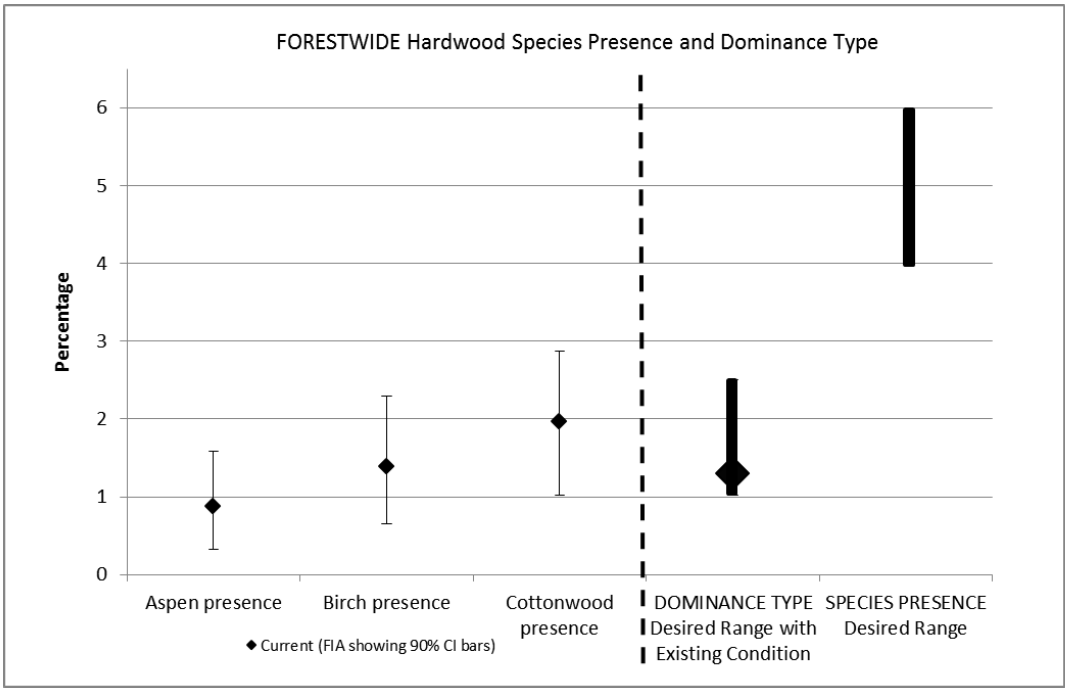

Figure 21. Current conditions forestwide for broadleaf hardwood tree species presence and dominance type, and desired range forestwide for species presence and dominance type.

Although hardwood tree communities are not common on the Forest, they are considered an important component of the overall vegetation diversity, and they also provide habitat for a wide variety of birds and other wildlife species (refer to section 3.7). As a transitional plant community, the aspen and birch types may co-exist with conifers for many decades after a disturbance, but as the conifers become more numerous and dense, the hardwoods gradually decline in vigor and number and are replaced by conifer-dominated forest. Much of the hardwood dominance types of aspen and cottonwood occurs in the warm-moist potential vegetation types and in the warmer and moister areas of the cool-moist type. Riparian management zones are also key areas for the development of hardwood tree communities.

The desired condition for hardwood dominance types (meaning persistent hardwood tree communities with one or a combination of aspen, birch, and cottonwood) is 1.0 percent to 2.5 percent forestwide. The current condition for hardwood dominance types is an estimated 1.3 percent forestwide; current conditions are within the forestwide desired conditions.

The presence of hardwood trees (i.e., one or a combination of hardwood tree species within stands that may be dominated by coniferous species) is desired across 4 to 6 percent of the Forest. Totaling up the current species presence amounts for each individual hardwood species in figure 21 results in about 4.5 percent of the Forest, which is just within the desired range. However, there is very likely overlap of acres

for the presence of these species, so the actual current area where hardwood species are present may be less. In any case, it would be desirable to increase both the presence and dominance type for hardwood tree species. To the degree that stand-replacement disturbances (either fire or harvest) occur on sites conducive to hardwood tree establishment and growth, hardwood tree-dominated communities will persist across the landscape.

Grass/forb/shrub

Similar to the hardwood communities, persistent grass/forb/shrub-dominated plant communities are uncommon on the Forest. They are of two main types: (1) those on mid- to high-elevation relatively moist sites, usually shrub dominated but may also have abundant grasses and forbs, and (2) those on mid-to low-elevation relatively dry sites, usually grass dominated but may also have abundant dry-site forbs and shrubs. These persistent plant communities are maintained by harsh site conditions that slow or preclude the establishment of trees or by frequent disturbances such as fire or avalanches. The desired condition for persistent grass/forb/shrub communities is from 5 to 7 percent of the Forest. Currently, it is estimated that about 5 percent of the Forest is in a persistent grass/forb/shrub community type, and it would be desired to maintain this relatively rare plant community type.

Most high-elevation persistent grassland/herbaceous types are not substantially altered from historical (reference) conditions, largely due to lower levels of accessibility and more frequent fires in recent decades. At lower elevations within the forested environment, some of the grass/forb/shrub-dominated communities are trending towards higher tree and shrub canopy cover due to less frequent fires that kill small coniferous trees and shrubs that are in the understory or are encroaching around the perimeter. On private valley bottomlands adjacent to the Forest, the trend has been to convert native grasslands to crop lands and developed lands, leading to the disruption of processes, such as fire, that played a role in maintaining them. Connectivity of grassland/herbaceous ecosystems has also been affected by development at these lower elevations, except within in the Bob Marshall Wilderness Complex. Invasive plants also are a threat to grass/forb/shrub communities in the lower elevations.

More often, grass/forb/shrub-dominated communities occur as a transitional vegetation type in the earliest stages of forest succession, such as after a stand-replacement fire. Through natural succession, coniferous forest cover eventually dominates on these sites, although the grasses, forbs, and shrubs may remain abundant components of the understory vegetation layers throughout the mid and later stages of succession. Similar to hardwood tree communities, sustaining a diversity and desired amount of grass/forb/shrub-dominated plant communities is dependent on disturbance processes that create openings, either through fire or harvest.

Environmental consequences

Effects of alternative A

Alternative A would retain all the existing 1986 forest plan direction regarding the management of forest vegetation and the terrestrial ecosystem. The 1986 forest plan does not explicitly describe desired conditions for overall vegetation composition, nor are there any specific numeric desired ranges for forest composition either forestwide or by potential vegetation type. However, the existing forest plan does incorporate an ecologically based approach in many of the goals, standards, and objectives related to vegetation and associated wildlife habitat, both forestwide and for potential vegetation types. This includes direction to manage for vegetation composition that would be expected to occur under natural succession and disturbance regimes and to use historical vegetation conditions and knowledge of natural disturbance regimes to guide the development of desired conditions at the project level. Most of this direction for vegetation management is located in the forestwide objectives under section A(6)-Vegetation (USDA, 1986, p. II-8) and forestwide standards under (H)-Vegetation (USDA, 1986, p. II-47). This

direction is designed to maintain or trend the Forest towards greater resilience at both the stand and landscape scales.

There is little to no direction in the current forest plan that provides for the development and sustainability of non-coniferous vegetation types.

Effects common to alternatives B modified, C, and D

Under all the action alternatives, the forest plan include specific plan components related to vegetation composition that will contribute to the biodiversity and ecological integrity of the Forest. This direction provides substantially more detail and clarity than the 1986 forest plan as to which vegetation conditions and species compositions to strive for. The direction is based on an analysis of the natural range of variation and natural disturbances that, based on current knowledge, will maintain or trend the Forest towards forest resilience and sustainability (Trechsel, 2016a).

This direction includes quantitative and qualitative desired conditions for vegetation composition (FW-DC-TE&V-07,08, 09) and objectives that specify the range of acres to treat to maintain or achieve desired vegetation conditions (FW-OBJ-TE&V-01 through 04). The objectives are specific to treatments that will promote not only overall desired conditions for vegetation composition but also desired conditions specifically for western white pine and for sustaining transitional and persistent non-coniferous plant communities (hardwood and grass/forb/shrub communities). The direction is expected to result in maintaining or increasing both the presence of species of particular importance for future forest resilience (early-successional fire-resistant conifers) and the more uncommon plant communities that contribute to overall plant community diversity (hardwood and grass/forb/shrub communities).

The design of components in the forest plan facilitates reliable and repeatable monitoring of existing conditions and trends over time, and the monitoring plan reflects this. Measurable monitoring components are important for determining how management activities and ecological processes, including climate change, may be influencing vegetation conditions and the achievement of desired conditions over time.

Modeled comparisons—Future vegetation composition by alternative

This section discusses and compares the projected future conditions by alternative resulting from the simulation modeling process (SIMPPLLE model). It discusses these conditions in the context of how they may or may not maintain or improve overall forest resilience and resistance, which is a key component of the Forest's strategy for responding to future uncertainties such as climate change. Listed below are the primary measurable vegetation components related to vegetation composition that would contribute to the overall Forest strategy for which vegetation modeling methods were employed to aid in the evaluation of alternatives.

- Increased presence and dominance of ponderosa pine
- Increased presence and dominance of western larch
- Increased presence and dominance of whitebark pine
- Increased presence of western white pine
- Limited dominance of Douglas-fir, particularly in the warm-dry potential vegetation type
- Limited dominance of subalpine fir, particularly in the overstory layers and in the cold potential vegetation type (whitebark pine habitat)
- Maintenance of uncommon species or vegetation types, specifically hardwood and persistent grass/forb/shrub communities

Note that, as explained earlier under “Methodology and analysis process,” model results are not objectives for plan implementation but are merely a useful indicator and tool to assess how vegetation may change over time. Model outputs are of greatest value for comparison between alternatives and are not intended to be predictive or to produce precise values for vegetation conditions. Model outputs augment other sources of information, including research and professional knowledge of how ecosystem processes (such as succession) and disturbances/stressors (such as fire, insect, harvest, and climate) might influence changes in vegetation conditions over time, especially at the scale of the Forest. Refer to section 3.3, subsection “Discussion of modeling and evaluation of vegetation change,” and to the planning record exhibits referenced in that section for more details on model development and results. Refer to appendix 2 for figures that depict the model results discussed below for vegetation components at the fifth decade compared to the existing and desired condition.

Coniferous vegetation types

Ponderosa pine: Forestwide, current condition for dominance type is basically at the minimum desired level and for species presence is about 1 percent below the minimum desired level. All alternatives showed little to no change in dominance type over the model period, but under all alternatives there is a small but favorable trend upwards forestwide in the species presence from 0.8 to 1.3 percent (highest under alternatives B modified and D). Alternatives B modified and D achieve (just barely) the minimum desired conditions, and alternatives A and C are less than a percent below minimum. This suggests that although there is not substantial change in the proportion or density of ponderosa pine relative to other species in the stand (the dominance type), the species is expanding in distribution across the Forest, particularly across the warm-dry potential vegetation type. A strong upward trend in ponderosa pine presence on the warm-dry potential vegetation type is indicated in the model. Although none of the alternatives achieved desired conditions in the warm-dry type over the model period, they are on a favorable trend, with alternatives B modified and D showing the greatest increase of up to 10 percent of the area. The increase on the warm-dry type is particularly desirable because this type contains the drier sites where this species presence is most suited, especially if future climate conditions are warmer and/or drier.

Douglas-fir: The dominance type shows an upward trend forestwide under all alternatives, with most potential for increase under alternatives A and C (up to 7 percent increase), with a slightly less potential increase under alternatives B modified and D (up to 5 percent increase). Although it remains within the desired range, it is in the upper half, and if the trend continues will soon have the potential to be above the desired condition. This is not a favorable trend and suggests that the density of Douglas-fir is increasing where it occurs across the landscape. This increase appears to be correlated most strongly with a decrease in the lodgepole pine dominance type, but it is also probably partly responsible for the minimal increase or static conditions of the western larch and ponderosa pine dominance type forestwide and the relatively static condition of the shade-tolerant dominance types of grand fir/cedar and subalpine fir/spruce. However, Douglas-fir distribution (presence) appears to stay relatively static forestwide, with no strong trend up or down over the model period. This indicates that at this scale, the species is not expanding in distribution across the Forest and remains within the desired range, which can be interpreted as a favorable situation forestwide.

Although at the forestwide scale the trend in Douglas-fir is not particularly favorable, results by potential vegetation types indicate a more favorable change over time. On the warm-dry type, the current proportion of the area where Douglas-fir is present is well above the desired conditions. The model indicates there would be a strong downward trend in species distribution under all alternatives on the warm-dry type, and under all alternatives Douglas-fir has the potential to move into the upper end of the desired range for species presence on this type. This is a particularly desirable outcome, as this is the type where this species is currently above desired maximum amounts and most likely to be contributing to

forest structures (i.e., densities) and species compositions that are less resilient. The modeled decrease in Douglas-fir on the warm-dry type is probably tied directly to the increase in ponderosa pine, which is linked to both harvest and prescribed fire treatments. Alternative D shows the greatest potential decrease from current condition in Douglas-fir on the warm-dry type (up to 30 percent), followed by alternatives B modified (up to 25 percent), alternative C, and alternative D (each about 20 percent).

On the cool-moist type, Douglas-fir presence has the potential to increase a little over the model period, which is desirable in that it moves more into the desired range. Douglas-fir is a wide ranging and relatively drought-tolerant species, and its presence on sites within this type increases the diversity of species. On the warm-moist type, Douglas-fir presence is currently within the desired range and remains relatively static over the model period, which is also a desirable outcome because it continues to contribute to the diversity of species in this type.

From most to least favorable, alternatives D and B modified show the greatest decrease in Douglas-fir presence on the warm-dry type (28 and 23 percent respectively) and the least increase forestwide of the Douglas-fir dominance type (5 and 4 percent respectively). Alternatives C and A show less decrease in species presence (21 and 20 percent respectively) and the most increase in species dominance forestwide (6 and 7 percent respectively). Similarly to ponderosa pine, it is likely that active vegetation management would be partly responsible for these differences. Harvest and prescribed fire, particularly in the warm-dry type, tend to favor ponderosa pine establishment and persistence.

Western larch: An indication of a small (about 1 percent) but important upward trend in both dominance type and species presence of western larch occurs forestwide under all alternatives, with little discernible difference among alternatives. None achieve the minimum desired condition, but they are moving towards it. The pattern of western larch presence among the different potential vegetation types is the same for all alternatives as well, increasing on the warm-moist type (by 1-3 percent) and on the cool-moist type (by 3-4 percent) but decreasing substantially on the warm-dry type (by 5 to 8 percent). On the warm-moist type, western larch remains within the desired condition; on the cool-moist type it remains below desired minimum levels but is progressing favorably, perhaps to achieve desired levels in another 50 years at the current rates. This indicates that western larch is both increasing in density and in distribution across the landscape, especially on those sites where it is best suited (the moist types). The persistence of Douglas-fir and subalpine fir and their increase in both presence and dominance types by vegetative successional processes may be factors limiting the spread of western larch.

From most to least favorable, alternative B modified showed the potential for the greatest increase (+9.5 percent overall for species presence), followed by alternative A (overall 9 percent), alternative D (overall +7 percent), and alternative C (overall +5 percent). Similarly to ponderosa pine, western larch benefits from disturbances that greatly open up the canopy and ensure its establishment, namely, fire and regeneration harvest.

Lodgepole pine: A consistent downward trend in both dominance type and species presence occurs over the model period for lodgepole pine. There is a potential for the area of dominance type and presence to shift from its current position within the desired range to below the minimum desired level, decreasing by up to 4 percent by the fifth decade. The decrease is greatest under alternatives C and D. Lodgepole pine presence declines in most of the potential vegetation types as well, except for the cold potential vegetation type, where the future range as modeled is centered over the existing condition. The projected conditions 50 years in the future suggest that lodgepole pine distribution will be within the desired range in the warm-moist and cool-moist types and that is has a likelihood of remaining with the desired range for the cold and warm-dry potential vegetation types, although there is a chance it may drop below minimum levels.

Although a downward trend in lodgepole pine is not necessarily undesirable, a steep drop or an exceptionally low amount of lodgepole may be indicative of ecological processes that are not functioning within natural ranges. For example, it is suspected that mountain pine beetle infestations are the likely reason for the drop in lodgepole pine presence and dominance. If other more desirable species are favored, this decline would be of less concern, and this may be the case. However, it is believed that the model may overestimate the impacts of mountain pine beetle on lodgepole pine; although a drop may occur over time, it may not be as steep as modeled.

Western white pine: All alternatives show favorable upward trends for western white pine in species presence forestwide and in the warm-moist and cool-moist potential vegetation types that best support its presence. It stays within and moves closer to the mid-range of the desired conditions within the warm-moist potential vegetation type. The increase on the warm-moist type is particularly desired because these are the sites the species is best suited to. On the cool-moist type, western white pine moves into the lower half but remains solidly within the desired range forestwide over the model period.

From most to least favorable, alternative B modified and D are equal and have the greatest potential for increase overall (5 percent increase on the warm-moist and cool-moist types and 2.6 percent increase forestwide); alternative A is the next most favorable, with a potential 4 percent increase on each of the potential vegetation types and 2.3 percent forestwide. Alternative C shows a potential increase of 5 percent on the cool-moist type, 1 percent on the warm-moist type, and 2.7 percent forestwide. The increase in this species is linked to the amount of timber harvest (specifically regeneration harvest), which favors its establishment (e.g., through planting) and growth. Natural regeneration after fire is also an important component that increases the distribution of this species.

Whitebark pine: The whitebark pine dominance type decreases over the model period under all the alternatives, although not to a large degree (about a maximum 1 percent decline), and it remains within the desired condition. The species seems to hold its ground in relation to its distribution (presence) across the landscape, with the model indicating that it may shift up or down slightly (1-2 percent), which is probably dependent mostly on climatic conditions and associated fire disturbances. In the cold potential vegetation type, whitebark pine presence increases over the model period under all alternatives, potentially by about 12 percent, which is again probably linked to the climate and disturbance patterns. Although it seems to be trending favorably, over the model period it does not yet achieve minimum desired levels. On the cool-moist type, whitebark pine declines in presence under all alternatives (1-2 percent) to at or below the desired conditions. These model results suggest that whitebark pine is not necessarily increasing in density in the areas where it occurs but instead is gradually expanding in distribution on the cold types where sites are most favorable for its establishment and persistence. However, although the trends are favorable, it will require more time for the species to reach even the minimum of its natural range prior to the effects of blister rust and the other factors that have caused its precipitous decline over the previous five decades. The limitations on whitebark pine restoration on the Flathead, and particularly the severely limited natural seed source (see section 3.5.1, subsection "Whitebark pine") may not be well portrayed in the model.

From most to least favorable, alternatives A and C show the greatest potential increase in species presence in the cold type (13 percent), followed by alternative D (11 percent) and alternative B modified (10 percent). In reality, the complexities associated with restoration of this species (see section 3.5.1, subsection "Whitebark pine") is difficult to reflect through vegetation modeling. It is likely that it will take far longer than a 50-year model period to see substantial increase in the abundance of whitebark pine. Restoration efforts, with particular focus on planting or seeding, are centered on sustaining and increasing this species over the long term.

Subalpine fir: Forestwide, subalpine fir/spruce dominance type and subalpine fir species presence are currently within the desired range. The resulting range after 50 years is relatively wide compared to most other species and overlaps the existing condition value, but it shows more probability of increasing than decreasing over time. Vegetative succession is responsible for increases in subalpine fir presence as this species is the primary shade-tolerant species and indicated climax species across nearly 80 percent of the Forest. It could move above the desired range for dominance type under all the alternatives, although its distribution (species presence), although increasing, stays within the desired range for the model period.

In the cold potential vegetation type, subalpine fir is currently within and is likely to stay relatively stable and remain within the desired range by the fifth decade. However, there is some probability that it may increase to above the desired range, especially under alternatives A, C, and D. In the cool-moist potential vegetation type, subalpine fir is currently within the desired range, and modeling indicates that the distribution (presence) of this species will increase over time by up to 15 percent, although it is still within the desired range at the fifth decade. In the warm-moist potential vegetation type, subalpine fir is slightly above the desired range, and modeling suggests it will increase in distribution over the model period to be 20 percent or more above desired levels.

This overall probability of increase in subalpine fir, both in density and distribution, is not a particularly favorable result from the standpoint of forest resistance and resilience to future disturbances. This is especially true if the increase in subalpine fir is occurring at the expense of western larch, western white pine, or whitebark pine. Forests dominated by subalpine fir and other true firs (e.g., grand fir) are typically more susceptible to damage from western spruce budworm, root/stem/butt rot fungi, and other harmful agents. Multicanopy and dense forest conditions are common in subalpine fir-dominated forests, potentially increasing fire severity.

From most to least favorable, alternative B modified has the least potential for increased dominance of subalpine fir forestwide (+7 percent) and on the cold potential vegetation type (+9 percent). Alternative D follows with 8 percent potential increase forestwide and 13 percent on the cold type. Alternative C shows a 9 percent potential increase forestwide and 15 percent in the cold type; alternative A shows a 10 percent increase forestwide and 15 percent in the cold type.

Engelmann spruce: This species' ecological role and response to fire is similar to subalpine fir. Fire tends to reduce its presence and vegetative succession increases its presence, although it is typically less abundant than subalpine fir. Forestwide, spruce presence is within the desired range, and its presence increases over time but remains in the desired range. In the cold type, there is a favorable increase in spruce presence, and it moves from below to within the desired range. In the cold-limited forests in this potential vegetation type, spruce is generally considered an important component and adds to the diversity of species. A similar increase from below to within desired conditions occurs for spruce presence in the cool-moist potential vegetation type. However, in the warm-moist type, spruce presence is currently high, exceeding the desired level, and increases over time to even higher levels. This increase may indicate forests that are progressing through successional stages where spruce (along with subalpine fir) are becoming more densely stocked in the mid- and understory tree layers. Depending on the location of these forest types, this may increase the risk of high-severity fire or impacts due to insect and disease. The alternatives are similar in the trends and degree of change.

Grand fir: Grand fir generally maintains its presence in the warm-moist type, where it is most prevalent, and stays within the desired range. Alternative results are similar, although alternative C shows the greatest potential for increase over time. The grand fir/cedar dominance type maintains itself generally at current levels over the model period; it is within the desired conditions.

Western red cedar: Similarly to grand fir, western red cedar maintains its presence on the warm-moist type, with the action alternatives all showing maintenance at existing levels or a potential for an increase of up to 5 percent (under alternative B modified). Vegetative succession is the likely reason for this increase.

Non-coniferous vegetation types: Hardwood and grass/forb/shrub

Trends over time in the non-coniferous vegetation types (hardwood and grass/forb/shrub plant communities) are difficult to portray through modeling. Persistent non-forest plant communities are relatively rare types on the Forest and are fragmented in nature, and there is no specific direction within the model to sustain these types. Therefore, model results, though helpful, should be supplemented with other information for discerning the trend and amounts of these communities over time. Since hardwood trees are largely associated with early-successional forest conditions, modeling of forest successional stages (i.e., forest size classes), disturbance processes and their effects on non-coniferous vegetation can provide insight and information for assessment of trends in hardwood species over time.

On the Flathead National Forest, the hardwood dominance type tends to occur as small patches and stringers scattered amongst the large matrix of coniferous forest types. It also occurs as a transitory vegetation type in the early-successional stages of coniferous forest development. Similar to hardwood types, most grass/forb/shrub-dominated communities on the Forest are transitional, present only in the early-successional stages of coniferous forest succession. Evaluation of potential patterns and trends in fire disturbance in the future would present a means of evaluating what future trends might be for these vegetation types.

Model results suggest a downward trend in the hardwood dominance type over the next five decades when assessed forestwide. However, the model indicates that fire will continue to be a dominant feature of the landscape, with a potential range of about 3.5 to 15 percent of the Forest affected by fire per decade (refer to figure 14 and figure 21). The model shows the amount of early successional forest (seedling/sapling size class) trending upward over time forestwide. This suggests that there may be more potential for hardwood species and the grass/forb/shrub types to maintain or increase their presence on the landscape than might be indicated by the model, due to the abundance of disturbances that create the early successional forest openings favored by these vegetation types. More fire over a particular time period might be expected to result in more acres in these vegetation types; more frequent fire might favor longer-term (more persistent) presence of these vegetation types if conifer regeneration is slowed or delayed.

3.3.4 Forest size class

Affected environment

Forest size classes are defined based on the predominant tree diameter (d.b.h.) in the stand. These different size classes are grouped for purposes of broad-scale forestwide analysis in this EIS. Refer to Barber et al. (2011), Brohman et al. (2005), and exhibits in the planning record (Trechsel, 2016c; USDA, 2015f) for detailed information on how forest stands are classified into size classes within the data sets used in this analysis (Trechsel, 2016c; USDA, 2015f). Five forest size classes are used in the vegetation analysis for this EIS, and they broadly describe and quantify the diversity of forest sizes classes and successional stages across the Forest: seedling/sapling, small tree, medium tree, large tree, and very large tree. A brief description of each of these forest size classes is provided below. A general association of the size classes with tree ages and forest successional stages is made based upon a general knowledge of common forest successional patterns and structures on the Forest in stands of different size classes.

The **seedling/sapling size class** represents the youngest forest conditions and the early-successional stage of development. Forests are dominated by trees in the seedling size class (less than 4.5 feet tall) and sapling size class (0.1 to 5 inches d.b.h). There may be very low numbers of overstory larger trees present. Most trees are less than 40 years old and less than 40 feet tall. On sites of lower productivity (higher elevation, poor soils) or in extremely dense stands, trees in this size class may actually be older than 40 years because of their slower diameter growth rates. In the early-successional stage, tree canopies do not dominate the site, particularly in the early stages where trees are seedling size, and therefore ample sunlight is able to reach the forest floor. Abundant grasses, forbs, and shrubs are a dominant feature within most areas.

Small size class forests are considered to be in the mid-successional stage of development, composed mostly of young, immature trees. Trees 5 to 8.9 inches d.b.h. dominate. Typical tree ages range from 40 to 75 years old. They are most often a single canopy layer, but two or more canopy layers are not uncommon, depending upon the disturbance history and site conditions. Most stands on the Forest in this class are relatively densely stocked, with greater than 40 percent tree canopy cover, and gave limited sunlight reaching the forest floor. Shade-tolerant understory grasses, forbs, and shrubs dominate, with species varying by site. However, an estimated 25 percent of the forests in this size class have a more open tree canopy, with 25-40 percent canopy closure. In these open forests, understory plant species requiring greater amounts of sunlight are more prevalent.

Medium size class forests are considered to be in the mid-successional stage of development. Trees 9 to 14.9 inches d.b.h. dominate. Forest structures vary considerably, with forests of single and multiple canopy layers that are mostly well stocked with trees and have greater than 40 percent canopy cover. Shade-tolerant grasses, forbs, and shrubs usually dominate the forest floor vegetation, with species varying considerably by site conditions. Tree ages can also be variable among stands in the medium size class, depending on species composition, site conditions, and stand densities. A typical tree in the medium size class would be 75 to 110 years old. However, on some of the more productive sites where stands are of optimum densities and fast-growing species are present, trees of this size class may be as young as 50 years old. In other situations, such as on harsher growing sites or in stands of very high densities that had low growth rates for many decades, trees in this medium size class might be substantially older than 120 years.

Large size class forests are usually (but not always) older than those classified as medium tree size class. Trees 15 to 19.9 inches d.b.h. dominate. Most trees are over 90 years old, and most stands are considered to be in the mid-successional stage of development. Some stands are old enough to be considered late successional. As with the medium size class, some sites and stand conditions have trees of this size class are of substantially younger ages (e.g., in this size class, 70 years old) or of very older ages (e.g., greater than 200 years old). Forests in the large tree size class are usually composed of two or more canopy layers, are well stocked with trees, and have greater than 40 percent canopy cover. Shade-tolerant trees and other vegetation typically dominate in the understory, with species varying considerably by site.

Very large size class forests represent the older forest stands, where trees ≥ 20 inches d.b.h. dominate. The larger trees are typically over 130 years old, and some of the oldest trees may be several centuries old. These forests are considered in the late-successional stage of development, and this is the size class that would correlate most closely to old-growth forest (see section 3.3.6). These forests typically have a more complex structure than other successional stages, with more variability in canopy layers, amounts of snags and downed wood, and individual tree size classes. Shade-tolerant species dominate in the understory. Most sites in this category are well stocked with trees and have fairly dense canopy layers (> 40 percent canopy cover), except on less productive sites where trees may be more widely spaced.

Figure 22 through Figure 26 display the current condition and desired range in proportion of forest size classes on national forest lands, both at the scale of the entire forest and by each potential vegetation type. Refer to section 3.3, subsection “Development of desired conditions and other plan components,” and to USDA (2016a) for information on the development of the desired ranges. Based on current knowledge, the desired condition reflects sustainable and resilient forest conditions relative to forest size class and a diversity of forest successional stages. Discussion and evaluation of forest size class current condition relative to the desired conditions follows the figures. For all the figures in this section, the source of the data on existing vegetation is Forest Inventory and Analysis (FIA) data using the R1 summary database (Hybrid 2011) analysis tools. The current proportion from this data set is expressed as an estimated mean percent, with a lower and upper bound estimate provided at a 90 percent confidence interval (abbreviated as CI in the figures below).

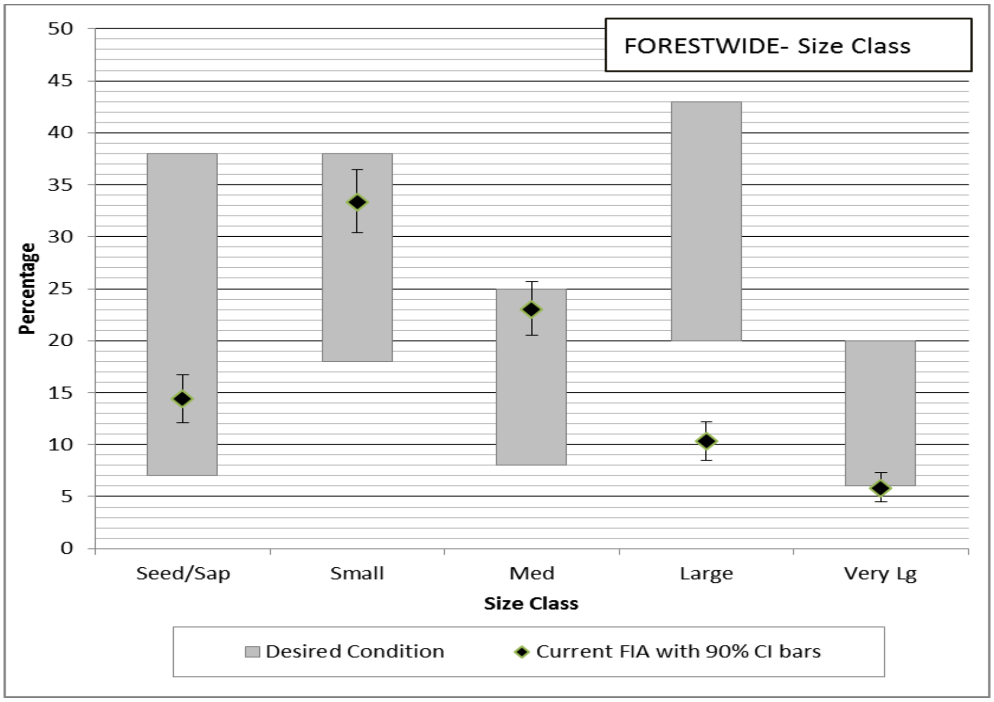

Figure 22. Current and desired conditions of forest size classes forestwide.

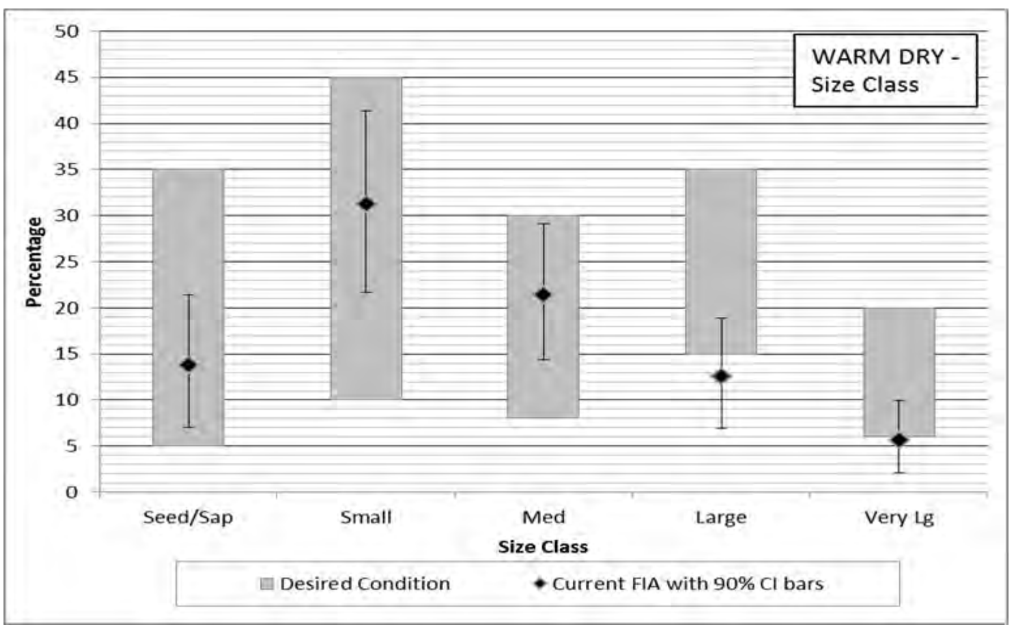

Figure 23. Current and desired conditions of forest size classes for the warm-dry potential vegetation type

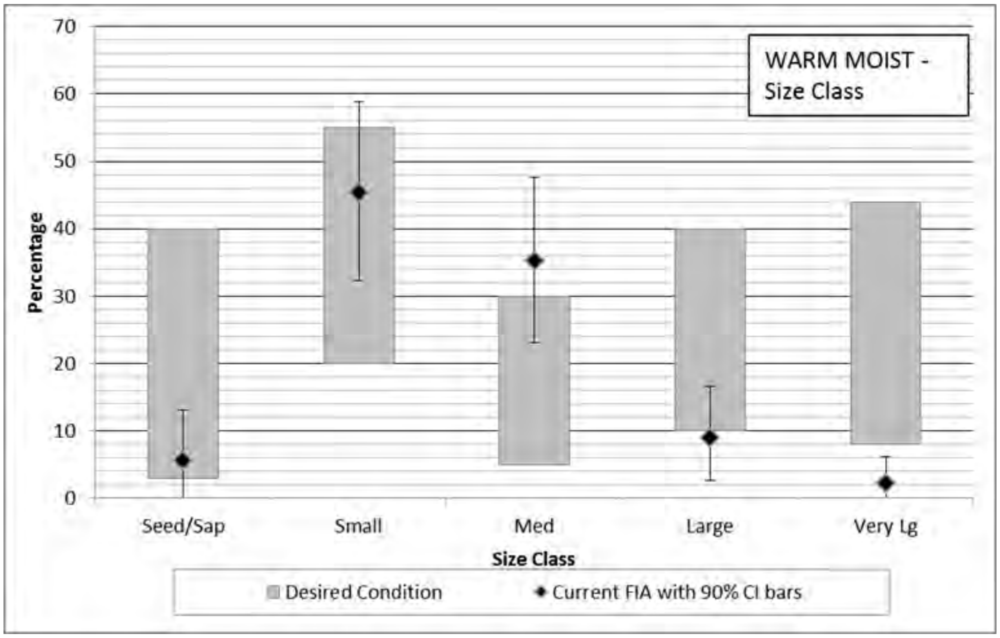

Figure 24. Current and desired conditions of forest size classes for the warm-moist potential vegetation type.

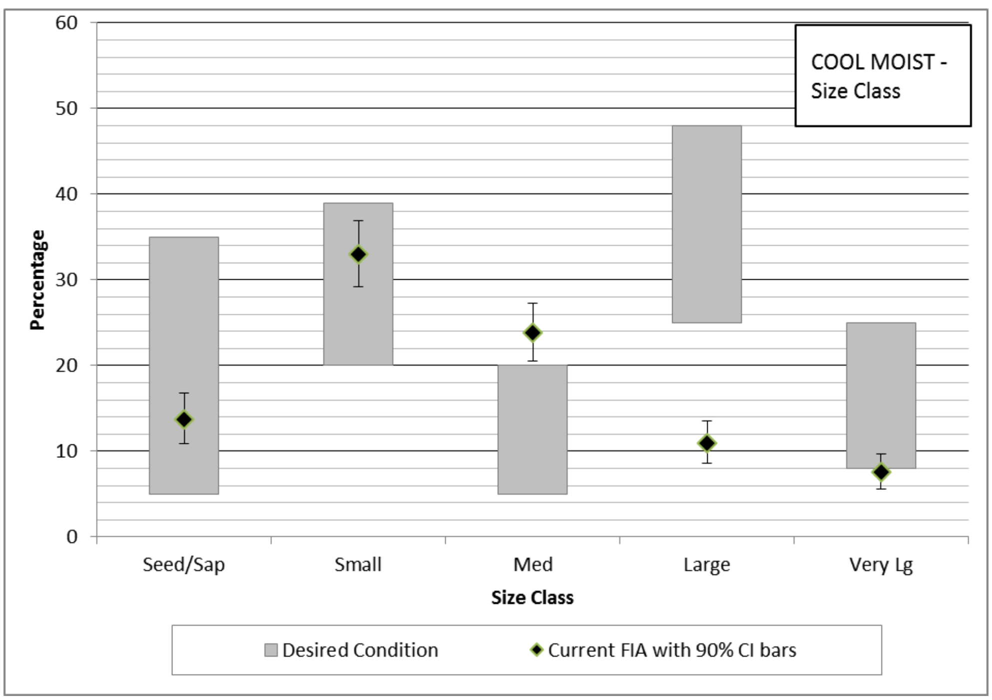

Figure 25. Current and desired conditions of forest size classes for the cool-moist potential vegetation type.

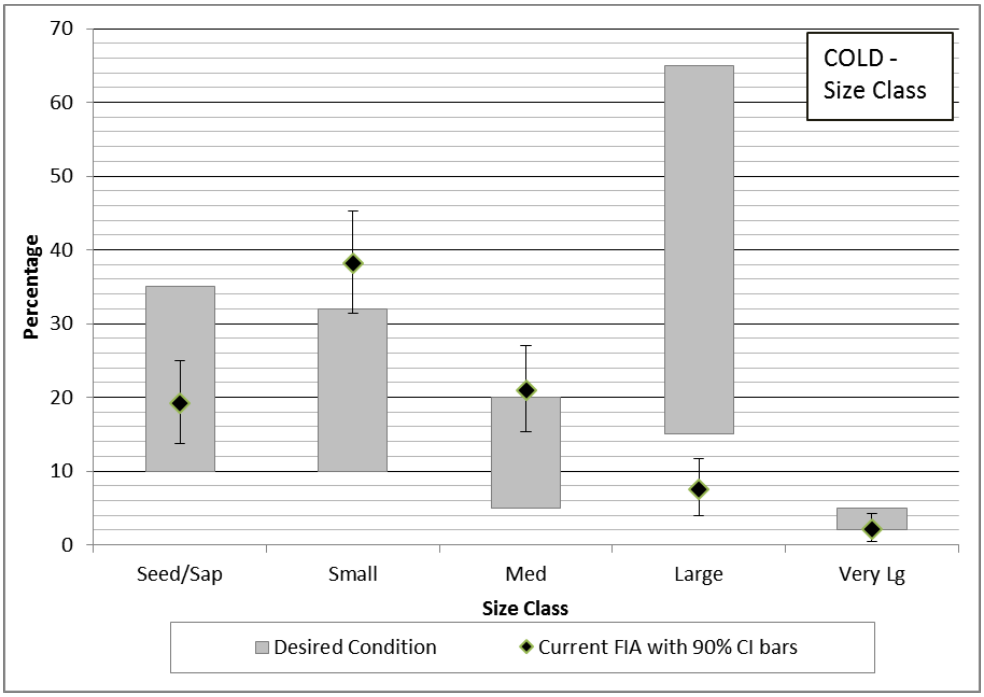

Figure 26. Current and desired conditions of forest size classes for the cold potential vegetation type.

Across most of the Flathead National Forest, desired forest size class distribution follows a pattern that is generally consistent with the predominant disturbance regime in this landscape, namely, relatively infrequent fires that are largely moderate and high severity, with the potential for very large and extensive areas to burn periodically (see section 3.8 for additional information). Proportions shift between the size classes over time, due both to different rates of growth and succession and in response to fire frequency and patterns.

A wide range in the amount of seedling/sapling forest types would be expected and desired, as well as a naturally lower level of very large forest size class, due to the natural disturbance regimes across the Forest.

Most of the Forest is in the small to medium and large size classes and could remain in those for long time periods, especially in densely stocked stands with relatively slow growth rates. The moist site conditions over most of the Flathead support high densities of trees. The early-successional tree species, especially lodgepole pine and western larch, are well adapted to moderate- and high-severity fire and seed in abundantly after fires, which also contributes to high tree densities over much of the Forest. Tree growth is reduced in higher-density stands. Subalpine fir and spruce also establish readily on the moist sites and persist for many decades as smaller-diameter trees in shaded understory conditions. All these factors contribute to the natural bulge of forests in the small and medium size class categories. High densities limit growth of trees, and only a portion of the Forest in the small size class would progress into the medium and then into the larger size classes before the next stand-replacing disturbance. Less dense forests or forests on more productive sites would transition through the smaller size classes and into the very larger tree size class relatively quickly (e.g., 100 years from a fire event). Higher-density forests may take 150 years or more to transition. Many would never achieve the very large size class due to stand conditions and/or to disturbances of fire, insects, and disease.

The desired forest size class distribution on the warm-moist potential vegetation type reflects the high site productivity of these lands as well as the mixed-severity fire regime that is more prevalent in this type.

Forests in the small and medium forest size classes would be expected to transition more rapidly into the large and very large size classes, which are more abundant in this type. The abundance of very large trees of fire-resistant species (such as western larch, Douglas-fir, and western white pine) would reduce fire severity and contribute to the persistence of the very large tree size class. This pattern is also indicated in the cold potential vegetation type. Although it is expected that very little of the Forest would achieve the very large size class due to growing conditions in the cold type, the large tree size class was historically dominated by whitebark pine and, to a lesser extent, Engelmann spruce. A mixed severity fire regime is more prevalent on this type, and the fire resistance of whitebark pine and its uniquely adapted regeneration strategy (see section 3.5.1, subsection “Threatened, endangered, proposed, or candidate plant species”) perpetuated its presence as mature, large-diameter trees across large portions of this type.

The desired condition for forest size class in the warm-dry type reflects a fire regime characterized by generally more frequent fire that would burn at low to moderate severity. High-severity fires would also occur periodically. The sites within the warm-dry potential vegetation type on the Flathead consist of sites at the moist end of the habitat types typically included within this group. Douglas-fir and, in some areas, grand fir are the indicated climax species. They are distributed widely across the mid to lower elevations within the matrix of more moist and cool forest types. The desired condition is for all forest size classes to be relatively well represented across these sites, with relatively low variability between the amounts of size classes.

The current pattern of forest size classes across most of the Flathead National Forest suggests a relatively high amount and in some cases an overabundance of forest in the small and medium forest size class (mid-successional forests), correlated with a low amount of forest in the larger forest size classes and, to a lesser degree, the seedling/sapling size class or early-successional forest. The vast majority of the current forests in the seedling/sapling size class is due to recent fire. In the past 25 years, a large amount of area on the Forest has burned in wildfires (over 400,000 acres, or about 17 percent of the Forest), mostly high-severity burns. As a comparison, approximately 72,000 acres, or about 3 percent, of Forest lands have been regeneration harvested, which also creates early-successional forest, over that same 25-year time period.

Current conditions of large and very large size classes are in the lower end or below the desired range both forestwide and on the potential vegetation types. Fire is a natural disturbance and is the primary factor that has historically limited the amount of very large forest size classes in this ecosystem. Large amounts of wildfire across the Flathead National Forest in the late 1800s and early 1900s created large expanses of early-successional forest at that time (see section 3.8). Forests within these fire areas have only recently reached the point where some may be transitioning through succession into the very large size class. The amount of large and very large size class may have been naturally at lower levels across the Forest prior to the onset of timber harvest activities in the 1940s and the large fire events of the last 15 years. Harvest practices over the past 60 or more years have also undoubtedly contributed to the removal of many forests in the larger forest size classes. Recent fires burned within forests of all size classes and undoubtedly are responsible for the loss of some forests in the large and very large size classes. Insect outbreaks (particularly Douglas-fir and spruce beetle) and disease also removed large trees across the Forest, particularly whitebark pine on the cold type and western white pine on the warm-moist type.

Very large live trees

Very large live trees (≥ 20 inches d.b.h.), and in particular the more long-lived, fire-tolerant western larch, ponderosa pine, and, to a lesser extent, Douglas-fir, are identified as a key ecosystem characteristic on the Flathead National Forest. Their presence within the Forest is valued whether they occur at low density or a high density within a stand. Large-diameter fire-tolerant species can survive low- to moderate- fire, contributing to the recovery of the forest after disturbance and to the long-term structural diversity of the

forest. They provide important wildlife habitat features, both as live trees and when they die as snags and downed wood, which provide denning habitat for lynx and a variety of other species. They occur within old-growth forest and also provide opportunity for development of future late-successional or old-growth forest. They can have high economic value as wood products.

Western larch and ponderosa pine are the most highly valued large-diameter tree species in the ecosystems of the Forest because of their ability to fill all of these roles. The decay and snag traits of these species are conducive to cavity formation and long-term snag persistence. Douglas-fir and western white pine also have relatively high value because they are long lived and somewhat tolerant of fire. Large Engelmann spruce is long lived and contributes to late-successional forest structures, but this species is intolerant of fire, more susceptible to insect and disease, and less persistent as a snag. Refer also to section 3.7.4, subsection "Old-growth forest," for additional information on wildlife associated with very large live trees.

The very large forest size classes (as described earlier) indicate areas where trees ≥ 20 inches d.b.h. occur at a level of such abundance that they dominate other trees of smaller size classes. However, because forest size class is based on an average diameter of trees across the stand, it does not provide the full picture of the amount or distribution of individual very large live trees across the Forest. Because of this, two other indicators are used in this analysis that provide information as to the very large live tree component across the Flathead National Forest.

The first indicator is referred to as the "very large tree component" indicator, which is a measure of those stands where very large live trees occur to a specified minimum density (this varies based on potential vegetation type, as described in table 22). These densities are designed to correlate as closely as possible with the very large tree densities that might be expected in late-successional and/or old-growth forest conditions and thus to provide associated wildlife habitat values. As a side note, a sizeable portion of the old-growth forest on the Flathead National Forest is actually within stands that are not classified in the very large forest size class but rather in the medium or large size classes. Section 3.3.6 describes this situation more thoroughly.

The second indicator measures the presence and the density of very large live trees, providing information on how widespread and common these trees are as individuals and on their overall density across the Forest and on potential vegetation types.

Density criteria and existing conditions for the very large tree component and for the density and presence of individual very large live trees are displayed in table 22 and table 23. The source of the data for the existing condition is Forest Inventory and Analysis data using the R1 summary database (Hybrid 2011) analysis tools. The current proportion from this data set is expressed as an estimated mean percent, with a lower and upper bound estimate provided at a 90 percent confidence interval.

Table 22. Very large live tree component definitions and current estimated percent, forestwide and by potential vegetation types

Potential vegetation type	Very large live tree density criteria	Current estimated percent
Forestwide	Incorporates the criteria specific to each potential vegetation type	14.1 (11.9-16.5)
Warm-dry	At least 8 trees per acre greater than or equal to 20 in. d.b.h.	16.4 (10.1-23.3)
Warm-moist	At least 10 trees per acre greater than or equal to 20 in. d.b.h.	9.5 (2.9-17.1)
Cool-moist	At least 10 trees per acre greater than or equal to 20 in. d.b.h.	16.7 (13.6-20.0)
Cold	At least 10 trees per acre greater than or equal to 15 in. d.b.h.	8.1 (4.3-12.4)

Table 23. Current estimated density and presence for very large live trees across Forest lands, forestwide and by potential vegetation type.

Potential vegetation type	Current estimated presence[1]	Current estimated trees per acre	Current predominant species of very large live trees
Forestwide	15.9 (13.5-18.5)	4.2 (3.5-5.0)	Douglas-fir, western larch, spruce
Warm-dry	16.4 (10.1-23.3)	4.0 (2.4-5.7)	Douglas-fir
Warm-moist	13.6 (5.3-23.3)	2.7 (0.9-4.8)	Douglas-fir
Cool-moist	19.1 (15.7-22.6)	5.2 (4.2-6.4)	Western larch, Douglas-fir
Cold	8.5 (4.4-13.1)	2.2 (1.1-3.4)	Spruce

1. Percentage of the analysis unit that has at least one live ≥ 20-inch-d.b.h. tree present

As is evident from the comparison of the very large *forest size class* percentages in figure 22 through Figure 26 with the very large tree *presence* percentage in table 23, there is more than 2.5 times the area where very large live trees are present forestwide than there is area actually in the very large forest size class. Similarly, by potential vegetation type there is 2.4 to nearly 7 times the area where very large live trees are present compared to the amount of area in the very large forest size class, depending upon the potential vegetation type. This means that although individual very large live trees are relatively widespread, occurring on up to 20 percent of the Forest area, they are mostly not present at the higher densities that would be necessary to classify as a very large forest size class. This situation directly reflects the adaptations native tree species have developed to persist under a fire-dominated disturbance regime where fires kill most trees on a site but a few larger individuals of fire-resistant species may survive, as described in the species descriptions in section 3.3.3. These larger live trees are scattered irregularly across the landscape, more densely in some areas (and sometimes enough to classify as very large tree size class) and more thinly in other areas. Overall, the density of very large live trees ranges from an average of 2.2 per acre in the cold type (which would be expected, given the more severe growing conditions) to an average of 5.2 per acre in the cool-moist type, as seen in table 23.

Additional analysis of existing conditions for very large live trees across the Flathead was conducted to assess existing conditions related to natural variation and help inform the development of forest plan components. This analysis involved evaluation and comparison of very large tree densities and distributions inside and outside wilderness and inventoried roadless areas. Conditions within wilderness and inventoried roadless areas are used to provide insight on conditions that might be expected under natural disturbance regimes and ecosystem processes where human influences (such as harvest) are minimal. Estimates from different points in time provide insight on trends and the influence of widespread, extensive wildfire disturbances. Conditions forestwide and within each geographic area were evaluated. Trechsel (2017i) contains the relevant data tables and describes this analysis in detail. Summarizing the results of this analysis, the densities of very large live trees outside wilderness and inventoried roadless areas on the Flathead are similar to the densities within wilderness and inventoried roadless areas for most potential vegetation types. Across most of the Forest, there has been relatively small change in the density of very large live trees over time compared to conditions measured in the early 1990s. All the geographic areas have a density and distribution of very large live trees that is mostly at or above the current forestwide conditions inside wilderness and inventoried roadless areas on the Forest. The data and analysis suggest that the condition of very large live tree density and distribution across the Flathead is consistent with what might be expected to occur under a natural disturbance regime. although wildfire, timber harvest, and firewood cutting has undoubtedly removed many very large live trees across portions of the lands outside wilderness and inventoried roadless areas, natural succession and the continuing growth of trees into larger size classes appear to have had a strong influence on very large tree conditions and have contributed to the maintenance, and in some the cases increase, of the very large tree component. Fire suppression may have had an influence as well by reducing potential burn

acreage in areas outside wilderness and inventoried roadless areas, thus avoiding the loss of very large trees by fire. The actual, quantifiable impact of each of these factors on the very large tree component, or what the conditions would be without these factors, cannot be accurately determined.

Environmental consequences

Effects of alternative A

A key difference between alternative A and the action alternatives is related to the forest plan direction associated with both forest size classes and the very large tree component. The 1986 forest plan does not explicitly describe desired conditions for forest size classes and has very little if any specific direction related to forest size classes or to very large tree components. It does incorporate an ecologically based approach to vegetation management, including managing for vegetation composition, structures, and patterns that would be expected to occur under natural succession and disturbance regimes; reducing the risk of undesirable fire, insect and pathogen disturbances; and providing for long-term recruitment of forest structural elements such as snags and downed wood. General direction to manage for old-growth forest or late seral stages is provided, which indirectly relates to the presence of very large live trees. Most of this direction is located in the forestwide objectives under section A(6)-Vegetation (USDA, 1986, p. II-8) and forestwide standards under (H)-Vegetation (USDA, 1986, p. II-47).

Effects common to alternatives B modified, C, and D

The forest plan for all action alternatives includes specific plan components related to the condition of forest size classes that will contribute to the biodiversity and ecological integrity of the Forest (FW-DC-TE&V-10, 11). This direction provides substantially more detail and clarity than the existing 1986 forest plan as to the desired conditions for forest size classes that is based on analysis of the natural range of variation and natural disturbances and that, based on current knowledge, will maintain or trend the Forest towards resilience and sustainability. Objectives in the forest plan specify acres of treatments to achieve desired conditions, emphasizing the importance of active management in maintaining or achieving these conditions.

Forest plan components provide specifically for the maintenance and development of very large live trees. A desired condition (FW-DC-TE&V-12) for very large live trees states that they are present not only in the very large forest size class but are also distributed throughout the Forest in other size classes as well, including in areas where timber harvest activities are more prevalent. Maintaining or creating forest conditions that facilitate the development of very large live trees over time is also a part of the desired condition, such as by managing for forest species compositions and densities that allow trees of desired species to grow relatively rapidly into larger size classes. Desired species of very large live trees are western larch in the warm-dry, warm-moist, and cool-moist potential vegetation types, with the addition of western white pine and western red cedar in the warm-moist type. Ponderosa pine is desired in the warm-dry and warm-moist types. For all forest size classes, it is expected that there will be wide fluctuation over the short and long term because of the complex interrelationships between ecological processes (such as succession) and disturbances (such as fire) and the influence of desired conditions and objectives for other resources.

A guideline under all action alternatives addresses the retention of live reserve trees within regeneration harvest areas (FW-GDL-TE&V-09), with the primary intent of contributing to the maintenance and/or development over time of very large trees of desired species. The guideline requires a minimum of three live reserve trees of western larch or ponderosa pine greater than 17 inches d.b.h. to be retained within regeneration harvest areas where present. These species and size classes are highly valued for a variety of reasons, as described earlier in section 3.3.3. Where these species and size classes are not present, the guideline requires consideration of alternative species, size, and conditions. This direction would help

maintain or achieve desired conditions for very large trees along with associated contributions to overall forest resilience and desired forest structures and wildlife habitat. Because the guideline addresses tree retention in harvest areas, it would have the most influence on conditions in areas of the Forest where harvest is concentrated, e.g., lands suitable for timber production, and it would especially contribute to the maintenance and development of desired distribution of the very large live tree component across the Forest. Refer to Trechsel (2017i) for a discussion of the data used and of the analysis that was conducted to establish the minimum density of live reserve trees for this guideline.

The guideline requiring the retention of live reserve trees within regeneration harvest units is also part of the Forest's strategy to provide for desired snag conditions, specifically by contributing to potential future snag habitat. Refer to the snag analysis in section 3.3.7.

In contrast to the existing 1986 forest plan, in the forest plan, desired conditions for certain key ecosystem components are developed in a manner that makes it possible to conduct reliable and repeatable monitoring of existing conditions and trends over time, and the monitoring plan reflects this. Measurable monitoring components are important for determining how management activities and ecological processes, including climate change, may be influencing vegetation conditions and the achievement of desired conditions over time.

Modeled comparison—Future forest size classes by alternative

This section discusses and compares the projected future conditions by alternative using the results of the simulation modeling process (SIMPPLLE model). It discusses these conditions in the context of how they may or may not maintain or improve overall forest resilience and resistance, which is a key component of the Forest's strategy for responding to future uncertainties such as climate change. Listed below are primary measurable vegetation components related to forest size class that would contribute to the overall Forest strategy for which vegetation modeling methods were employed to aid the evaluation of alternatives.

- Decreased proportion of small and medium size classes (on all but the warm-dry potential vegetation type)
- Increased proportion of large size class
- Increased proportion of very large size class and the presence of very large trees (> 20 inches d.b.h.), particularly fire-, insect-, and disease-resistant species

Note that as explained earlier in the section on the methodology and analysis process, model results are not objectives for plan implementation but are merely a useful indicator and tool to assess how vegetation may change over time. Model outputs are of greatest value for comparison between alternatives and are not intended to be predictive or to produce precise values for vegetation conditions. Model outputs augment other sources of information, including research and professional knowledge of how ecosystem processes (such as succession) and disturbances/stressors (such as fire, insects, harvest, and climate) might influence changes in vegetation conditions over time, especially at the scale of the planning unit. Refer to section 3.3.1 and to planning record exhibits referenced in that section for additional details on model development and results. Refer to appendix 2 of the final EIS for figures that portray graphically the model results discussed below for vegetation components at the fifth decade compared to the existing and desired condition.

Seedling/sapling size class: All alternatives show a likelihood of an upward trend over the model period for the seedling/sapling size class, both forestwide and by potential vegetation type, with the exception of the warm-moist type, which trends downward under all but alternative A. The increase and persistence of the seedling/sapling size class indicates that fire (mostly high-severity wildfire but also some prescribed

fire), remains a main ecosystem process and driver of vegetation change into the future across the Forest. The range for the amount of this size class at the fifth decade is very wide, reflecting the wide variability and uncertainty in the amount of future fire over time. However, across most of the Forest this range remains within the desired conditions, suggested that although there is a probability of high amounts of fire, it is not expected to be outside the range of natural variation, at least in the next five decades. Exceptions occur in the cold potential vegetation type, where the upper end of expected amounts of seedling/sapling extend above the desired conditions. This could reflect a severity and/or extent of fire in forests on the cold type that is more than historical amounts, which could be possible under a warming climatic trend, and an increasing amount of spruce and subalpine fir. The other exception is in the warm-moist type, which is the only area where the amount of seedling/sapling type declines (except under alternative A), and there is a possibility of the amount going below the desired minimum level (which is very low anyway at 3 percent of the landscape). This type occupies on a very small portion of the Forest. Fire suppression is generally more effective in the lower-elevation and more easily accessed areas where these sites occur. A higher proportion of low- to moderate-severity fire may occur in this type, including prescribed burns, and these fires would leave more live trees and create less area dominated by seedling/saplings as well as reduce stand densities.

Small/medium forest size class: A downward trend occurs for the amount of area in small and medium size class in all alternatives, both forestwide and in all potential vegetation types. This is generally a desirable trend for the small size class in all locations in that it either stays soundly within or moves from above to within the desired condition. For the medium size class, existing amounts are quite high forestwide and in all potential vegetation types (except the warm-dry type), either above the desired maximum level or at the upper end of the desired level. By the fifth decade, in all but the warm-moist type the medium size class declines to the low end or below the desired level. It declines to zero in the warm-dry type. This precipitous decline in the medium size class is more of a peculiarity of the modeling process rather than a reality on the ground, reflecting model assumptions associated with natural succession and the timing of the change from one size class to another, because change actually occurs along a continuum. To appropriately interpret these results, assume that some of the large forest size class is actually more in a medium size class and then mentally combine those two categories for the purpose of evaluating trends over time. Refer to Trechsel (2017a) for additional information on these model results. All this being said, there is still likely a trend downward for the medium size class under the alternatives, although likely not to the degree reflected in the model results. It is more likely that forestwide and for all the potential vegetation types (except perhaps the warm-moist type), the amount of medium size class would decline but probably would remain within the desired conditions, although likely at the low end. In short, under all alternatives there is a relatively equal beneficial downward trend in the small and medium forest size classes over the model period, associated with an equally beneficial upward trend in the large size class, as discussed in the next paragraph. Most of the changes in size classes are associated with forest growth and successional progression (seedling/sapling growing into small size class and small size class growing into medium size class).

Large forest size class: All alternatives indicate a strong increase in the amount of area in the large size class by the fifth decade forestwide and within all potential vegetation types, although likely not to the degree that the model directly indicates for the reasons discussed in the previous paragraph. However, even assuming a lower level of increase, the trend upwards would still occur and conditions would be likely to move from below the desired minimum levels to within the desired range for all areas. The trend is very desirable, suggesting that the disturbance levels (i.e., insects, disease, and fire) may not adversely impact the natural succession of forests into larger size classes over at least the next five decades. Natural disturbances have a substantially greater impact than harvest amounts (see table 20), with fire and insects and disease the primary disturbances that would reduce forest size class by either killing primarily the larger trees (i.e., Douglas-fir and spruce beetle) or killing all trees indiscriminately (such as from stand-

replacement fire). The model includes a scenario of maximum fire that is near the estimated maximum natural range of variation, so this level of fire is represented in the model results. Timber harvest would remove a minor amount of the large forest size class on portions of the forest, but has a much smaller impact compared to natural disturbances. Improved tree growth within stands that have been harvested, particularly with a commercial thin, increases the forest size class by removal of smaller diameter trees and retention of larger diameter trees. This has likely contributed a minor amount to the large forest size class across the Forest, though to a much smaller degree than natural succession on lands not subject to harvesting.

Very large forest size class: Forestwide and within all potential vegetation types, the existing conditions for the very large forest size class are at the minimum desired level. At the fifth decade, model results suggest that the amount of this size class will increase in the warm-dry and warm-moist potential vegetation types; stay relatively static compared to current conditions in the cold type and forestwide; and potentially decrease in the cool-moist type. The trend upwards in the warm-dry type is particularly favorable because of the desire to manage for more frequent fire in this type in order to favor ponderosa pine over Douglas-fir. The lower-severity fires in this type (both prescribed fire and unplanned ignitions) are probably contributing to the upward trend, with these types of fires killing the smaller size trees but not the very large trees. The trend upward in the warm-moist type is probably tied to the higher productivity and growth rates in this type, and this too is a highly favorable trend that contributes ecological (i.e., wildlife habitat) and economic values. Maintenance of the very large size class forestwide, although not as favorable as an upward trend, at the very least suggests that this size class may be sustainable across the landscape into the future. The downward trend in the cool-moist type is undesirable and is likely due largely to the effects of fire in this type (mostly wildfire but also prescribed fire), which would mostly be stand-replacement fire that would reset the stand to an early-successional stage. Some loss would be due to the activity of insect and disease, primarily Douglas-fir beetle. Forest growth rates appear to be a limiting factor in the transition of the large forest size class into the very large size class over the model period. If trends in the large size class remain consistent, over a longer time period (e.g., 60 or more years) an increase forestwide in very large forest size class might be expected, as a result of successional development of the large size class. Timber harvest may remove a small amount of forest in the very large size class, but compared to natural disturbances would be a very small impact. Old-growth forest is most likely to be in a very large forest size class, and forest plan components limit harvest in old-growth forest.

From most to least favorable, alternative C shows the greatest potential increase (1 percent forestwide, 6.6 percent on warm-dry, 12 percent increase on warm-moist) or the least potential decrease; followed by alternative D (3.5 percent increase on warm-dry, 11 percent on warm-moist), alternative B modified (2.9 percent increase on warm-dry, 11 percent on warm-moist) and alternative A (3.6 percent increase on warm-dry, 11 percent on warm-moist). This suggests that harvest patterns and types may have an increased level of influence on the very large size class relative to other size classes, probably related to the smaller overall area in this size class and its elevated contribution to other desired conditions and objectives, namely, economic value. Although alternative C has nearly as many average acres harvested per decade as the other alternatives, the model applied much less regeneration harvest than it did non-regeneration harvest (i.e., commercial thinning). Commercial thinning would result in an increase in forest size class, both by increasing growth rates and by removing smaller size trees, which bump up the size class category. However, actual treatments on the ground may or may not be of the same proportions as the model projected. Treatment prescriptions depend entirely on site-specific conditions and project objectives.

There are no modeling results available to determine the future conditions of very large tree presence; but knowing that the probability of very large trees being present is highest in the large and very large size

classes (refer to the analysis earlier in this section), the trends associated with these two size classes give an indication of the presence and trend of very large trees across the landscape into the future. The strong upward trend in the large tree size class across all areas of the Forest, and the smaller but still increasing trend of the very large forest size class in some portions of the Forest, suggest that the presence of individual very large trees across the landscape is at the least sustained near current conditions, and likely trending upwards over the model period, coinciding with the upward trend of the large size class.

Considering the pattern of past disturbances on the Forest that have created the current pattern of forest size and age classes, these model results for trends in forest size classes appear reasonable. It is reasonable to assume that with the continuation of vegetation succession and expected future disturbances, a portion of the forest in the currently abundant small and medium forest size classes (resulting from large disturbances 80-100 years ago) would continue to grow and transition into larger forest size classes over time. This process would continue relatively unaffected by active forest management (i.e., timber harvest) across the great majority of the Forest.

3.3.5 Forest density

Affected environment

Forest density is a measure of the area occupied by trees. The density of trees can influence the growth and vigor of individual trees in a forest stand and the susceptibility of the trees to drought, insects and disease, wildfires, and other disturbance events. It can influence the rate of forest succession and the composition of other plant species in the community. These factors in turn affect whether or not the stand is suitable habitat for certain wildlife species.

Tree density can be described quantitatively in various ways, such as number of trees or basal area per acre, which are common measures that are compiled at the site-specific level. At the Forest-level scale of analysis, using existing vegetation databases and to facilitate the analysis of the natural range of variation, tree canopy cover is used as a means to assess forest density. Tree canopy cover is defined as the percentage of ground covered by a vertical projection of the outermost perimeter of the tree crowns, considering trees of all heights.

Canopy cover is typically low when the stand is in the earliest stage of succession, when grass, forbs, and shrubs dominate the site and trees are in the seedling size class. As trees grow, crowns expand to fill up the growing space, and canopy cover gradually becomes greater. The growth of understory trees over time also adds to the canopy cover on many sites, especially as the forest grows into the later successional stages. Site productivity also affects canopy cover, with more productive, moist sites tending to support higher canopy cover and harsh sites with poor soils supporting lower canopy cover.

Four canopy cover classes are defined based on percentage of area covered by tree crowns:

Very low = less than 15 percent tree canopy cover

Low = 15 to 40 percent tree canopy cover

Moderate = 41 to 60 percent tree canopy cover

High = greater than 60 percent tree canopy cover

Refer to Barber et al. (2011), Brohman et al. (2005), and exhibits in the planning record (Trechsel, 2016c; USDA, 2015f) for detailed information on how forest stands are classified into canopy cover classes in the data sets used in this analysis.

The evaluation of the natural range of variation for canopy cover was completed using the SIMPPLLE model as well as considing historical fire regimes and disturbance patterns as they might have influenced forest density on the Flathead National Forest. A summary of this analysis follows. Refer to exhibits in the planning record (Henderson, 2017; Trechsel, 2016a, 2017f) for greater detail.

The relatively moist conditions across most of the Forest have the potential to support forests fully occupied by trees. Forests in the very low canopy cover class have historically been the least common type, usually occupying on average less than 20 percent of the Flathead. They were historically most common on the cold and the warm-dry potential vegetation types, both representing sites with lower productivities. Very open forests on the warm-dry types may also occur due to the more frequent and lower-severity fire regimes that were historically common.

Forests with low canopy cover, however, were historically relatively common forestwide, averaging about 30 percent of the area forestwide with a range of about 16 to 45 percent forestwide. They commonly occurred across 20 to 35 percent of the Forest on average, depending upon the potential vegetation type. Forests of low density are common in early-successional stages, where grasses, forbs, and shrubs still dominate and tree canopy closure has not yet occurred. They may also result from mixed- or moderate-severity fires or other disturbances that kill only some of the trees in the stand.

Moderate canopy cover is historically the most common forest density forestwide, occupying up to 50 percent of the Forest area. It is an especially high proportion of the total forest area in the cold potential vegetation types. Subalpine fir and spruce forests are likely the reason and can be relatively abundant in lower canopy layers, with (historically) an overstory of whitebark pine as well as spruce, subalpine fir, and lodgepole pine. Less frequent high-severity fire and more mixed-severity fire regimes also can perpetuate moderate canopy cover conditions.

High canopy cover forests may have occupied on up to 40 percent of the Florest historically, averaging about 25 percent of the area. However, high canopy cover forests on average comprised 50 percent of the warm-moist potential vegetation type, sometimes up to 70 percent of the area. This high density reflects the higher site productivity on this type. The cool-moist type also historically had about 30 percent on average of high canopy cover, which could range as high as 50 percent of the area. High canopy cover forests were uncommon on the cold potential vegetation type, normally occupying less than 20 percent of the area. This was likely due to the low site productivity of these higher-elevation lands.

Figure 27 to figure 31 display the current estimated area on Forest lands that are in the different canopy cover classes, forestwide and by potential vegetation type. The natural range of variation as modeled is displayed for the canopy cover classes as well. For all the figures and tables in this section, the source of the data for existing vegetation is Forest Inventory and Analysis (FIA) data using the R1 summary database (Hybrid 2011) analysis tools. The current proportion from this data set is expressed as an estimated mean percent, with a lower and upper bound estimate provided at a 90 percent confidence interval (abbreviated as CI in figures below).

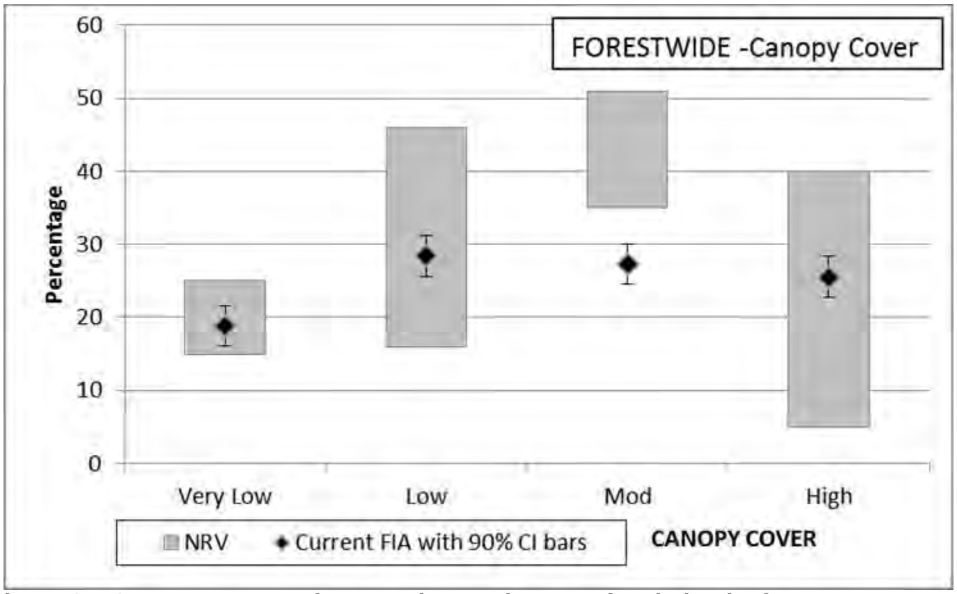

Figure 27. Current percent of area and natural range of variation by forest canopy cover class, forestwide

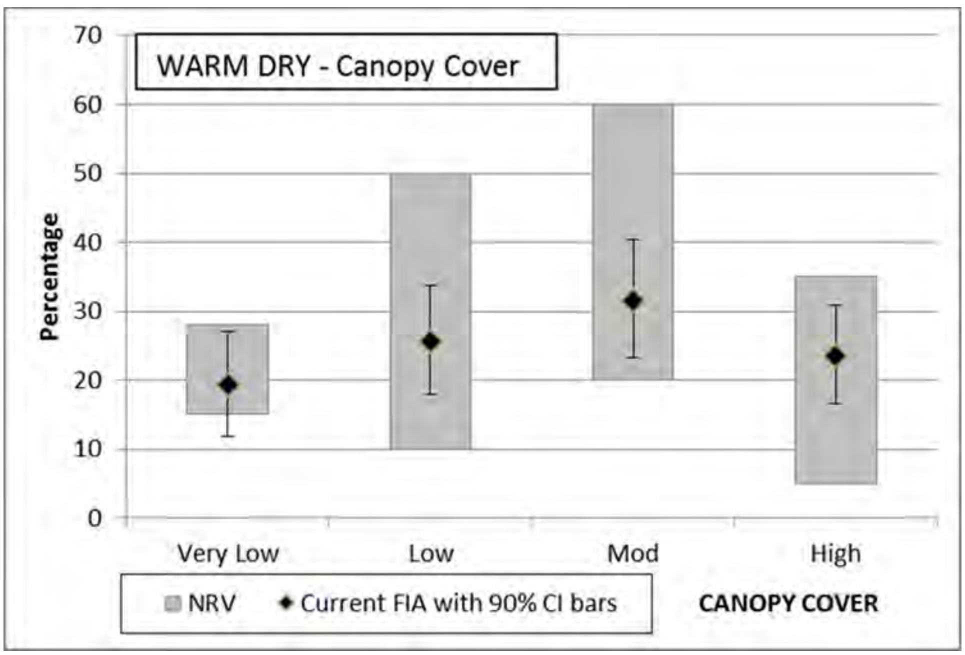

Figure 28. Current percent of area and natural range of variation by forest canopy cover class in the warm-dry potential vegetation type

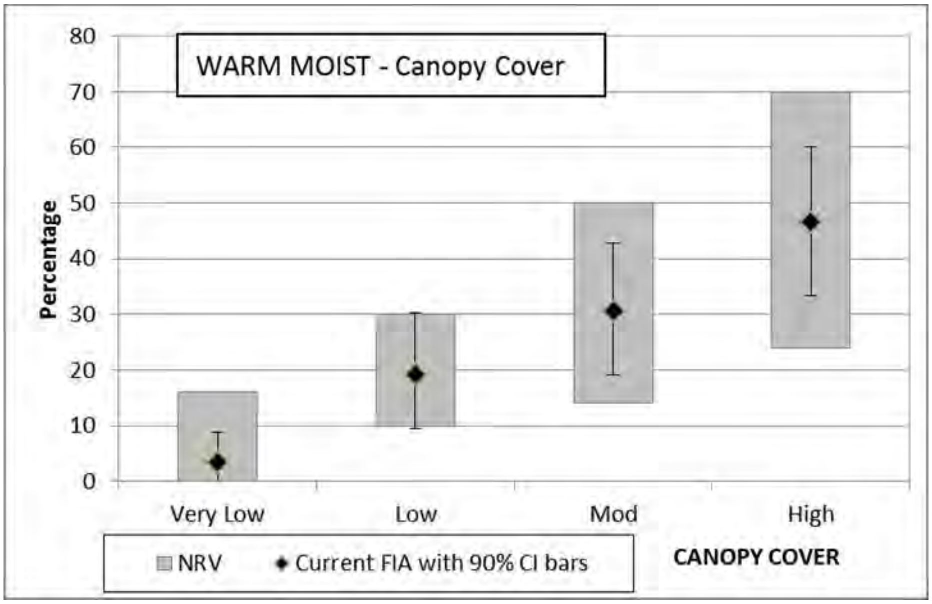

Figure 29. Current percent of area and natural range of variation by forest canopy cover class in the warm-moist potential vegetation type

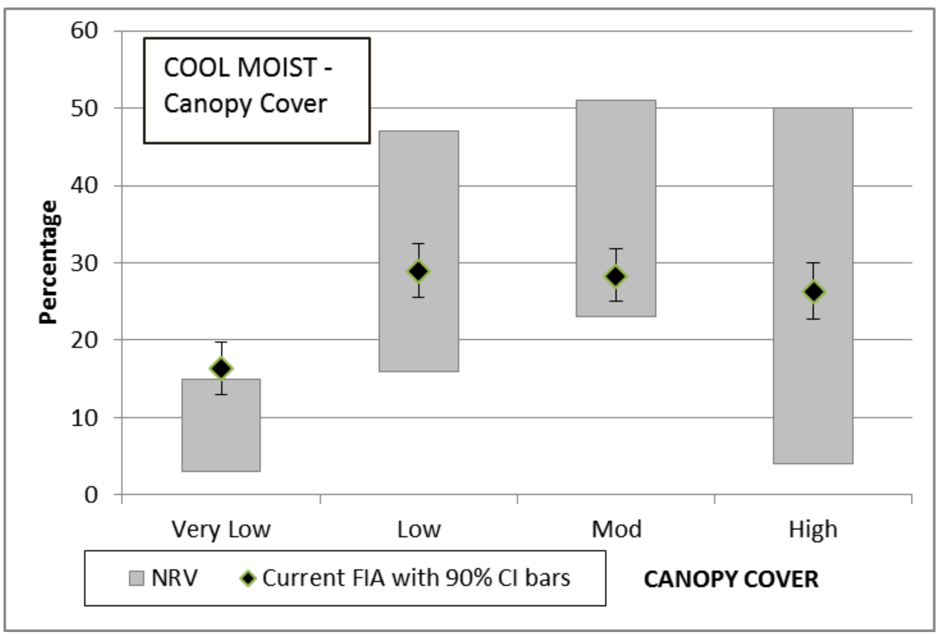

Figure 30. Current percent of area by forest canopy cover class in the cool-moist potential vegetation type

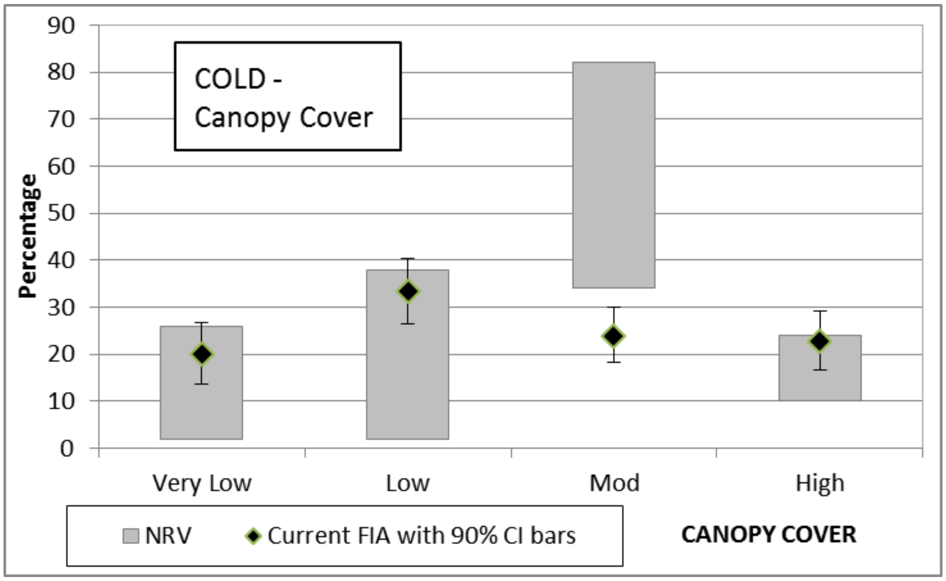

Figure 31. Current percent of area by forest canopy cover class in the cold potential vegetation type

Most of the Forest displays fairly similar amounts between the low, moderate, and high canopy cover classes among the potential vegetation types, following a similar curve as the natural range of variation. For the most part, densities fall within the estimated natural range of variation. The low proportion of moderate canopy cover forestwide is primarily tied to the conditions in the cold potential vegetation type, which could be the influence of the recent wildfires in these higher-elevation areas, killing most but not all of existing trees. The high level in the very low canopy cover for forests in the cool-moist type could also be related to the extensive recent fires, but in these areas they burned at high severity, and these are mostly forests in the very early stages of succession that are dominated by seedlings and saplings.

There are several ecological concerns associated with conditions or trends away from desired conditions for forest density. In general, the denser the forest the greater the likelihood that fuel characteristics could support a fast-moving, intense crown fire. This is a result not only of the greater fuel quantities in a dense forest but also of the vertical and horizontal continuity of fuels. Within wildland-urban interface areas in particular, lower forest densities are desired.

The susceptibility of a forest to insects and diseases is heavily influenced by density and its impact on tree vigor. As the density increases, a deficit of soil moisture develops and trees lose their ability to withstand attacks by insects, pathogens, and parasites (Safranyik, Nevill, & Morrison, 1998). Density-related tree mortality from insects, disease, and competition leads to increased dead fuel quantities and higher fuel hazards.

Forest density also influences tree species composition. Western larch and ponderosa pine are intolerant of shade and cannot survive in the lower canopy layers. Shade-tolerant species, such as subalpine fir grand fir, and spruce can prosper in dense stand conditions with limited light. Unless a disturbance (such as fire) reduces competition from these shade-tolerant species, species such as western larch and ponderosa pine will die out.

The desired condition is for a diversity of densities across the landscape that are consistent with natural disturbance patterns. Moderate and high canopy cover forests are desired across 50 to 75 percent of the forested area of the Flathead, and lower-density forests on 50 percent or less. The maximum level of moderate and high canopy forest is slightly less than the combined maximum natural range of variation

for these canopy cover classes. This is designed to manage for and emphasize the beneficial aspects of lower-density forests for improved tree growth and vigor, development of larger-diameter trees, lower forest fuel loadings, and increased resilience of stands in the face of potential future disturbances. The current amount of moderate and high canopy cover forests are about equal to the minimum 50 percent desired level. This level is within the natural range of variation and will maintain the forest densities that provide for desired wildlife habitat conditions that provide important cover and foraging for many species (including the Canada lynx). Lower densities are expected in areas of high concern for fire hazard, such as the wildland-urban interface. Current forest densities are expected to trend upward over the next few decades as forests recover in the recently burned areas and move out of the early-successional seedling/sapling forests into the small forest size class.

Environmental consequences

Effects of alternative A

The 1986 forest plan does not explicitly describe desired conditions for forest density or give direction to manage for any particular forest density conditions. The existing plan does incorporate an ecologically based approach to vegetation management, including managing for vegetation composition, structures, and patterns that would be expected to occur under natural succession and disturbance regimes and reducing the risk of undesirable fire, insect, and pathogen disturbances. Managing forest density could be one of the means to achieve this direction.

Effects common to alternatives B modified, C, and D

Based on the best available knowledge, the current densities of the forests on the Flathead National Forest are mostly consistent with and within the natural range of variation at the broad scale of the Forest, and the desire is to maintain the forest density within the natural range. The desired condition in the forest plan for forest densities (FW-DC-TE&V-13) focuses on retaining the current contribution of forest density conditions to the ecological, social, and economic desired conditions for the Forest, which vary depending on location and site-specific factors. These contributions include

- providing for the cover and foraging conditions that maintain desired wildlife habitat;
- maintaining densities at levels that facilitate the growth of individual trees into very large tree sizes and potential future old-growth forest;
- maintaining densities that provide for forest resilience, which is related to growing very large trees but is also related to simply reducing intertree competition and improving the vigor of trees and their resistance to insects and disease and drought;
- maintaining densities that reduce forest fuels and potential future fire severity; and
- maintaining densities that facilitate the development of forests of high economic value (for their forest products).

Compared to alternative A, this direction provides substantially more detail and clarity regarding the desired conditions for forest densities that, based on current knowledge, will maintain forest resilience and resistance as well as meet social and economic needs. Objectives in the forest plan specify the acres of treatments to achieve desired conditions, emphasizing the importance of active management in maintaining or achieving these conditions.

In contrast to the existing 1986 forest plan, in the forest plan, desired conditions for certain key ecosystem components are developed in a manner whereby reliable and repeatable monitoring of existing conditions and trends over time is possible, and the monitoring plan reflects this. Measurable monitoring

components are important for determining how management activities and ecological processes, including climate change, may be influencing vegetation conditions and the achievement of desired conditions over time.

Modeled comparison—Future forest density by alternative

This section discusses and compares the projected future conditions by alternative resulting from the simulation modeling process (SIMPPLLE model). It discusses these conditions in the context of how they may or may not maintain or improve overall forest resilience and resistance, which is a key component of the Forest's strategy for responding to future uncertainties such as climate change. Listed below is a primary measurable vegetation component related to forest density that would contribute to the overall Forest strategy and for which vegetation modeling methods were employed to aid in the evaluation of alternatives.

- Reduction in high-density forest conditions where appropriate, focusing on the wildland-urban interface and the warm-dry and cold potential vegetation types

Note that, as explained earlier in the section on the methodology and analysis process, model results are not objectives for plan implementation but merely a useful indicator and tool to assess how vegetation may change over time. Model outputs are of greatest value for comparison among alternatives and are not intended to be predictive or to produce precise values for vegetation conditions. Model outputs augment other sources of information, including research and professional knowledge of how ecosystem processes (such as succession) and disturbances/stressors (such as fire, insects, harvest, and climate) might influence changes in vegetation conditions over time, especially at the scale of the Forest. Refer to section 3.3.1 and to planning record exhibits referenced in that section for additional details on model development and results. Refer to appendix 2 for figures that portray graphically the model results discussed below for vegetation components at the fifth decade compared to the existing and desired condition.

Results: Forestwide, the trends and changes in canopy cover classes are desirable and bring the landscape closer to a desirable balance of density classes. All alternatives show a potential downward trend in the high canopy cover class forestwide, although the amount stays well within the desired range. This is associated with an increase primarily in the moderate canopy cover class, moving it to near or within the desired range. A similar trend and changes occur in the warm-moist and cool-moist types. These are generally favorable trends, as these types are likely to be the areas where moderate or lower density forest conditions would be beneficial across portions of the Forest, both for reducing tree stress, increasing tree growth and for reducing the amount of forest fuels and effects of fire. On the warm-moist type, the decrease in high-density forests is more substantial, moving to below desired minimum levels. However, moderate or lower-density forests are desirable on much of the area within this type, due to its location in lower elevation areas that are often within the wildland urban interface, and the desire to manage for forest structures that reflect a more mixed-severity fire regime and lower the potential for high severity fire. On the cold potential vegetation type, forests in the high-density category trend upward over time, going above the desired conditions, and this is associated with a downward trend in the moderate density to a level below the desired condition. This is not a favorable trend and is likely linked to natural disturbance processes and the natural succession of forests dominated by spruce and subalpine fir.

3.3.6 Old-growth forest

Introduction

Old growth is defined generically as an ecosystem or community of forest vegetation that is distinguished by old trees and related structural attributes (see glossary). Specific attributes and characteristics of old

growth vary substantially by ecological regions, forest types, local conditions, literature source, and a host of other factors. In October 1989, Forest Service Chief Dale Robertson directed regional foresters to develop definitions for old-growth forests specific to each Forest Service region as a way to increase consistency in the management of old-growth forests. This task was completed for the Northern Region of the Forest Service, with definitions of old-growth forest documented in a publication by Green et al. titled Old-Growth Forest Types of the Northern Region (Green et al., 2011). Old-growth forest as defined in this publication is the basis for the analysis and discussions in this EIS of the affected environment and environmental consequences of the forest plan.

Old-growth forest is defined as a community of forest vegetation that is distinguished by sufficient numbers of large, old trees and by stand densities and related structural attributes occurring at levels that meet the definitions established for the Northern Region of the Forest Service in Green et al. (2011). Old-growth forest definitions vary by habitat type grouping. Old-growth forest provides habitat for old-growth associated species, including invertebrates, mammals, and bird species. The primary statistically measurable criteria that define old-growth forest in the Northern Region are basal area and trees per acre above a certain size (d.b.h.) and age. Associated structural attributes in old-growth forest include amounts of dead, broken-top, or decayed trees, amount and size of downed wood, and number of canopy layers (table 24).

To qualify as old-growth forest, a stand usually meets a minimum basal area and contains a minimum number of trees above a certain d.b.h. and age, which vary by habitat type groups (e.g., potential vegetation types). However, not all old-growth forest needs to meet the minimum thresholds for these measurable criteria, as clarified in Green et al. (2011, pp. 11-12). This is due to a number of reasons, including the recognition that there are often uncertainties associated with sampling and statistical processes, as well as potential sampling errors or biases that may be influencing the results such that minimum criteria cannot be reliably determined. The numbers provided by various sampling methods are estimates, not absolutes. This approach also acknowledges that there is wide variation in old-growth forest structures and that no set of minimum numerical criteria can be relied on to identify all stands that fully function as habitat for old-growth-associated wildlife species.

The application of ecological concepts to the real world is rarely a black-and-white situation. Although quantifiable criteria are an important basis for determining old-growth forest, there is great variation in forest structures and associated characteristics that could and should be integrated into the determination at the site-specific level. This determination should occur cooperatively by the Forest Service wildlife and vegetation specialists, integrating their professional knowledge and judgment with information from field surveys, which may include statistical surveys, transects, or walk-through exams.

The statistically quantifiable and measurable key characteristics that define old-growth forest (basal area, trees per acre, d.b.h., and age) provide the means to monitor existing amounts and trends of old-growth forest over time at the broad scale and to know the reliability of the estimates. This is an important basis of the adaptive management approach to monitoring that the Flathead is incorporating in the forest plan for determining how management activities and ecological processes may be influencing old growth and the achievement of desired conditions over time. Although the minimum numerical criteria in the Green et al. publication (2011) are not absolutes in terms of defining old-growth forest, they do reflect conditions that would be expected in most situations to indicate stands with older forest characteristics that would provide values associated with old growth.

As mentioned earlier, field inventory is necessary to identify old-growth forest on the ground and to confirm the conditions of such necessary features as the size, age, and density of large, old trees. This has to be done at the project level because it is infeasible to maintain a field inventory that covers every acre within a large analysis area such as a national forest for the purpose of determining the exact amount and

location of old-growth forest. Therefore, to conduct an analysis in support of the forest plan and to monitor changes in old-growth forest over time to evaluate the effects of management and natural disturbances, another method to estimate old-growth conditions is necessary. Estimates of old-growth forest are compiled using Forest Inventory and Analysis plot-level data and applying the minimum measurable criteria (basal area and trees per acre above a certain age and certain d.b.h) for old-growth forest definitions as displayed in table 24 (R. Bush, Berglund, Leach, Lundberg, & Zack, 2007; Czaplewski, 2004). Also refer to Trechsel (2016c) for more information on the Forest Inventory and Analysis database.

Refer to the glossary for the definition of old-growth forest and to section 3.7.4 for discussion and analysis of old-growth forest related to its benefits and values to wildlife species.

Affected environment

Old-growth forest, like all forest conditions, is dynamic, with stands moving into and out of old-growth forest conditions and the proportion and distribution of old-growth forest across the landscape changing naturally over time. Although all old-growth forest is late-successional forest, not all late-successional forest qualifies as old-growth forest. As described in the introduction to this section, old-growth forest is specifically defined for the Northern Region. Green et al. (2011) contains the complete documentation and details related to old-growth forest definitions, the analysis process used to develop the old-growth forest classifications for the Northern Region, and how the definitions should be applied. Table 24 provides a summary of old-growth forest characteristics for the old-growth forest types that may be present on the Flathead National Forest. Old-growth forest types in the table refer to a group of forest cover types that have similar characteristics relative to size, number and age of dominant overstory trees. Forest cover types are assigned to the tree species with plurality of basal area for trees equal to or greater than 9 inches d.b.h.

Old-growth forest is one component of the shifting mosaic of stand conditions across the Flathead National Forest's ecosystem. The time it takes for a forest stand to develop into old-growth forest conditions depends on many local variables, such as forest composition, density, habitat type, and climate. Natural chance events involving forces of nature such as weather, insects, disease, fire, and the actions of humans, such as harvest, also affect the rate of development of old-growth forest conditions. Under the natural disturbance regimes of the Flathead, old-growth forest can develop through multiple different successional pathways, usually with fire and other disturbances along the way. Mixed severity and stand-replacement fire regimes are the most common on the Flathead, with historical fire frequencies from 35 to 100 years most prevalent (see section 3.8). Although there are pockets and areas that may not have fire events for many centuries, the likelihood of any particular forest stand to experience within 100 to 150 years a moderate- to high-severity wildfire where most or all existing trees are killed is relatively high. However, even within the boundaries of large stand-replacing fires, there are often small pockets or islands of forest that burn less severely, through chance or because of site specific conditions such as pockets of lower tree densities, less downed woody fuels, and/or more sheltered or moist site conditions. Lower-severity fires may kill fire-sensitive species, particularly subalpine fir, Engelmann spruce, and grand fir, but not the fire-resistant species. Thus, because of the frequency of fire in this ecosystem, a common successional pathway for old-growth forest development on the Forest involves the survival of a sufficient number of trees after a fire and the regeneration of a new forest under the canopy of the surviving trees. The overstory trees continue to grow and develop into the very large, old trees that are key components of old-growth forests. The mid- and understory trees, along with the snags and downed wood from the fire, contribute structural diversity and may themselves grow and develop into old, overstory tree layers themselves. If they, too, are fire-resistant species, then there is the potential that some of them will survive the inevitable next fire event.

Table 24. Western Montana Zone (Flathead, Lolo, and Kootenai National Forests) old-growth forest characteristics (based on Green et al., 2011, Feb. 2005 errata edit)

Old-growth forest type[a]	Habitat type group[b]	Minimum criterion: age of large trees (above the minimum d.b.h.)	Minimum criterion: number of trees per acre by d.b.h.	Minimum criterion: basal area (sqft/acre)	d.b.h. variation[d]	Percent dead/ broken top[c]	Proba-bility of downed woody[d]	Percent decay[c]	Number canopy layers[e]	Snags ≥ 9 inches d.b.h.[c]	Number of samples[f]	Flathead National Forest potential vegetation types[g]
1–PP, DF, L, GF, LP	A, B	170	8 ≥ 21”	60	M	12 3-23	L-M	5 0-11	SINGLE	6 0-22	4,847	WD
2–DF, L, PP, SAF, GF	C	170	8 ≥ 21”	80	H	11 0-21	M	5 2-12	SINGLE/ MULTIPLE	7 2-37	2,505	WD
3–LP	C, D, E, F, G, H	140	10 ≥ 13”	60/70/80[h]	L	11 5-2	H	6 2-15	SINGLE	19 0-92	2,648	WD, WM, CM
4–SAF, DF, GF, C, L, PP, WP, WH	D, E, F	180	10 ≥ 21”	80	H	9 0-19	H	9 1-31	SINGLE/ MULTIPLE	15 2-43	13,867	WM, CM
5–SAF, DF, GF, L, PP, WP, WB	G, H	180	10 ≥ 17”	70/80[i]	M	9 1-18	H	6 0-12	MULTIPLE	12 3-36	4,053	WD, CM
6-–SAF, WB, DF, L	I	180	10 ≥ 13”	60	M	11 2-31	M	10 2-17	MULTIPLE	25 5-38	255	CO
7–LP	I	140	30 ≥ 9”	70	L	8 3-14	H	5 0-11	SINGLE	17 9-22	95	CO
8–SAF, WB/AL	J	180	20 ≥ 13”	80	M	12 10-14	M	5 0-8	SINGLE/ MULTIPLE	37 33-40	14	CO

a. Forest cover type species codes: PP=ponderosa pine; DF=Douglas-fir; L=western larch; GF=grand fir; LP=lodgepole pine; SAF=Engelmann spruce/subalpine fir; C=western redcedar; WP=western white pine; WH=western hemlock; WB=whitebark pine; AL=alpine larch

b. Habitat types that occur within these groups are found in Green et al. (2011).

c. These values are not minimum criteria. They are the range of means for trees ≥ 9” d.b.h. across plots within forests, forest types, or habitat type groups.

d. These are not minimum criteria. They are low, moderate, and high probabilities of abundant large downed woody material or variation in diameters based on stand condition expected to occur most frequently.

e. This is not a minimum criterion. The number of canopy layers can vary within an old-growth forest type based on age, relative abundance of different species, and successional stage.

f. Plot data from the Northern Region stand exam inventory.

g. Flathead National Forest-specific column added to Green’s table to show which potential vegetation types in the forest plan apply to the old-growth forest type. WD = warm-dry; WM = warm-moist; CM = cool-moist; CO = cold

h. In old-growth forest type 3, for basal area, 60 square feet/acre applies to habitat type group E for LP; 70 square feet/acre applies to habitat type group C for LP and habitat type group H for ES, AF, and WBP; 80 square feet/acre applies to all other habitat type and cover type combinations.

i. In old-growth forest type 5, for basal area, 70 square feet/acre applies to habitat type group H for SAF; 80 square feet/acre applies to all other habitat type and cover type combinations

This successional pathway is why fire-resistant tree species play a particularly important role—especially those that have achieved larger diameters—in the development of old-growth forests on the Forest. Species such as western larch, ponderosa pine, and, to a lesser degree, Douglas-fir and western white pine have the potential to survive low- to moderate-severity fire, sometimes even when they are smaller diameter (i.e., 10 to 15 inches d.b.h.). Although it may not occur for several centuries in some spots, forests across most of the Flathead will at some point experience a high-severity fire that kills event the fire-resistant, largest trees. Old-growth forest then reverts back to an early-successional stage and the successional process begins anew.

Existing old-growth forest conditions

Figure 32 and figure 33 display estimates of current old-growth forest acres on the Forest as derived from Forest Inventory and Analysis inventory data (Hybrid 2011). Following these is a discussion and description of current old-growth forest amounts and distribution and of the composition and structural characteristics associated with old-growth forests on the Forest.

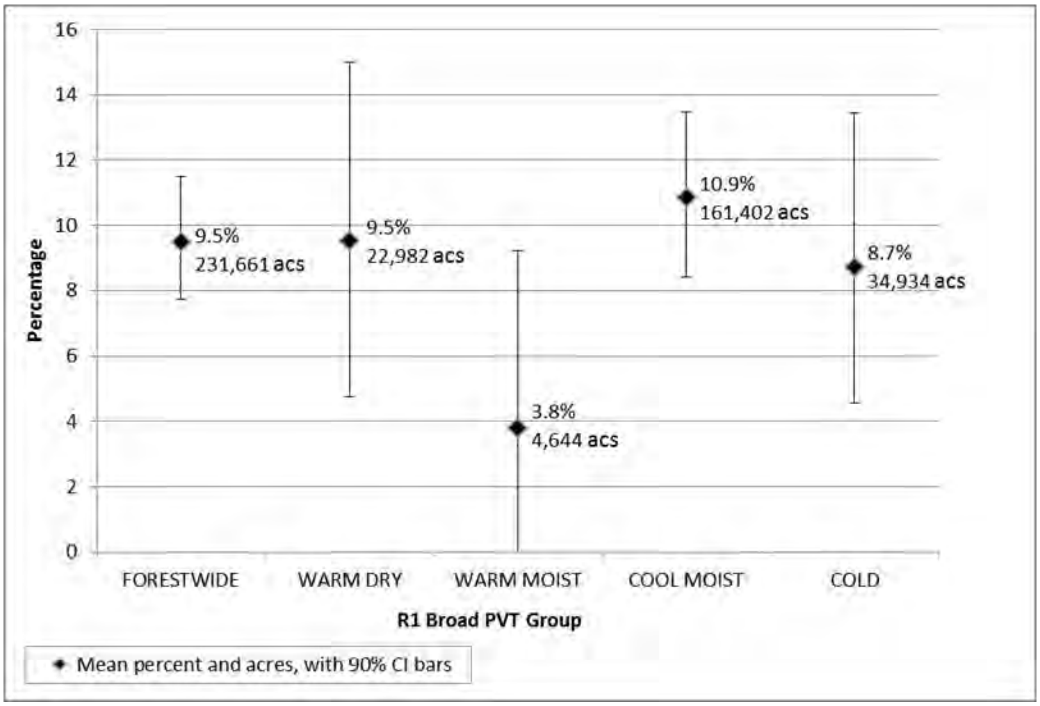

Figure 32. Current estimated acres and percent of old-growth forest forestwide and by potential vegetation type, on NFS lands (CI = confidence interval)

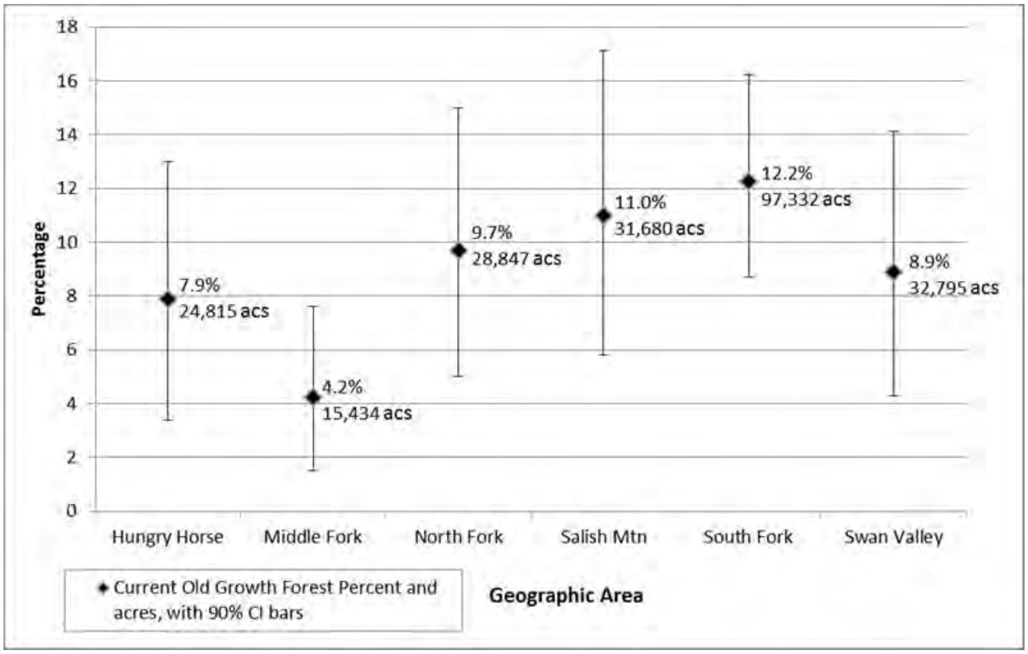

Figure 33. Current estimated acres and percent of old-growth forest by Flathead National Forest geographic areas on NFS lands (CI = confidence interval)

Old-growth forest conditions are not limited just to the stands that are classified as very large forest size class (e.g., dominated by very large trees). They also occur in the medium and large forest size class categories (see section 3.3.4 for descriptions of the forest size classes). The Flathead is characterized by a fire-dominated ecosystem, and the successional pathway described in the previous paragraph typically produces old-growth forest structures that are dominated by smaller, usually younger trees in the mid- and understory tree layers. Under the criteria for classifying forest size classes, these stands would be classified as medium or large forest size class rather than very large forest size class. Also, some of the forests in the very large tree size class are not necessarily composed of older trees but rather are younger trees (i.e., less than 140 years old) that have sustained good growth rates due to favorable stand density and/or site moisture and soil conditions. The R1 summary database (Forest Inventory and Analysis) was used to calculate the proportion of old-growth forest within the different forest size class categories, both to gain insight into where the old-growth forests occur on the Flathead and to allow for a means to gain insight into the natural range of variation (see the section titled “Historical old-growth forest conditions” later in this section). The results are as follows: 12 percent of the medium forest size class is old-growth forest, 28 percent of the large forest size class is old-growth forest, and 38 percent of the very large forest size class is old-growth forest (see Trechsel, 2017h). A very small amount (less than 1 percent) of the small forest size class, and none of the seedling/sapling size class, meets old-growth forest conditions.

As seen in figure 32, old-growth forest is fairly well distributed across the different potential vegetation types except that there is a substantially lower proportion of the warm-moist type in an old-growth forest condition. The warm-moist type occupies the smallest proportion of the forest (less than 5 percent of the Forest), and as can be seen in figure 32, the estimate on this type has somewhat lower reliability than on the others. However, the lower estimated amount of old-growth forest may also be due to the location of these sites. They tend to be in the lower-elevation areas, to be relatively accessible by roads, and to have a higher intensity of past timber harvest and fuel treatments (about

70 percent of the area lies in the wildland-urban interface). These factors have likely been at least partly responsible for the relatively low existing proportion of old-growth forest.

The distribution of old-growth forest varies across the Forest, as can be seen in the proportion by geographic area (figure 33). This variation can be largely linked to different historical fire severities and patterns; different levels of human activities; and variation in site conditions related to the capability and potential for forests to develop into old-growth forest conditions.

The South Fork and Salish Mountains geographic areas represent two very dramatically different landscapes, with very different disturbance histories and different site capabilities, and both have higher proportions of old-growth forest compared to the other geographic areas. The South Fork geographic area has the highest. Over 85 percent of this geographic area is in designated wilderness, and thus human influences have much less influence. Large areas of the South Fork geographic area are higher-elevation sites (22 percent cold potential vegetation type) where, although they may be forested, the capability and potential to develop into old-growth forests is limited due to site conditions. In addition, fire history records suggest that half or more of the area within the South Fork geographic area has experienced wildfire (moderate to high severity) over the past 130 years, which undoubtedly burned up some old-growth forest. In contrast, more than 90 percent of the Salish Mountains geographic area is within management areas that are suitable for timber production, and nearly 50 percent of the area has had some type of timber harvest activity in the past. Records suggest that perhaps one quarter of the Salish Mountains geographic area has experienced moderate- to high-severity fire over the past 130 years. Also, most of this geographic areas is characterized by relatively productive sites (99 percent cool-moist, warm-dry, or warm-moist potential vegetation types) that support a wide variety of conifer species; these sites are capable of developing into old-growth forest given the opportunity. It is reasonable to assume that human activities (e.g., timber harvest) has had a major influence on the amount of old-growth forest within the Salish Mountains geographic area, certainly removing some old-growth forest but also perhaps allowing other areas to develop into old-growth forest through fire suppression activities. It is also reasonable to assume that natural disturbances, mainly fire, has been a major influence and limiting factor on old-growth forest development in the South Fork geographic area.

Similar to the South Fork geographic area, in the Middle Fork geographic area over 80 percent of the land area is within designated wilderness, although it has a substantially lower proportion in old-growth forest compared to the South Fork geographic area. This low proportion is tied to a relatively high proportion of cold potential vegetation types (15 percent of the area) and to the fire history. Records suggest that about two thirds of the area experienced moderate- to high-severity fires in the last 130 years, which undoubtedly burned up some old-growth forest.

Another important feature of old-growth forest, particularly in regard to its importance to wildlife habitat and connectivity, is its spatial arrangement and patch size. Because the Forest does not have the data to spatially map old-growth forest, the pattern cannot be quantitatively described. However, as with the amount, the pattern of old-growth forest is likely to vary across the Forest as influenced by both human and natural disturbances. In addition, old-growth forest that may have existed on lands within the boundaries of the Flathead National Forest that are not NFS lands has largely been removed over the past 120 years or more through harvest or conversion of lands to other uses, such as agriculture. The average size of the remaining old-growth forest patches on all land ownerships is likely less than it was in the recent past, particularly in areas where large patches have been fragmented by harvest or development patterns.

It is clear that fire is a primary natural disturbance that removes old-growth forest from the ecosystem. Although exactly how much old-growth forest was harvested or burned up over the past

130 years of fire history records cannot be calculated, it is possible to estimate the amount of old-growth forest that was lost due to the most recent period of large-scale fire events on the Flathead. Since 1995, approximately 350,000 acres of NFS lands within the boundaries of the Flathead National Forest have been burned by fire, mostly stand-replacing burns (USDA, 2014a; see also section 3.8 of this EIS). It has been about 100 years since the Forest has experienced this amount of fire. The modeling and evaluation of historical fire records suggests that the amount of fire since 1995 was within the natural range of variation on the Forest but at the maximum level (Trechsel, 2017f).

Old-growth forest estimates forestwide derived from Forest Inventory and Analysis plots measured before 1995 (Forest Inventory and Analysis Hybrid 2007 database) were compared with the updated Forest Inventory and Analysis plot data inventoried mostly during or immediately after the fire events (Forest Inventory and Analysis Hybrid 2011 database) to estimate how much old-growth forest was lost due to these recent fire events (Trechsel, 2017h). Approximately 267,447 acres (11.8 percent forestwide) of old-growth forest was estimated to occur forestwide using the Hybrid 2007 data set (mostly pre-1995 data; fire plots not removed from estimates). Approximately 231,661 acres (9.5 percent forestwide) of old-growth forest was estimated to occur about 15 years later using the Hybrid 2011 data set (mostly 2003-2011 plot data; fire plots not removed from estimates). In the Hybrid 2011 data set, an additional approximately 16,300 acres are known to be affected by fire but have not yet been remeasured. Thus, about 52,086 acres of old-growth forest was affected by fire since 1995 (about 15 percent of the total burned area), and most if not all no longer meets old-growth forest conditions. This leaves approximately 215,400 acres of old-growth forest currently existing forestwide, or about 9.2 percent of the Flathead, a decrease of about 2.6 percent over the past 15 years due mainly to fire. No old-growth forest on the Forest has been removed through harvest treatments for at least 15 years because old-growth forest removal through harvesting has been prohibited in plan direction since 1999. Some additions to old-growth forest probably occurred during that time period as well through natural succession across unburned lands, so this represents a conservative estimate of loss of old-growth forest over this time period.

Old-growth forest character

Old-growth forest character can vary depending on site capabilities (e.g., potential vegetation type) and on other factors unique to the site, such as disturbance history. Descriptions of typical old-growth forest conditions may be found in the regional old-growth forest publication (Green et al., 2011). Brief descriptions of a typical species composition and forest structure in existing old-growth forest and habitat on the Forest follow below.

The long-lived, early-successional, fire-tolerant tree species play a particularly critical role in the successional process and development of old-growth forests on the Flathead National Forest. These are the trees that have a chance of surviving moderate- and even high-severity fires and that also have adaptations that enable them to regenerate and grow rapidly in burned forest conditions. These species include western larch, ponderosa pine, and western white pine, as well as Douglas-fir and whitebark pine on some sites. Individual trees of these species can persist on some sites well into the late-successional stages. They become the large-diameter old trees that are key features of the old-growth forest and habitat condition. See also the discussion under section 3.3.4, subsection "Very large live trees."

Old-growth forest conditions on the warm-dry potential vegetation type contain large-diameter, old, overstory Douglas-fir and ponderosa pine, with minor amounts of western larch on some sites. Typically, there are at least eight trees per acre greater than 21 inches d.b.h. and greater than 170 years old. A relatively open overstory canopy exists, but Douglas-fir can often be dense in the mid-

and understory canopy layers—a condition resulting from lack of disturbance, which thins out the smaller-diameter Douglas-fir. When this more dense condition occurs, the large, older Douglas-fir and ponderosa pine become more susceptible to mortality caused either by the Douglas-fir beetle or the western pine beetle, respectively, thereby possibly changing old-growth forest characteristics.

Old-growth forest on the warm-moist types have the widest range of species that may comprise the overstory tree layer, including western larch, Douglas-fir, western white pine, ponderosa pine, Engelmann spruce, and western red cedar. Typically, at least 10 trees per acre greater than 21 inches d.b.h. and greater than 180 years old occur. Forests are usually dense and multicanopy, with understory tree layers mostly composed of the more shade-tolerant species such as grand fir, cedar, and Douglas-fir. Subalpine fir and Engelmann spruce may also occur in the understory layers.

Western larch, Douglas-fir, and Engelmann spruce are the dominant large-diameter old trees within old-growth forests on the cool-moist type. Typically, at least 10 trees per acre of old trees (minimum age 180 years) occur, with the minimum size of the old trees ranging from 17 inches d.b.h. on the drier sites to 20 inches d.b.h. on the moist sites. These forests are typically dense and have with multicanopy layers, with subalpine fir and Engelmann spruce the most common mid- and understory tree species.

Engelmann spruce and subalpine fir are the most common large old overstory tree in old-growth forests on the cold potential vegetation type, although in a few rare situations there may still be a few scattered, large old whitebark pine present (that have not yet been killed by blister rust or bark beetles). Because of the cold, harsh growing conditions, tree growth is slower and old trees are smaller than in old-growth forests at lower elevations. Old-growth forests in these cold types typically have a minimum of 10 trees per acre greater than 13 inches d.b.h. and greater than 180 years old. They are usually multicanopy layers, although overall tree density may be low. Subalpine fir and spruce dominate in the mid- and lower canopy layers.

Historical old-growth forest conditions

There are a variety of means to gain some understanding of historical conditions of old-growth forest, including dendroecology (using dated tree rings and fire scars to analyze historic ecological processes), forest structural information, stand-level pollen records, historical records, and landscape simulation modeling. Although these methods can provide useful insights, the quantification of historical amounts of old-growth forest and the natural range of variation is problematic because of the site specificity of the old-growth forest definitions and the need for field inventory to confirm its presence and location.

Evaluating existing old-growth forest conditions within wilderness and large unroaded areas can contribute to an understanding of historical conditions that might be expected to occur under natural disturbance regimes. Using Forest Inventory and Analysis data, it is estimated that the proportion of old-growth forest within wilderness and inventoried roadless areas on the Forest is nearly the same as the proportion outside these areas (table 25). This could be interpreted to mean that only a relatively small impact on old-growth forest outside wilderness might be attributed to increased amounts of human activities. However, this interpretation must be balanced against the difference in site capabilities inside and outside wilderness as well as differences in disturbances. For example, the higher proportion of cold, high-elevation lands within wilderness and inventoried roadless areas lowers the proportion of lands that are most capable of developing into old-growth forest. Old-growth forest has undoubtedly been removed through timber harvest on lands outside the wilderness and inventoried roadless areas; however, fire has also removed old-growth forest. Large acreages of fire over the past 130 years have removed old-growth forest in wilderness and inventoried roadless

areas. Fire exclusion and suppression efforts, particularly outside wilderness areas, may have kept some old-growth forest from being burned up over this time period. Because of these complexities, estimating historical conditions for old-growth forest based on current conditions inside and outside wilderness and inventoried roadless areas is likely subject to a high degree of uncertainty.

Table 25. Current estimated acres and percent of old-growth forest inside and outside wilderness and inventoried roadless areas on Flathead National Forest lands (data source: Forest Inventory and Analysis Hybrid 2011 database)

Amount	Inside Wilderness and Inventoried Roadless Areas	Outside Wilderness and Inventoried Roadless Areas
Acres of old-growth forest	150,549 acres	83,089 acres
Percent of old-growth forest	9.4%	9.7%
Total acres within estimate area	1,567,290 acres	836,519 acres

Because of the site-specificity of old-growth forest as defined and applied in the Flathead forest plan, estimating the natural range of variation for old-growth forest is problematic and cannot be directly accomplished through a modeling process as was done for other vegetation attributes. However, an indirect approximation of the natural range of variation for old-growth forest may be achieved by using the modeled natural range of variation completed for the forest size classes, as reflected in the desired conditions developed for size classes (see earlier section 3.3.5 and Trechsel, 2017f). As discussed earlier, current estimates using Forest Inventory and Analysis data sets indicate that 12 percent of the medium forest size class, 28 percent of the large forest size class, and 38 percent of the very large forest size class is estimated to be old-growth forest. These percentages were applied across the modeled natural range of variation for the forest size classes (the minimum, maximum, and average proportions of the forest size class forestwide) to approximate a possible natural range of variation for old-growth forest across the Flathead National Forest. Of course, this approach assumes that the current percentage of old-growth forest within the medium, large, and very large forest size classes would not change over time, which of course is not the case, so interpretation of analysis results must be made with care. However, this analysis can contribute to greater understanding and insight into historical old-growth forest conditions. This analysis process results in an approximation of the natural range of variation for old-growth forest as between 8 to 20 percent of the Forest, with an average of 14 percent forestwide. Refer to Trechsel (2017h) for additional information. The current amount of old-growth forest is estimated at 9.5 percent forestwide, which is within but at the low end of this approximation of the natural range of variation. These results seem reasonable considering the effects of recent natural disturbances and human activities on old-growth forest discussed earlier, leading to the assumption that the current proportion of old-growth forest is likely relatively low compared to historical conditions.

Environmental consequences

The common successional pathways and structure of old-growth forest as discussed in the “Affected environment” section and its close connection to disturbances (particularly fire) and to the presence of fire-resistant tree species render this forest structural type especially vulnerable to loss in possible future climatic scenarios, for example, if fire increases in frequency, extent, and/or severity due to warming climate. It could be argued there is not a great deal the Forest (as a land manager) can do to correct or remedy this situation at the Forest level, especially considering that about 65 percent of the Flathead is within wilderness areas or large, unroaded areas where natural processes (i.e., fire) have played and will continue to play a large role in affecting vegetation. However, the direction in the

forest plan is designed to focus attention on those areas where the Forest may have some ability to influence old-growth forest conditions now and into the future.

Effects of alternative A

The existing 1986 forest plan has direction for old-growth forest management that focuses on the maintenance and protection of existing old-growth forest across the landscape and managing for desired old-growth forest amounts and patterns into the future. This direction has been in place on the Flathead National Forest since 1999, with the completion of amendment 21 to the 1986 forest plan. Thus, no old-growth forest has been removed through harvesting on the Forest since 1999. Table 26 compares the existing forest plan direction with that of the action alternatives.

Effects common to alternatives B modified, C, and D

All action alternatives have the same forest plan direction related to old-growth forest. The forest plan integrates and is consistent with existing 1986 forest plan direction for old-growth forest that addresses the protection of existing old growth (it may not be removed through harvest) and managing for future old growth. The forest plan direction provides more clarity than the 1986 forest plan on the desired conditions for old-growth forests, including a focus on the resilience and resistance of old-growth forest to potential future disturbances and climate change and on the importance of old-growth forest connectivity to provide for the needs of old-growth-associated wildlife. The forest plan recognizes the dynamic nature of old-growth forest across the landscape and its vulnerability to loss due to fire and other natural disturbances and emphasizes the need to consider treatment of stands in ways that promote old-growth forest development over time.

Table 26 provides a comparison and discussion of the forest plan direction related to old-growth forest between the existing 1986 forest plan and the forest plan action alternatives.

The action alternatives include the desired condition to maintain the existing amount of old-growth forest, and this functions as a minimum desired amount of old-growth forest. This approach replaces the goal in the current 1986 forest plan that directs the Forest to manage for old-growth forest at “75% range around the median of the historical range of variability.” The current amount of old-growth forest is estimated at 9.5 percent forestwide, which is within but at the low end of the best estimate available for the natural range of variation (see “Historical old-growth forest conditions” above). This forest plan direction, in conjunction with the standards and guidelines that limit treatments and activities within old-growth forest (see table 26) provides protection to current old-growth forest from potential impacts of human activities.

All the action alternatives contain a forest plan standard that restricts management activities within old-growth forest (FW-STD-TE&V-01). Vegetation management is limited to actions that do not result in the stand no longer qualifying as old-growth forest. No loss of old-growth forest should occur under the action alternatives due to timber harvest activity. However, the plan also acknowledges the naturally dynamic nature of old-growth forest over time and the fact that natural disturbances, such as fire, insects and disease, will continue to result in loss of old-growth forest in the future. Perpetuating old-growth forests in dynamic landscapes will require a combination of conditions and diversity within stands and across the landscape that enhance resilience and repetition of these stand conditions across the landscape (Salwasser, 2009). Forests moving through succession into the older stages need to be present across the landscape to replace old-growth forests that are removed through stand-replacing disturbances such as fire.

Table 26. Comparison and discussion of different forest plan components by alternative for old-growth forest.

Category	1986 forest plan (alternative A)	Forest plan (alternatives B modified, C, and D)
Protection of existing old-growth forest	"Protect old growth, consistent with vegetation standard H(6)."[1] Vegetation standard H(6) states "Maintain or restore existing old-growth forest consistent with Wildlife and Fish objectives and standards."[2] and (b) limits vegetation management within old-growth forest to actions that would maintain or restore composition and structure consistent with native disturbance regimes or actions that would reduce risks to sustaining old growth. Provides exceptions to vegetation standard H(6) by stating that the standard "does not apply to personal-use firewood permits; tree removal to protect health and safety in administrative and recreational special-use areas; tree removal necessary for trail or trailhead construction; or legally required private land access."[2]	Standard FW-STD-TE&V-01 addresses old-growth forest and habitat conditions and is consistent with the direction in the 1986 forest plan. "In old-growth forest, vegetation management activities must not modify the characteristics of the stand to the extent that stand density (basal area) and trees per acre above a specific size and age class are reduced to below the minimum criteria in Green et al. (2011). Vegetation management within old-growth forest shall be limited to actions that: (1) maintain or promote old-growth forest characteristics and ecosystem processes; (2) increase resistance and resilience of old-growth forest to disturbances or stressors that may have negative impacts on old-growth characteristics (such as severe drought, high-severity fire, epidemic bark beetle infestations); (3) reduce fuel hazards in the wildland-urban interface; or (4) address human safety."
Protection of existing old-growth forest	"Road construction associated with vegetation management shall avoid or minimize impacts to old growth to the extent feasible."[2]	FW-GDL-TE&V-07: "To maintain connectivity and avoid adverse impacts to old-growth forest, new road construction or reconstruction should not be located within old-growth forest. Exceptions may occur, such as when there are no feasible alternatives to road locations."
Management of old-growth forest at the landscape-level and over time	Forestwide objectives for vegetation,[3] at the stand level, provide extensive guidance on managing for desired late seral and old-growth forest compositions and structures within each potential vegetation type. Forestwide goals[4] and objectives[5] for vegetation at the landscape level specifies managing landscapes to "attain the 75% range around the median amount of old growth that occurred historically" and to "actively manage to recruit additional old growth." Further guidance is provided in the objective to "manage landscape patterns to develop larger old-growth forest patch sizes where needed"; "restore the amount and distribution of old-growth forests to within the historical range of variability"; "prescribe landscape treatments that protect old-growth forests from disturbances that	The forest plan integrates these same concepts into numerous desired conditions for forest structures and compositions, both forestwide and within potential vegetation types. These include desired conditions for forest composition, size classes, large tree size class, old-growth forest, forest density, snags and downed wood, landscape patterns, and ecosystem processes (insects, disease, fire).[6] FW-DC-TE&V-14 provides desired conditions specifically for old-growth forest composition, structure and pattern, forestwide and by potential vegetation type. FW-GDL-TE&V-06 addresses patch size and the development of future old-growth forest when harvesting adjacent to existing old-growth forest. The direction states: "To increase the patch size of old-growth forest in the future, if managing vegetation within 300 feet of existing old-growth forest, treatment prescriptions that would promote the development of old-growth forest in the future should be considered. At a minimum, the following structural and composition components associated with old growth-forest

Category	1986 forest plan (alternative A)	Forest plan (alternatives B modified, C, and D)
	threaten old growth composition and structure." Treatments within existing old-growth forest "may be appropriate where current insect and disease conditions pose a major and immediate threat to other stands."	should be retained if present within at least 300 feet of the old-growth forest patch: • larger live trees (e.g., greater than 17 inches d.b.h.) of species and condition that will persist over time (such as western larch, ponderosa pine, Douglas-fir) and not cause unacceptable impacts to future stand conditions (e.g., dwarf mistletoe infection or potential dysgenic seed source); • large downed wood (greater than 9 inches diameter); and/or • snags and decayed, decadent trees greater than 15 inches d.b.h. No quantitative range for future desired conditions is provided specifically for old-growth forest because of the difficulty of determining a reliable natural range of variation to base this upon (as discussed in this EIS). FW-DC-TE&V-14 provides qualitative desired conditions for old-growth forest at the stand and landscape levels. This includes having old-growth forest and habitat that is resistant and resilient to future disturbances and is maintained at current levels or trending upward over time. Forest plan components related to the very large tree class and very large live trees, as well as guidelines for the retention of large live trees within harvest areas, complement and contribute to the development of the structural conditions desirable in old-growth forest (FW-DC-TE&V-10, 11, 12; FW-GDL-TE&V-09; FW-GDL-RMZ-09). Quantitative and qualitative desired conditions and guidelines for these forest size classes are provided based on analysis of the natural (i.e., historical) range of variation.

1. 1986 forest plan, Forest-Wide Standards, F(4), Wildlife and Fish—Old Growth and Cavity-Dependent Wildlife, p. II-35.
2. 1986 forest plan, Forest-Wide Standards, H(6), Vegetation—Old growth, p. II-48.
3. 1986 forest plan, Forest-Wide Objectives, 6(c), Vegetation—Forest Composition and Structure, Stand-level: Late Seral/Old Growth, p. II-10.
4. 1986 forest plan, Forest-Wide Resource Goals B(10), Old Growth, p. II-5.
5. 1986 forest plan, Forest-Wide Objectives, 6(c), Vegetation—Forest Composition and Structure, Landscape-level, p. II-9.
6. FW-DC-TE&V-DC 03, 04, and 07 through 25.

Managing for forest conditions that are capable of maintaining existing structures and/or recovering from future disturbances and have the ability to restore structure and composition over time is a key adaptation strategy for the management of all Flathead National Forest lands to address the uncertainties of the future, including those associated with climate change. Because old-growth forest is vulnerable to losses due to future disturbance, perhaps exacerbated by climate change, all the action alternatives have forest plan direction that emphasizes managing for the resilience of old-growth forest, as well as other forest conditions, at the landscape and stand levels (FW-DC-TE&V-14; FW-STD-TE&V-01). In the context of the fire regimes of the Flathead, managing for resilience means increasing tree species diversity, particularly increasing fire-resistant species, and managing for variable tree densities both within stands and across the landscape. Management techniques within old-growth forest may occur under forest plan direction, with the desired result of developing resistant or resilient old-growth forest conditions to increase the probability of maintaining the composition and structure where possible. If fire or other natural disturbance kills trees to the degree that the stand no longer meets old-growth forest conditions, a stand with a more resilient forest condition stand would have the capability to restore its previous composition and structure over time. For example, in the case of a fire event, there may be a few large-diameter trees of fire-resistant species that survive the fire and provide seed to regenerate a new forest of similar fire-resistant species composition, and this forest could, over time, develop into old-growth forest once again.

Although treatments in existing old-growth forest is a controversial approach, there is support in current literature for carefully designed silvicultural treatments as a valid approach in specific situations where needed to restore forest composition and structure so that fire can play its characteristic role (N. K. Johnson & Franklin, 2007; Noss, Franklin, Baker, Schoennagel, & Moyle, 2006; Salwasser, 2009). The forest plan direction allows for the treatment of old-growth forest, although it is not expected to be frequently employed due to the strict conditions under which treatment may occur (FW-STD-TE&V-01). Often these treatments are most needed on the drier forest types because these are where fire suppression and exclusion have most often created uncharacteristically dense forests and a high risk of high-severity fire. On the Flathead National Forest, these types of old-growth forest conditions occur primarily in the warm-dry potential vegetation type and on the drier portions of the warm-moist type where ponderosa pine, Douglas-fir, and, on some sites, western larch occur. Treatments to restore forest resilience could include reducing density with thinning in the mid- and understory tree layers, selective removal of overstory shade-tolerant species, and retaining large, old fire-tolerant species. These activities could reduce the risk of high-severity fire, provide for the growth of smaller, younger trees into larger, old overstory trees, and create gaps in the canopy that would allow establishment of new seedlings of fire-resistant species (J. K. Agee & Skinner, 2005; C. E. Fiedler, 2002; Jerry F. Franklin, Mitchell, & Palik, 2007; Kolb et al., 2007; T. A. Spies, Hemstrom, Youngblood, & Hummel, 2006). A number of other studies also suggest that forest resilience can be improved through a variety of silvicultural treatments while still retaining diversity of plant and animal species (Carl E. Fiedler, 2000; Fule, Crouse, Roccaforte, & Kalies, 2012; Lindh & Muir, 2004; Metlen & Fiedler, 2006; Ritchie, Wing, & Hamilton, 2008; S. L. Stephens, 1998; S. L. Stephens & Moghaddas, 2005; Youngblood, Metlen, & Coe, 2006; J. W. Zhang, Ritchie, & Oliver, 2008). Treatments can maintain sufficient stand structure in old forests to provide habitat requirements for cavity-nester species and a diversity of birds and small mammals as well as to maintain or improve understory plant diversity (Metlen & Fiedler, 2006; Steeger & Quesnel, 2003; Steventon, MacKenzie, & Mahon, 1998). However, there is some uncertainty associated with the treatment of old-growth forest for the purpose of improving forest conditions and resilience (W. L. Baker & Ehle, 2003; DellaSala et al., 2013).

Treatments in existing old-growth forest stands on the Flathead that occurred in 2010 and 2011 provide a local example for evaluating the potential benefits of treatment in old-growth forest.

Several stands were treated in the Swan Valley wildland-urban interface area with a selective cut followed by understory prescribed fire with the objectives of increasing resilience by reducing forest density and promoting open, large-tree stands, reducing the potential for stand-replacing fire, and reducing susceptibility to insects and disease, all while maintaining old-growth forest characteristics. As part of the monitoring plan, plots were establishing within units and control stands, and these were measured both before and after the treatments. A monitoring report published in 2015 (Renate Bush, 2015) indicates that the treatment objectives were largely achieved, with an increase in the proportion of desired fire-resistant species (ponderosa pine and western larch), an increase in the average d.b.h. of the stand, a decrease in stand density, maintenance or decrease in insect hazard ratings, and an overall reduction in fire hazard. An open forest condition dominated by large trees was created, as desired, with all but one plot still maintaining old-growth forest characteristics. The plot that did not maintain these conditions had a density (basal area) that was below the minimum required to meet old-growth forest criteria. With the continued growth of the overstory trees, it is expected that the basal area will increase and this stand will soon transition into old-growth forest conditions.

Promoting the development of future old-growth forest is also a key strategy on the Forest and in the forest plan's management direction as a means of addressing future uncertainties related to climate change and its effects on disturbances and old-growth forests (FW-GDL-TE&V-06). Actively managing current non-old-growth forests in ways that increase their potential to become old-growth forests in the future is a means to increase the probability that there will continue to be new old-growth forests coming up through the line through natural succession, at faster rates if possible and with the desired species compositions. Treatments would be applied based on an understanding of disturbance processes and the development of old-growth forest stand structures. Treatments in stands adjacent to existing old-growth forest may occur to facilitate larger patch sizes of old growth in the future. Management approaches that may be applied to achieve this direction are described in appendix C of the plan. Below are listed some examples of possible treatments:

- Develop thinning prescriptions for young (e.g., sapling) stands to promote species composition and stand structures favorable for the relatively rapid development of desirable future old-growth structures. Thinning provides a means of influencing species compositions (to favor fire-resistant species), growth rates (to enable trees to grow into larger size classes at a faster rate), and forest density and canopy structure (to retain shorter understory shade-tolerant trees but thin taller trees to facilitate both improved growth and diverse forest vertical structure).

- In mature forests, thin the main canopy layers where tree species and vigor is conducive, to improve tree growth and advance into very large size classes.

- Design a shelterwood harvest that retains the larger overstory trees and other old-growth forest structures and promote regeneration (planting or natural) to species that will contribute to the long-term development of desired old-growth forest structures and composition (such as western larch, ponderosa pine, western white pine, and Douglas-fir).

Forest plan direction includes desired conditions (FW-DC-TE&V-12, 15, 16, 17) and standards and guidelines (FW-STD-TE&V-03; FW-GDL-TE&V-09; FW-GDL-RMZ-01, 08, 10) that emphasize the importance of large-sized trees and other forest structural components (such as snags) important to wildlife habitat and that may contribute to potential future old-growth forest structures. These include retaining live trees within vegetation treatment units (particularly larger trees or trees capable of growing into larger trees) and placing more emphasis on leaving the larger downed wood and snags and live trees with decay.

Old-growth forest at the landscape scale is a part of the mosaic of vegetation conditions that provides for the desired connectivity of habitat for wildlife species (FW-DC-TE&V-19). Refer to section 3.7.6 for a discussion of wildlife habitat connectivity.

Future old-growth forest

The amount of future old-growth forest across the Flathead National Forest is dependent upon the balance that occurs between natural disturbance processes (especially moderate- to high-severity fire) and natural succession. Under all the alternatives, fire and other natural disturbances will continue to be the primary processes influencing the conditions of old-growth forest across the Forest due to the large portion of the Forest (at least 65 percent, see table 20) that is within wilderness, recommended wilderness, or backcountry management areas (the latter are predominantly inventoried roadless). Succession will continue to be the primary means by which old-growth forest is formed. Vegetation treatments that promote the development of old-growth forest over the long term and the retention of large, live trees within harvest units are management tools that would contribute to old-growth forest development in the areas where active management occurs, although this is a relatively small portion of the Forest.

Predictions for warmer springs and continuing warm, dry summers suggest that forests in the northern Rockies and the western United States will experience longer fire seasons with larger and potentially more severe fires in the future (see section 3.1.2). Existing old-growth forest on the Forest will be vulnerable to loss due to fire as well as to impacts from insects and disease. This is especially true in the wilderness and large unroaded areas, where fire (and other natural disturbances) is the primary process. Outside wilderness and inventoried roadless areas, fire use will also occur, although it is more likely that wildfires would be actively suppressed to protect other resource values. Fire exclusion and suppression in areas where a low- or mixed-severity historical fire regime is typical (e.g., on the warm-dry and some of the warm-moist potential vegetation types) can alter vegetation structure and composition in old-growth forest and other forest types and may make them more vulnerable to loss due to fire. Particularly on the warm-dry potential vegetation type, increasing tree densities, canopy layers, and proportions of Douglas-fir in many areas have increased tree stress and vulnerability to mortality from insects, pathogens, and high-intensity crown fires. In the absence of fire, insects and disease are responsible for about 75 percent of the changes in vegetation trends (Byler & Hagle, 2000).

In the context of the probable fire regimes in the future and the level of uncertainty and complexities associated with old-growth forest development through succession, it becomes difficult to predict future old-growth forest amounts or to determine whether these amounts will be consistent with the historical range of variation. Modeling results (see section 3.3.5) suggest that there will be a strong increase in the amount of area in the large forest size class by the fifth decade forestwide and within all potential vegetation types. The results also indicate that the amount of the very large size class will increase in the warm-dry and warm-moist potential vegetation types; stay relatively static compared to current conditions in the cold type and forestwide; and potentially decrease in the cool-moist type. The large and very large forest size classes likely contain the most old-growth forest, as explained in the “Existing old-growth forest conditions” section above. These results suggest that future disturbance levels (i.e., insect, disease, and fire) may not adversely impact the natural succession of forests into larger size classes and into old-growth forest conditions over at least the next five decades.

3.3.7 Snags and downed wood

Dead wood in the forest occurs both as standing dead trees (snags) and as fallen trees or other woody material that lies on the ground. A dead tree, from the time it dies until it is fully decomposed, contributes to many ecological processes (J. K. Brown et al., 2003). These include contributing to the biodiversity of forest life by being part of the life cycle of many animals, vertebrates and invertebrates, providing habitat for feeding, reproduction, and shelter. Dead wood plays an important role in protecting the soil, enhancing soil development, and maintaining soil productivity over the long term. Because snags and downed wood are so closely interconnected, they are discussed together in this section.

Affected environment

A detailed analysis of snag conditions and downed wood, including the estimate tables that were specifically used for this final EIS analysis and how they informed development of plan components for the forest plan, is found in Trechsel (2017i). A summary of snag conditions and key points from this analysis are included in this section of the final EIS.

Snags

Snags are naturally created over time as a result of various disturbance processes that kill trees (fire, insects, disease) and as a natural byproduct of succession, as trees die due to being crowded out by the more dominant trees. Different types of snags have different value to wildlife. They provide important nesting, feeding, perching, and roosting habitat for a wide variety of wildlife species, and they are a valuable component of old-growth and late-successional forest conditions. Refer to section 3.7 for details on snag characteristics and the value to wildlife species.

Snag densities, sizes, and distribution are influenced by the disturbance history (i.e., time and severity of the last fire or insect or disease outbreak) and on pre-existing forest conditions (i.e., size classes or species composition as it might relate to snag longevity). Snag patterns and conditions are highly complex and diverse, both spatially and temporally. Refer to Trechsel (2017i) for greater detail on snag dynamics and the variation on the Forest related to natural disturbance processes. This variability of snag conditions is not exclusive to the Flathead and is characteristic of the snag component in other ecosystems as well (Harris, 1999; Ohmann & Waddell, 2002). Snag longevity varies greatly, both among species and among individual trees of the same species. Longevity is tied to several factors, including size, species, cause of death, age of tree at death, rate of decay, and site characteristics (e.g., moisture, temperature).

Methodology and data sources

Because of the naturally wide variation in snag conditions both spatially and temporally, evaluating and managing for desired snag densities and other conditions (i.e., sizes, distribution) is best considered at a broad scale such as a watershed rather than a small scale such as a specific forest stand. Maintenance of a diversity of species requires a landscape perspective and a strategy that considers the diversity of habitat structures (Lyon, Huff, & Smith, 2000; Tobalske, Shearer, & Hutto, 1991).

The R1 summary database, produced from the Forest Inventory and Analysis program, is the source of estimates of snag conditions (densities and distribution) across the Forest (see Trechsel, 2016c for a description of the Forest Inventory and Analysis database). Snag estimates using the R1 summary database were provided for national forests across the Northern Region in a publication by Bollenbacher et al. in 2009 (Bollenbacher, Bush, & Lundberg, 2009), and this was the information used for the analysis in the draft EIS. New snag estimates were produced for the region in early 2017

(Trechsel, 2017i), following the same templates and using the same data source as the 2009 report except for the use of updated Forest Inventory and Analysis inventory data. Although not yet formally published, these new estimates were available and were used as the primary data source for the updated analysis of snags and downed wood in this final EIS.

For the purposes of understanding or determining a natural range of variation for snags, very little if any quantifiable historical data exists on snag densities or distribution, either at the stand or landscape scale. Using existing snag conditions to understand the natural range of variation can be misleading because of the influence of humans across the landscape (e.g., harvesting, firewood removal, fire suppression, etc.). Fortunately, there are large landscapes on the Flathead and in the Northern Region region that have been relatively “untouched” by human activities affecting snags. These areas are the wilderness areas and large unroaded lands (i.e., inventoried roadless areas; see section 3.16) on the national forests. Very little to no timber harvest or firewood removal has occurred in these areas, and fire has generally had more opportunity to function as a natural process (although fire suppression has occurred to varying degrees). A large portion (approximately 65 percent) of the Flathead is composed of designated wilderness and inventoried roadless areas. These areas, particularly when added to the other wilderness and inventoried roadless areas in the Northern Region’s Western Montana Zone (Flathead, Lolo, and Kootenai National Forests), provided a substantial land base over which to evaluate current snag conditions and trends on the Forest under relatively natural disturbance regimes. Additionally, a broad understanding and assessment of the natural range of variation for disturbance processes that create snags (i.e., fire, insects, and disease) can provide further insight into snag conditions and variation that might have occurred historically.

The natural disturbance pattern under the stand-replacement and mixed-severity fire regimes on the Flathead is typically characterized by relatively short periods of extensive fire (usually associated with warmer climatic periods) separated by relatively long periods of lower, and often less severe, fire activity (refer to section 3.8). A comparison of snag estimates inside wilderness and inventoried roadless areas from the 2009 snag estimate report (Bollenbacher et al., 2009) to those in the updated 2017 snag estimate tables provided insight into the changes in snag conditions over time and the natural variation in snag conditions that might occur under this natural disturbance regime. This comparison is possible because the measurement date for the Forest Inventory and Analysis inventory used for the 2009 snag estimate tables is from periodic plots measured 1993-1994, prior to the recent period of extensive fire activity on the Flathead National Forest (and western Montana as a whole). However, the updated 2017 snag estimate tables use Forest Inventory and Analysis data from plots measured mostly 2003-2011 on the Forest, during and immediately after this period of extensive fire activity (see Trechsel, 2016c for information on Flathead National Forest Inventory and Analysis plot data). Approximately 428,000 acres burned on Flathead National Forest lands between 1994 and 2012 (18 percent of NFS lands on the Forest), mostly in the decade 2000 to 2010 when about 355,000 acres burned. About half of these fires were in wilderness areas, and the majority were stand-replacement fires. This period of high fire activity mirrors the amount of fire that occurred about 100 years ago in the early part of the 20th century, which is consistent with the fire frequency of 35-100+ years that is typical of the natural fire regimes characterizing much of the Forest (refer to section 3.8 for further information on fire regimes and fire history). Thus, the snag estimates within wilderness and inventoried roadless areas in the 2017 snag estimate tables (the existing conditions) for the Flathead National Forest are considered to be generally representative of snag conditions on the Forest, representing a point at the upper end of the natural range of variation for average snag densities and distribution under the natural fire regimes characteristic of the Forest. The snag estimates for the wilderness and inventoried roadless areas of the Forest in the 2009 report (Bollenbacher et al., 2009) are considered to be generally representative of a more “average” point in the natural range of variation for snag condition at the landscape scale and across the temporal scale

of 35 to 100+ years, the fire frequency associated with the most common fire regimes on the Flathead.

Table 27 through table 32 display estimates of snag densities and their presence (distribution) both currently (based on the 2017snag estimate tables) and prior to the recent fires (Bollenbacher et al., 2009), both at a broad scale across the Flathead National Forest and by geographic area. Note that for the warm-moist potential vegetation type, estimates from the Western Montana Zone (Flathead, Lolo, and Kootenai National Forests) were entered for the snag conditions within wilderness and inventoried roadless areas rather than the estimates using Flathead National Forest data only. This is because this is a very minor type in the Forest's wilderness and inventoried roadless areas; only three Forest Inventory and Analysis plots are available within wilderness and inventoried roadless areas compared to the 50 Forest Inventory and Analysis plots available inside wilderness and inventoried roadless areas for the Western Montana Zone, so using the data for the zone results in a more reliable estimate. See Trechsel (2017i) for detailed information on this snag analysis and for additional estimate tables that display the snag conditions currently, as well as the Bollenbacher et al. (2009) report, all of which were used to develop plan components and analyze snag conditions in this final EIS. Estimates across both the Flathead National Forest and the broader landscape of the Western Montana Zone informed the analysis of snags for the Forest.

Key summary points and interpretations of the data related to snag conditions on the Flathead are listed below. Refer to Trechsel (2017i) for additional supporting data and more detailed discussions related to each of these points.

- Snag densities and distribution for most snag analysis groups and size classes have increased since the early 1990s, both in the Flathead National Forest and across all of western Montana, both inside and outside wilderness and inventoried roadless areas (table 27 through table 30). This is largely attributed to the extensive amount of fire during that time period. Insects and disease may have had some effects, but these effects are likely masked or overridden by the effects of large amounts of fire.
- The densities and distribution of larger (greater than 15 inches d.b.h.) snags is consistently greater in wilderness and inventoried roadless areas compared to outside wilderness and inventoried roadless areas (table 27 through table 30). This is likely related to human influences, such as the effects of past timber harvest, firewood gathering, and fire suppression and exclusion. The difference is much less pronounced in the estimates from the 2009 report (Bollenbacher et al., 2009), which was completed prior to the recent large fire events, than in the 2017 snag estimate tables, which reflect the recent large amount of area that has experienced fire and the difference in forest conditions prior to the fires inside vs. outside wilderness and inventoried roadless areas.
- Lodgepole pine dominance types usually have the lowest density and distribution of snags in all the size classes analyzed (table 27 through table 30), reflecting the disturbance history of these forests (e.g., large-scale stand-replacement fire and rapid reforestation to predominantly lodgepole pine) and the unique characteristics of lodgepole pine stands (e.g., high densities, smaller diameters). Forests in the warm-moist potential vegetation type tend to have the highest density and distribution of snags and the greatest number of snags in the largest size classes, reflecting the higher site productivity and species diversity as well as, in some areas, a more mixed-severity fire regime with more moderate-severity fire occurrences (favoring the development of large trees).

- Snags are naturally very unevenly distributed across the landscape. Snags do not exist across every acre, and larger snags in particular are relatively rare, even when recent fire has increased the overall abundance of snags. The existing distribution of snags (table 28) under conditions that generally reflect those of natural disturbance regimes (inside wilderness and roadless) indicate that snags greater than or equal to 20 inches d.b.h. do not exist across at least 90 percent of the area and snags greater than or equal to 15 inches d.b.h. do not exist across at least 75 percent of the area, considering the data from before, during, and after large fire events. Although considerably more abundant, even the smaller snags greater than or equal to 10 inches d.b.h. are not very widely distributed across the landscape under a natural disturbance regime, with an estimated 58 percent of the area inside wilderness and roadless areas currently containing no snags in those size classes. This data highlights the fact that forest densities, species compositions, natural disturbance regimes (i.e., stand-replacing fire), and other factors that are naturally characteristic of western Montana (including Flathead National Forest) landscapes are not particularly favorable for development of the very large trees that ultimately become the large and persistent snags when killed by fire, insects, or disease.
- Snag densities and distributions differ among the geographic areas of the Forest (table 31 and table 32). There are several reasons for this variation:
  - Each geographic area has different proportions of land in wilderness or inventoried roadless lands and in lands suitable for timber production, where active management has and will continue to be concentrated. Timber harvest and human access can have substantial impacts, causing reductions in snag density, distribution, and longevity (Wisdom & Bate, 2008). The lowest proportion of acres within management areas suitable for timber production (management areas 6b, 6c, and portions of management areas 4b and 7) are in the Middle Fork and South Fork geographic areas (from 0.1 to 6 percent of NF lands, depending on alternative) and the highest proportion is in the Salish Mountains geographic area (81 to 93 percent of NF lands, depending on alternative). The proportion of acres in management areas suitable for timber production in the other geographic areas range between approximately 16 to 21 percent (alternative C) and 30 to 50 percent (alternatives A, B modified and D) of NF lands within the geographic area.
  - Related to the first point, there are different types and intensities of disturbances that are prevalent in the geographic area. Some have higher intensity and/or concentrations of past timber harvesting (i.e., Salish Mountains and Swan Valley geographic areas). Some have had a high proportion of area that recently burned (North Fork, South Fork, and Hungry Horse geographic areas).
  - The proportion of lands within wildland-urban interface probably influences snag conditions to some degree, generally with fewer snags retained in some situations to address fuel and fire hazard concerns. The percent of NF lands within the wildland-urban interface is greatest in the Salish Mountains geographic area (approximately 51 percent), and least in the South Fork geographic area (approximately 1 percent). The other geographic areas range from approximately 11 percent (Hungry Horse) to 33 percent (Swan Valley) of lands within the wildland-urban interface.

Table 27. Current snag densities[a] on the Forest, inside and outside wilderness and inventoried roadless areas

Snag analysis group (potential vegetation type)	Snags per acre equal to or greater than 10 inches d.b.h.			Snags per acre equal to or greater than 15 inches d.b.h.			Snags per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Inside wilderness and roadless areas									
PICO[b]	4.0	1.6	7.1	0.4	0.0	1.0	0.0	0.0	0.0
Warm-dry	15.3	7.8	24.0	7.1	3.2	11.8	2.1	0.0	4.7
Warm-moist[c]	17.1	12.4	22.4	7.2	4.8	10.0	1.6	0.7	2.7
Cool-moist	23.0	18.3	28.1	6.9	5.0	9.1	2.7	1.6	4.0
Cold	15.9	10.6	21.8	4.2	2.3	6.4	1.5	0.6	2.7
Outside wilderness and roadless aAreas									
PICO[b]	16.7	7.7	26.9	2.0	0.3	4.2	1.1	0.0	2.4
Warm-dry	6.7	1.8	12.7	1.3	0.0	3.3	0.3	0.0	1.2
Warm-moist	9.9	3.8	16.9	4.5	1.7	7.8	1.7	0.3	3.6
Cool-moist	11.9	7.8	16.8	4.0	2.2	6.2	1.3	0.5	2.1
Cold	26.7	12.0	41.3	6.9	0.0	15.0	0.9	0.0	3.0

a. Data source: R1 summary database, Hybrid 2011, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all the Forest's NFS land, displaying lower and upper bounds at the 90 percent confidence interval. Reports run February 2017 by Northern Region specialists.

b. PICO = lodgepole pine dominance type.

c. Data is from the Western Montana Zone (Flathead, Lolo, and Kootenai National Forests). See explanation in the text above the tables.

Table 28. Current snag presence[a] (distribution) on the Forest, inside and outside wilderness and inventoried roadless areas

Snag analysis group (potential vegetation type)	Percent of area with at least one snag per acre equal to or greater than 10 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 15 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Inside wilderness and roadless areas									
PICO[b]	11.2	5.4	17.7	1.7	0.0	4.3	0.0	--	--
Warm-dry	32.9	20.0	46.4	23.1	11.5	35.7	7.4	1.0	15.6

Snag analysis group (potential vegetation type)	Percent of area with at least one snag per acre equal to or greater than 10 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 15 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Warm-moist[c]	39.0	30.6	47.6	25.2	17.9	33.0	8.8	4.1	14.2
Cool-moist	42.1	36.4	48.1	21.4	16.9	26.2	10.4	7.1	14.2
Cold	32.2	23.8	40.8	16.5	10.1	23.4	8.5	3.9	13.6
Outside wilderness and roadless areas									
PICO	30.4	18.0	43.6	9.2	1.3	19.1	8.0	0.0	17.9
Warm-dry	16.7	6.3	28.8	4.2	0.0	10.0	1.4	0.0	5.0
Warm-moist	26.5	12.5	42.2	19.1	8.3	31.3	10.3	2.3	19.7
Cool-moist	25.5	19.5	31.8	13.2	8.8	18.0	6.6	3.2	10.3
Cold	53.6	30.0	75.0	21.4	0.0	44.4	3.6	0.0	12.5

a. Data source: R1 summary database, Hybrid 2011, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all the Forest's NFS land, displaying lower and upper bounds at the 90 percent confidence interval. Reports run February 2017 by Northern Region specialists.

b. PICO = lodgepole pine dominance type.

c. Data is from the Western Montana Zone (Flathead, Lolo, and Kootenai National Forests). See explanation above the tables.

Table 29. Snag densities[a] in the early 1990s on the Forest, inside and outside wilderness and inventoried roadless areas

Snag analysis group (potential vegetation type)	Snags per acre equal to or greater than 10 inches d.b.h.			Snags per acre equal to or greater than 15 inches d.b.h.			Snags per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Inside wilderness and roadless areas									
PICO[b]	3.9	1.5	6.9	0.3	0	0.6	0.1	0	0.2
Warm-dry	4.9	0.9	10	2.9	0.4	6.4	0.7	0.1	1.3
Warm-moist[c]	13.0	9.0	17.4	5.9	3.7	8.3	1.8	0.9	2.8
Cool-moist and cold	12.5	9.5	15.7	3.6	2.8	4.5	1.1	0.8	1.5
Outside wilderness and roadless areas									
PICO[b]	6.9	0.4	16.9	0.8	0	2.3	0.6	0	1.9
Warm-dry	9.3	2.9	17.1	2.6	0.3	6.5	1.0	0.1	2.1

Snag analysis group (potential vegetation type)	Snags per acre equal to or greater than 10 inches d.b.h.			Snags per acre equal to or greater than 15 inches d.b.h.			Snags per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Warm-moist	10.2	1.9	21.8	6.6	1.0	13.7	2.9	0.4	6.0
Cool-moist and cold	10.4	7.5	13.6	2.6	1.8	3.5	1.1	0.6	1.6

a. Data source: R1 summary database, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all the Forest's NFS land, displaying lower and upper bounds at the 90 percent confidence interval. The reports were run in 2009 and published in Bollenbacher et al. (2009).

b. PICO = lodgepole pine dominance type

c. Data is from the Western Montana Zone (Flathead, Lolo, and Kootenai National Forests). See explanation above the tables.

Table 30. Snag presence[a] (distribution) in early 1990s in the Western Montana Zone (Flathead, Lolo, and Kootenai National Forests), inside wilderness and inventoried roadless areas[b]

Snag analysis group (potential vegetation type)	Percent of area with at least one snag per acre equal to or greater than 10 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 15 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Inside Wilderness and Roadless Areas									
Warm-dry	15.3	11.3	19.3	10.8	7.5	14.3	6.3	3.9	8.8
Warm-moist	31.7	23.8	39.8	21.9	15.0	29.2	11.5	6.4	17.3
Cool-moist and cold	27.9	25.2	30.7	17.6	15.3	19.9	9.1	7.4	10.9

a. Data source: R1 summary database, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all the Forest's NFS land, displaying lower and upper bounds at the 90 percent confidence interval. The reports were run in 2009 and published in Bollenbacher et al. (2009).

b. Estimates are not available in the 2009 publication for lands outside wilderness and roadless areas, for the PICO snag analysis group, or for individual national forests.

Table 31. Current snag densities[a] on the Forest within each geographic area

Geographic area	Snags per acre equal to or greater than 10 inches d.b.h.			Snags per acre equal to or greater than 15 inches d.b.h.			Snags per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Hungry Horse	15.9	9.1	23.8	5.5	2.9	8.7	2.1	0.9	3.6
Middle Fork	13.0	8.7	18.0	2.8	1.4	4.6	0.8	0.2	1.6
North Fork	19.5	12.8	26.8	5.8	3.3	8.7	1.0	0.3	1.8
Salish Mountains	9.4	5.2	14.1	2.3	1.0	3.8	0.4	0	1.0

Geographic area	Snags per acre equal to or greater than 10 inches d.b.h.			Snags per acre equal to or greater than 15 inches d.b.h.			Snags per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
South Fork	18.4	14.5	22.8	5.8	4.1	7.8	2.8	1.8	4.1
Swan Valley	9.1	6.0	12.5	3.0	1.7	4.5	0.5	0.1	1.0

a. Data source: R1 summary database, Hybrid 2011, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all NFS land, displaying lower and upper bounds at the 90 percent confidence interval. The reports were run February 2017.

Table 32. Current snag presence[a] (distribution) on the Forest within each geographic area

Geographic area	Percent of area with at least one snag per acre equal to or greater than 10 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 15 inches d.b.h.			Percent of area with at least one snag per acre equal to or greater than 20 inches d.b.h.		
	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound	Mean	Lower bound	Upper bound
Hungry Horse	30.4	21.9	39.1	18.6	12.2	25.6	10.3	5.3	16.0
Middle Fork	27.9	20.6	36.1	10.4	5.7	15.7	3.8	1.0	7.4
North Fork	34.9	26.6	43.4	17.6	11.2	24.4	5.5	1.7	9.9
Salish Mountains	20.2	12.8	28.0	8.7	3.9	14.3	1.7	0	4.0
South Fork	34.8	29.5	40.5	18.9	14.6	23.5	11.4	7.9	15.1
Swan Valley	25.3	18.0	32.9	12.3	7.3	17.9	4.6	1.5	8.3

a. Data source: R1 summary database, Hybrid 2011, from data produced by the Forest Service's Forest Inventory and Analysis program. Estimated mean across all NFS land, displaying lower and upper bounds at the 90 percent confidence interval. The reports were run February 2017.

Historical fire patterns, intensity, and frequency varies by geographic area and is related to terrain, site potential (e.g., potential vegetation types), and resulting differences in the forest conditions (structure, composition, densities) that develop. Existing forest conditions reflect the historical disturbance regimes but also reflect the influence of human actions over the past 100 or more years that have altered the natural disturbance regimes in some areas, including wilderness and inventoried roadless areas (e.g., fire suppression in the Mission Mountains Wilderness). These actions affect current snag conditions. Although stand-replacement fire has occurred periodically, the Salish Mountains and Swan Valley geographic areas historically had more mixed-severity fire regimes, which would tend to favor a complex pattern of forest conditions, including larger trees of fire-resistant species and highly variable snag patterns across both space and time. In contrast to a landscape more dominated by stand-replacement fire (such as the North Fork, Middle Fork, and Hungry Horse geographic areas), a mixed-severity fire regime would tend to create a landscape with a more sporadic and variable amount of snags over time, without the very large spikes in snag densities and distribution. Stand-replacement fire regimes tend to create very large amounts of snags periodically, followed by gradual decline to a low point midway between fire intervals (James K. Agee, 2002b).

Downed wood

Snags are not only of ecological value while they are standing but are also the primary source of downed woody material when they fall. Downed woody material plays a critical ecological role, retaining moisture on the site, contributing to the ecosystem processes that recycle nutrients and sustain soil productivity, and adding to the biodiversity of the ecosystem by being part of the life cycle of soil mites, insects, reptiles, amphibians, mammals, and birds (J. K. Brown et al., 2003). Downed wood provides important habitat structures for a wide variety of wildlife species, many of them different from those associated with snags (refer to section 3.7.4, subsection “Burned forest and dead tree habitats”). Long (greater than 6 feet) and larger-diameter (greater than 9 inches d.b.h.) downed wood is generally more valued because it can be used by a greater range of species and provides a stable and persistent structure as well as better protection from weather extremes.

Downed wood is derived directly from snags as well as from live trees or parts of trees that fall due to wind, fire, or other factors. Thus, the variability in abundance, distribution, size, and other characteristics of the downed wood component across the Forest and over time is closely tied to and similar to that of the snag component described above. As with snags, the Forest’s analysis of existing and desired conditions for downed wood considered the conditions within wilderness and inventoried roadless areas and the trends over the past 20 or so years as a means to gain insight into the natural range of variation. Refer to Trechsel (2017i) for details of this analysis.

Since the early 1990s, the total tons per acre of downed woody material decreased across the Forest in all potential vegetation types. Similar to snags, this is likely due to the amount of fire on the Forest during the past 20 years. Current conditions represent to some degree a period of relatively low amounts of downed wood under the disturbance regimes common on the Flathead. They represent conditions that might occur immediately during and after a period of widespread and high-intensity fire events, which would consume much of the pre-existing dead wood. Because these fires were so recent, much of the dead trees are still standing and not yet contributing a large amount to the downed wood component. Table 33 displays the existing conditions for the amount of downed wood across the Forest.

Table 33. Current condition for average total tons of downed wood per acre, as measured across all forested acres within each potential vegetation type on the Forest

Potential vegetation type	Current mean (and 90 percent confidence interval) total tons of downed wood per acre
Warm-dry	14 (10-18)
Warm-moist	22 (17-29)
Cool-moist	25 (22-28)
Cold	15 (12-19)

Source: Forest Inventory and Analysis data using the R1 summary database (Hybrid 2011) analysis tools. Upper and lower bounds are at a confidence interval of 90 percent.

Environmental consequences

Effects common to all alternatives

Snag and downed wood conditions are largely dependent on the pattern of natural and human disturbance processes. Snag and downed wood conditions are expected to be very dynamic, highly variable, and unevenly distributed across time and space. Dead wood components will continually be created by fire, insects, disease, and mortality over the course of natural succession. Snags will continually be lost as they fall to the ground and then become part of the downed wood component,

where they will decompose and become part of the soil. Decomposition and fire are the primary ecological processes that remove—or, more accurately, recycle—dead wood within the ecosystem. Vegetation treatments (i.e., timber harvest, fuels reduction treatments) and firewood cutting also remove dead wood. Some of this removed wood may be stored in wood products, but eventually it is also recycled (either through decomposition or fire), although typically not on the site where it originated (refer also to section 3.4 for more detailed information on this harvested wood component).

Across most of the Forest, the highest amounts of dead wood would occur in areas where recent fire or insect or disease outbreaks have occurred, with snags predominant at first and then shifting to predominantly downed wood as the dead trees fall. High amounts also tend to occur in the late-successional stage of forest development, where higher rates of mortality of the older trees may exist. Lower amounts of snags and downed wood would tend to occur in the small and medium size class forest types (the mid-successional stage) because much of the snag and downed wood component created by the disturbance that initiated the stand (commonly fire) would have decomposed (James K. Agee, 2002b).

Lower amounts would also tend to occur in developed recreation sites, areas where concern for fire hazard is elevated (i.e., wildland-urban interface), areas closer to communities and accessible to firewood cutting, and areas where more intensive timber harvesting has occurred. Lower densities and sizes of snags also naturally tend to occur within lodgepole-pine-dominated stands, unless they are affected by mountain pine beetle infestation.

A key element of the Forest's overall approach to snag management includes the recognition and incorporation of the contribution of large backcountry (i.e., largely unroaded) and wilderness areas to desired conditions of snags and snag habitat. The majority of Forest lands are within management areas where natural ecological processes and disturbances will be the primary factor affecting snag and downed wood conditions, such as wilderness areas and inventoried roadless areas. These areas range from 66 to 73 percent depending on alternative (table 20). Timber harvesting or firewood cutting would be very minor or nonexistent in these areas. These natural processes are expected to create snags and downed wood conditions that would generally be within the natural range of variation, with the diversity of conditions at the forestwide scale that would provide habitat for wildlife species associated with dead wood components. Fire suppression on some of these lands has likely influenced the snag and downed wood conditions and will continue to do so into the future. Exactly how or where dead wood conditions may have been affected by fire suppression is uncertain; however, more fire events, especially smaller fires and those of moderate severity, probably would have occurred over the past 70 or more years had suppression not been the practice. This would have created more snags in some areas of the Forest. In addition, the amount and pattern of large stand-replacing fires that occur infrequently but periodically under the fire regimes of the Forest have probably been much less affected by suppression efforts. The recent period of extensive fire activity on the Forest (see the "Affected environment" section above) is consistent with the amount and frequency of such fire events under the stand-replacement fire regimes that characterize much of the Forest (refer to section 3.8 for more information on fire regimes and fire history).

Lands where active vegetation management may occur more often (particularly the lands suitable for timber production) cover a minority of the Forest (from 17 to 29 percent depending on alternative; see table 20), however they are unevenly distributed across the Forest area. The largest concentrations of areas where more intensive vegetation management is expected are in the Salish Mountains geographic area and the lower to mid elevations of the Swan Valley geographic area. More intensively managed areas are typically where snag densities and distributions tend to be

lowest (Ohmann & Waddell, 2002; Wisdom & Bate, 2008), and, as discussed in the “Affected environment” section above, this situation appears to occur on the Flathead as well. In contrast to natural disturbances, in a regeneration harvest most of the standing tree component is removed, and these trees are no longer available to develop into future snags. Existing snags are also sometimes removed or are felled for safety during the logging operation. Higher densities of open roads occur in the more intensively managed areas, which are used for firewood cutting, and this removes snags. In addition, forests on lands suitable for timber production are typically managed in ways that maintain relatively vigorous trees and limit losses of trees due to insects, disease, and fire where possible. This management tends to result in lower tree mortality rates and a potentially lower density of snags across these areas over time compared to areas less influenced by human actions and affected more by natural disturbances (such as wilderness). Because of the effects of active forest management on snag conditions and associated snag habitat, the persistence of snags and snag habitat conditions in areas dominated by active vegetation management largely depends upon deliberate human intervention.

All alternatives have standards and guidelines that direct the management of snags and downed wood within timber harvest units. These are designed to support the active role that is more likely to be needed to achieve the desired distribution of snag habitat conditions within these actively managed landscapes and to address the unequal distribution of snags and downed wood across the Forest that is partly the result of timber management and fuel reduction activities. This type of direction has been in place on the Forest since the late 1990s, when amendment 21 (related to old-growth forests) was made to the current 1986 forest plan. The forest plan integrates and expands on the existing plan direction for snags and downed wood. Snag retention direction for harvest areas is designed to retain the least common snag components in the Forest’s ecosystem and those most important in terms of their contributions to key wildlife habitat conditions—larger snags, particularly the species that are most persistent and of highest value for wildlife, such as western larch.

Vegetation management, including timber harvest, is a tool that is expected to be used across portions of the Forest to achieve desired ecological, social, and economic conditions. The snag retention standards for harvest areas contribute to achieving desired snag and snag habitat conditions. It is not expected that the lands where more active vegetation management occurs would have the same level of snag densities or distribution as the wilderness and unroaded portions of the Forest because other resource objectives, desired conditions, and purposes for the project would be integrated during project-level analysis, and these might influence the snag conditions. On the other hand, with active vegetation management there may be greater opportunity to manage for the species and larger tree sizes on these lands that would contribute to desirable future snag and downed wood conditions.

In addition to vegetation management to achieve multiple resource objectives, firewood gathering is an activity that will continue to reduce snag habitat along roads open to the public. Desired conditions for snags recognize this use of the Forest and the anticipated reduced densities of snags along open roads. Approximately 90,000 acres (4 percent) of Flathead National Forest lands are within 300 feet of an NFS road open to the public. However, some of these areas are site specifically closed to firewood cutting or firewood removal is not allowed under the personal-use permit conditions (such as in riparian management zones). Refer to Trechsel (2017i) for details.

The Forest has been implementing existing 1986 forest plan direction for snags and downed wood at the project level for about 15 years. Monitoring of post-harvest snag and downed wood conditions occurs at a site-specific level. Recent fires, as mentioned earlier, have increased the abundance of snags but decreased the amount of downed wood across the Forest, including in areas outside

wilderness and inventoried roadless areas and on lands suitable for timber production. The most recent forest plan monitoring report (see Trechsel, 2017i, attachment 3), which addresses snags and coarse woody debris retention, concluded that treatments over the previous decade have been designed to maintain much more structure than in the past and to protect current snags as much as is possible and safe, using fire salvage prescriptions and other methods. The value of dead wood is fully recognized, and the fact that treated areas have fewer snags than untreated areas is a possible concern over the long term. However, the evaluation of the data has not raised any concerns about meeting desired conditions for snags and coarse woody debris at the broad scale. Management direction under all alternatives should continue to meet desired conditions for snags and downed wood, providing habitat and other ecological values consistent with natural disturbance regimes. Monitoring would continue to provide information and insight into snag and downed wood habitat and conditions over time, and, using an adaptive management approach, would allow for the adjustment of plan components if determined necessary. Refer to section 3.7.4, subsection "Old-growth forest: Very large live and dead tree associates" for information on snag and downed wood-associated wildlife species trends and conditions.

Alternative A

The existing 1986 forest plan has direction for retention of snags that has been in place since 1999, with the completion of amendment 21 to the 1986 forest plan. Table 36 compares the existing forest plan direction with that of the action alternatives.

Effects common to alternatives B modified, C, and D

Forest plan management direction related to snags and downed wood is the same under all the action alternatives. The forest plan is consistent with the approach used for snag direction in the existing 1986 forest plan that was implemented through amendment 21. However, the forest plan uses more recent information and interpretation of the natural range of variation to update and clarify snag retention direction as well as increase the focus on snags and downed wood as needed, such as in riparian management areas.

The 2012 planning rule directives (Forest Service Handbook 1909.12 chap. 20) describe using the natural range of variation as a basis from which to understand ecosystem integrity and establish desired future conditions for ecosystem characteristics. In developing plan components for the forest plan, the Forest evaluated snag estimates in wilderness and inventoried roadless areas in the context of the natural disturbance regimes (discussed in the "Affected environment" section above). Desired conditions for snags and downed wood are designed to reflect the Forest's best estimate of the conditions that would be expected to occur under natural disturbance regimes. Standards and guidelines are designed to maintain or make progress towards achieving desired conditions where determined necessary. In the case of snag and downed wood conditions, this would be primarily in those areas and situations, such as timber harvest areas, where more active vegetation management would be likely to occur and might notably influence these ecosystem components. Refer to Trechsel (2017i) for details of the snag analysis and for the full rationale of how the desired conditions, standards, and guidelines were developed. An abbreviated summary is provided below.

Evaluation of mean snag and downed wood densities inside wilderness and inventoried roadless areas was the basis for the development of the desired conditions for snags, including establishing the minimum average snag densities and tons per acre of downed wood for the Flathead. This approach uses the best available scientific information to develop a quantitative desired condition for snags based on conditions across landscapes influenced mostly by natural ecosystem processes and functions. Densities prior to the recent period of extensive wildfire (see table 29 in the "Affected environment" section) are considered generally representative of average snag conditions that might

be expected to occur during the intervals between periods of exceptionally high fire activity, and these levels guided the development of the minimum desired level of snags forestwide, as displayed in table 34. Fire has been managed as a natural disturbance process within wilderness areas for many decades, so the conditions displayed in table 29 reflect the natural fire presence and patterns as well as other disturbance processes.

Downed wood amounts, in contrast to snags, are more likely to be at their lowest levels immediately after fires, when the downed wood has been consumed by fire and the snags have not yet fallen. Therefore, for downed wood, the existing conditions mean value (table 33) was used as the basis for development of desired conditions (table 35) because this is considered the Forest's best estimate of an amount at the lower end of the natural range of variation for this component. This desired condition would maintain amounts that would continue to contribute to forest structural diversity, soil ecological function, and habitat for animal species associated with downed wood for feeding, denning, reproduction, and shelter. For both snags and downed wood, it would not be appropriate to set a minimum that is at an elevated level within the natural range of variation. This approach to developing minimum desired conditions is relatively conservative in that it uses the mean values rather than the low end of the 90 percent confidence intervals to ensure that the lowest level of snags and downed wood does not become the desired condition across the landscape.

Desired conditions

The desired condition provides a means to systematically monitor change in the snag and downed wood structural components over time and interpret these results in the context of ongoing ecological processes and the conditions of other key ecosystem components. Desired conditions establishing minimum average densities of snags and amounts of downed wood were developed forestwide (FW-DC-TE&V-15 and 17) and for riparian management zones (FW-DC-RMZ-03) for all action alternatives. Higher densities of snags and larger downed woody material is desired in harvest units within riparian management zones because these areas naturally have higher levels of these components, and are important areas for wildlife habitat (refer to section 3.7). Table 34 and table 35 display the desired conditions for snags and downed wood forestwide.

Table 34. Desired minimum in average snags per acre of conifer species, as measured across all forested acres of the Forest, by forest dominance type, potential vegetation type, and snag diameter.

Forest dominance types	Potential vegetation type	Desired minimum in average number of snags per acre greater than or equal to 10 inches d.b.h.	Desired minimum in average number of snags per acre greater than or equal to 15 inches d.b.h.	Desired minimum in average number of snags per acre greater than or equal to 20 inches d.b.h.
All except lodgepole pine	Warm-dry	5.0	2.9	0.7
All except lodgepole pine	Warm-moist	13.0	5.9	1.8
All except lodgepole pine	Cool-moist	15.0	4.0	1.2
All except lodgepole pine	Cold	10.0	3.0	0.9
Lodgepole pine	All	6.0	1.0	0.1

Table 35. Desired condition for minimum average total tons per acre of downed wood, as measured across all forested acres within each potential vegetation type on the Forest

Potential vegetation type	Desired minimum in total tons per acre as a forestwide average
Warm-dry	14
Warm-moist	22
Cool-moist	25
Cold	15

Desired conditions for snag conditions specific to wildlife diversity and particular species are provided in the plan (FW-DC-WL DIV-01, black-backed woodpecker, fisher, and flammulated owl). Desired conditions are also provided for recently burned forest (FW-DC-TE&V-25), an important stage contributing to the biodiversity of Forest ecosystems. Other wildlife species that use snags are also recognized in the plan in the descriptions of desired condition (FW-DC-WL DIV-01) and for the host of species associated with cavity-nesting habitat (FW-DC-TE&V-16). Refer also to section 3.7 for additional details on snags and downed wood values and effects to wildlife

Current snag densities (table 27) are above the minimum desired conditions for all size classes and potential vegetation types except the warm-moist type. Levels of snags are slightly below desired conditions in all size classes in the warm-moist type, likely influenced by the types of disturbances that are prevalent in these areas (human activities rather than wildfire). The higher current densities across the majority of the Forest is reasonable considering the large amount of recent fire. However, over the next 10-20 years snag densities would be expected to decline as they decay and fall to the ground. Fire events or other disturbances in the future would also continue to create new snags across the landscape as well as burn up existing snags. With warming climatic conditions, fire frequency and severity may increase rather than subside. How this will play out and influence snag densities and associated wildlife habitat over the life of the plan is uncertain. An adaptive monitoring approach would be used to provide necessary information to validate or adjust approaches to snag management as needed.

Standards and guidelines

Although forestwide snag densities appear to be within natural variation, there is wide variation in the distribution of snags across the Forest as influenced by the location of fires and pattern of past and ongoing timber harvest and other activities. There are currently fewer snags outside wilderness and roadless areas compared to areas within wilderness and roadless areas (see table 27 and table 28). Snag densities and distribution have been affected by past timber harvesting, firewood gathering, and fire suppression and exclusion activities (see Trechsel, 2017i for more details). Dead trees will continue to be removed across the lands that are suitable for timber production to achieve desired conditions related to timber values and supporting local economies and providing firewood-gathering opportunities. The creation of snags by natural disturbance will be limited in some portions of the Forest due to fire suppression and the desire to limit excessive mortality due to insects and disease in lands suitable for timber production. To address these factors and the uneven distribution of snag densities across the landscape, standards and guidelines have been developed in the plan to support the active role that is more likely to be needed to provide desired levels of snag and downed wood habitat within the more actively managed landscapes where timber harvest activities would be occurring.

All action alternatives include standards and guidelines in the forest plan that use an approach to snag management in timber harvest areas similar to the one that has been used under the current

1986 forest plan for over 15 years, with some refinements based on newer information related to snag conditions across the Forest (as described in previous discussions and in Trechsel (2017i)). In general, the standards and guidelines related to snag retention in the forest plan are intended to retain a certain level of snags distributed across the Forest to contribute to wildlife habitat and for other ecosystem benefits—not just within wilderness and roadless areas but also within areas that are more intensively managed and where snag-producing natural disturbances (fire, insects, and disease) are expected to be more limited (i.e., the lands identified as suitable for timber production). Making allowance for the fact that most snags do not last for long periods of time (smaller snags often less than ten years), direction is also provided in the plan to leave live trees for long term recruitment of snags and to contribute to future snag habitat (Harris, 1999). Table 36 provides a summary of standards and guidelines for snags and downed wood management within timber harvest areas in the existing 1986 forest plan compared to the action alternatives. A more detailed discussion of the standards and guidelines follows the table.

Table 36. Comparison and discussion of different forest plan standards and guidelines for snags and downed wood, by alternative.

Category	Existing 1986 forest plan[1] (alternative A)	Forest plan[2] (alternatives B modified, C, and D)	Notes on forest plan direction
Snag diameter classes for retention	12 to 20 inches d.b.h. Greater than 20 inches d.b.h.	15 inches d.b.h. and greater, 20 inches d.b.h. and greater, 10 inches d.b.h. and greater (in Salish Mountains and Swan Valley geographic areas only), 12 inches d.b.h. and greater in riparian management zones	Designed to emphasize the selection of the larger-diameter snags and also the retention of smaller snags in landscapes most impacted by human activities. Because of relative high importance of snags and downed wood in riparian areas, snags as small as 12 inches are retained within riparian management zones.
Site (habitat group) categories	Three categories: dry, moist, and cold potential vegetation groups[3]	Four potential vegetation types: warm-dry, warm-moist, cool-moist and cold. Also, specific direction for harvesting and snag retention in riparian management zones.	The direction is consistent with other forestwide plan components for key ecosystem characteristics, incorporates the natural range of variation approach in the development of plan components, and is designed to retain snags based on site potential and opportunities. The forest plan recognizes the elevated importance of snag habitat in riparian areas.
Total numbers of snags retained: average snag per acre minimum	Snags ≥ 12” d.b.h.: Dry: 3 total, Moist: 8 total, Cold: 7 total	See table 37 below for levels by geographic areas. In all harvest areas, all ≥ 20” d.b.h. western larch, ponderosa pine, and cottonwood snags would be retained. In most cases, all snags ≥ 12” d.b.h. will be retained in harvest units within riparian management zones.	This better reflects the Forest’s best estimate of conditions related to natural variation, recognizing variation in existing snag conditions across the Forest due both to human and natural influences. There is greater emphasis on the retention of larger snag sizes and the importance of snags in riparian areas. The minimum number of ≥ 20” snags is greater than the minimum levels in the existing 1986 forest plan.

Category	Existing 1986 forest plan[1] (alternative A)	Forest plan[2] (alternatives B modified, C, and D)	Notes on forest plan direction
Live tree retention and snag replacement	Leave 5 replacement trees > 12" d.b.h. for each > 20" d.b.h. snag that is unavailable. If cannot meet minimum snag densities, substitute other live trees.	Decadent and decayed live trees of certain species qualify as snag replacements and must be left for each unavailable snag. There is additional forest plan direction for the retention of live trees within regeneration harvest areas and for harvest within riparian management zones.	Plan also includes a live reserve tree guideline (FW-GDL-TE&V-09) for leaving live trees within regeneration harvest areas. The intent is primarily to maintain and develop very large trees of desired species, but these trees also serve as future potential snags. The plan also has a live reserve tree standard for harvest in riparian management zones (FW-GDL-RMZ-08) that would contribute to future snag habitat.
Downed wood	Specifies average minimum number of pieces of downed wood to leave within units, in the 9" to 20" and > 20" diameter classes and for the dry, moist and cold potential vegetation groups.	Specifies a minimum of 8 tons per acre of > 3-inch d.b.h. downed wood left within units, with a maximum of 30 tons per acre. The downed wood should consist of the longest and largest material available of a variety of decay conditions.	The plan is generally consistent with recommended amounts (J. K. Brown et al., 2003) of downed wood to achieve multiple objectives for typical sites on the Forest. Site-specific analysis would determine the amounts to leave. Tons per acre is used as the indicator and measure rather than pieces per acre. This is consistent with the majority of literature and research related to retention of downed wood and is necessary to allow for effective and efficient monitoring of this component at scales ranging from the stand to the Forest level.
Exceptions	Cases where removal is necessary for human health and safety. Also, areas within 200 feet of open road; personal-use firewood permit areas. Allows for alternative prescription to meet the snag or downed wood standard (for example, where the minimum number of snags is not present).	Cases where removal is necessary for human health and safety. Allows for variation in analysis area over which to apply snag retention standard.	Variation in analysis area configuration is designed to achieve the intent of preserving the most desirable snags where they are present, recognizing the naturally uneven distribution of snags. Also allows for the flexibility to address areas where insufficient numbers of snags occur or where firewood cutting is expected.
Snag retention specific to wildlife species	No direction provided	Forest plan direction is provided for snag habitat needs of several species. Refer to section 3.7 for details.	Recognizes that snags and downed wood are important habitat components for a number of wildlife and animal species.

1. Forest-Wide Standards, H—Vegetation (7), p. II-48.

2. FW-DC-TE&V-DC 15, 16, and 17 (snags and downed wood); FW-STD-TE&V-03 (snags); FW-GDL-TE&V-09 (live tree retention); standards for all geographic areas for snags.

3. These potential vegetation groups are similar to but different from those used in the forest plan, alternatives B modified, C and D.

Features of standards and guidelines that apply forestwide

The presence of riparian management zones is an important component in the Forest's overall approach to providing for desired snag conditions forestwide, particularly within the portions of the Forest that are expected to have more active vegetation management. Approximately 20 percent of lands within the management areas that are suitable for timber production (management areas 6b, 6c, and portions of management areas 4 and 7) are within riparian management zones (nearly the same proportion for all action alternatives). The riparian management zones are very broadly dispersed in a weblike pattern throughout these management areas (see figure 1-07), and they are identified as unsuitable for timber production. Although vegetation management and timber harvest are allowed in riparian management zones, they would be much more limited and constrained compared to areas outside the riparian management zones by plan direction that ensures that desired conditions for aquatic and wildlife resources are emphasized. Compared to the existing 1986 forest plan, the widths of the protected zones adjacent to water features have been increased for wetlands and for intermittent streams in all the action alternatives (see FW-STD-RMZ-01), incorporating more area into these zones than presently occurs under the 1986 forest plan.

In addition, a guideline for harvest units that occur within riparian management zones requires all snags greater than or equal to 12" d.b.h. to be retained (FW-GDL-RMZ-10), with some exceptions. This recognizes the naturally more diverse nature of these areas, their elevated importance to wildlife, and the desire to maintain and promote higher structural diversity within riparian management zones. Exceptions are allowed, for example, in areas where a decreased amount of wildland fuels is desired to protect communities and community assets (i.e., within the wildlife-urban interface). In addition, it is recognized that there may be exceptions to this direction in salvage harvest within areas burned by stand-replacement fire on sites where snag conditions are very abundant and the removal of some of the snags greater than 12 inches d.b.h. may be desired to achieve other resource objectives (such as fuel reduction).

Snag retention direction applies to all types of timber harvest and within all forest dominance types, even those that naturally have few snags. This is because the larger snags (i.e., greater than 15 inches d.b.h.) are important enough to retain wherever they may exist. In some forest conditions (such as the lodgepole pine dominance type or immature forests), large-diameter snags are naturally rare or nonexistent and minimum snag or live replacement tree densities may not be achieved within harvest areas. This would be consistent with the naturally high spatial variation that occurs in snag conditions across the forested landscape.

Larger-diameter snags (e.g., greater than 15 inches d.b.h.) are the focus of the forest plan snag retention direction because they are the least common and are of particularly high value to wildlife (see section 3.7). Although minimum snag retention levels within harvest areas are established for snags greater than or equal to a certain d.b.h. (depending on geographic area), the retention direction specifies that the largest snags that are present above the specified d.b.h. should be selected. This approach would require the selection of the larger and more valuable snags (or live replacement trees) when they are present, instead of the smaller snags, to meet the required total minimum number of snags, which would provide greater assurance that the higher-quality snag habitat would be retained within harvest areas.

Very large snags in particular (≥ 20 inches d.b.h.) are especially limited and especially important features for snag-dependent wildlife and in late-successional and old-growth forests. All western larch, ponderosa pine, and cottonwood snags greater than or equal to 20 inches d.b.h. are required to be retained within harvest units. These species at these larger sizes also tend to have the greatest longevity as snags.

The standards provide for leaving live snag replacement trees when sufficient numbers of snags are not present as well as for retaining within regeneration harvest units live reserve trees (FW-GDL-TE&V-09) that may also contribute to future snag habitat. Refer to the "Live replacement snags" section below for additional discussion.

Snag retention standards incorporate consideration of the potential hazard snags present to humans in certain circumstances. For example, exceptions are provided where human safety considerations require some snags be felled and/or removed, such as in developed recreation sites or adjacent to landings. Also, certain snags or large numbers of snags may not be desired in areas where decreased fuels are desired to influence expected fire behavior, fire-control efforts, and safety during fire suppression activities.

Snag standards and guidelines address the multiple values associated with snags, such as the contribution both live and dead trees provide as timber products to local economies. The salvage of dead and dying trees within areas burned by fire or areas with other high-severity disturbance is balanced against economic and other resource management objectives. Guidelines constrain salvage harvest by requiring the retention of unburned or low-severity patches of trees within the burn perimeter for habitat diversity (FW-GDL-TIMB-01), the leaving of clusters of burned trees in a variety of sizes for species that require burned habitat (FW-GDL-TIMB-02), and the retention of all standing live, dying, and dead western larch, ponderosa pine, and cottonwood trees greater than 20 inches d.b.h. when salvaging within stands that were old-growth forest prior to the fire (FW-GDL-TIMB-03).

Occasionally, after appropriate analysis, a decision is made to temporarily open certain gated roads to the public to provide a short-term opportunity for the public to gather firewood for personal use. To address the need to preserve high-value snags in this situation, a guideline is provided in the plan to take measures to protect the most valuable snags, such as by signing trees (FW-GDL-OFP-01).

Multiple scales of analysis may be applied to implement the standards for snag retention within harvest areas. The minimum densities and snag replacement requirements may be applied within each individual unit, by groups of units, or across all units within a particular project. In situations where there are very high snag densities, such as salvage harvest projects after a wildfire or a severe bark beetle outbreak, an alternative analysis area for the application of snag retention direction may be developed, based on site-specific conditions and potentially including areas outside harvest units. Such an analysis would take a landscape approach in recognition of the naturally uneven distribution of snags across the forested landscape, particularly of the larger, higher-quality snags and decadent trees (see the "Affected environment" section above) (Harris, 1999). It not reasonable to expect that each harvest unit would have the potential or would need to contain larger snags, even after a stand-replacement fire or other natural disturbance situation. The intent of the multiple scales of analysis is to promote the retention of more snags and of the most desirable large snags (or decadent trees) where they exist, recognizing that some units will have insufficient numbers of snags to achieve the standard. The standard allows for the retention of larger numbers of snags within units that have more abundant and/or higher value snags to compensate for units that are deficient. It also recognizes that there may be some situations in which the desired minimum numbers of snags may not be able to be left because of human safety concerns or concerns about the level of wildland fuels.

Snag retention standard for geographic areas

The forest plan direction sets different minimum average levels of snag retention depending on geographic area, recognizing the differences in past and future human and natural disturbance patterns and the current conditions of snags. Snag retention standards were developed by evaluating current and recent past snag densities and distribution (e.g., Bollenbacher et al., 2009), inside and

outside wilderness and inventoried roadless areas, for the Flathead National Forest and the other two western Montana national forests. Snag and live large tree levels in the seedling/sapling successional stage were also reviewed to assess conditions that might be relevant to snag and snag replacements in regeneration harvests. Minimum retention levels were increased for harvest areas in the Salish Mountains and Swan Valley geographic areas due to low current amounts relative to other geographic areas and to conditions that might be expected under natural disturbance regimes. More intensive management is expected to occur in these geographic areas into the future, as well. Refer to Trechsel (2017i) for full details on the analysis conducted to establish minimum levels of snags within timber harvest areas for the geographic areas. Table 37 displays the snag retention standards for harvest areas within the different geographic areas in the forest plan.

Table 37. Minimum average number of snags or live replacement trees per acre greater than 10 feet tall to retain within timber harvest areas

Geographic Areas	Forest dominance types	Potential vegetation type	Total minimum number of snags or live replacement trees per acre of the largest d.b.h. present (greater than 15 inches d.b.h. *or* greater than 10 inches d.b.h. for Salish Mountains and Swan Valley)	Minimum number of snags or live replacement trees per acre greater than or equal to 20 inches d.b.h.
Hungry Horse, Middle Fork, North Fork, and South Fork	All except lodgepole pine	Warm-dry	4	2
Hungry Horse, Middle Fork, North Fork, and South Fork	All except lodgepole pine	Warm-moist	7	2
Hungry Horse, Middle Fork, North Fork, and South Fork	All except lodgepole pine	Cool-moist	5	2
Hungry Horse, Middle Fork, North Fork, and South Fork	All except lodgepole pine	Cold	4	1
Hungry Horse, Middle Fork, North Fork, and South Fork	Lodgepole pine	All	2	1
Salish Mountains and Swan Valley	All except lodgepole pine	Warm-dry	9	2
Salish Mountains and Swan Valley	All except lodgepole pine	Warm-moist	13	3
Salish Mountains and Swan Valley	All except lodgepole pine	Cool-moist	10	2
Salish Mountains and Swan Valley	All except lodgepole pine	Cold	10	1
Salish Mountains and Swan Valley	Lodgepole pine	All	7	1

Similar to the development of desired conditions, levels of snags that existed prior to the recent large fire events guided the development of minimum snag retention levels (Trechsel, 2017i). Comparison to current snag conditions outside wilderness and inventoried roadless areas was also done in order to not only maintain but to also contribute towards an increase in snags in these areas that are likely to have greater amounts of active vegetation management. In all snag potential vegetation types and forest dominance types, the minimum density retention standard established in the forest plan is higher than the snag densities in Bollenbacher et al. (2009) inside wilderness and roadless areas (table 28) and higher than the current densities outside wilderness and roadless areas for both the > 15 inches d.b.h. and > 20 inches d.b.h. snag components (table 27). The purpose is to promote the overall improvement of snag density levels across the managed landscape of the more valuable existing snags and, if snags are not available, to leave replacement trees at levels that would have the potential to provide for snags in the future after the existing snags have fallen.

Live replacement snags

The presence, abundance, and distribution of long-lasting large-diameter snags of high-value species depends entirely on the presence, abundance, and distribution of these species and size classes as live trees across the landscape. Retention of live trees—either those deliberately left as snag replacements (such as the decadent trees) or those left for other reasons—are acknowledged as an important feature in the overall snag management strategy (FW-GDL-TE&V-09; FW-GDL-RMZ-08). Many snags are fairly short lived. Leaving live trees, especially those that may grow into larger sizes, and leaving decadent trees to gradually deteriorate and die is a strategy that would provide a more consistent and steady supply of snags over time across an area. Managing forests to achieve desired species compositions and size classes is also part of the overall strategy to ensure the future recruitment of snags, especially of desired species such as western larch and ponderosa pine. The desired conditions for both these species are for an upward trend over time.

The snag retention standards for harvest areas require leaving live snag replacement trees if insufficient snags are available to meet the minimum levels. A snag replacement tree would be retained for each unavailable snag in order to achieve the required minimum density of snags or live replacement trees within timber harvest areas. The snag retention standards specify the characteristics required for snag replacement trees. They are to be of the largest sizes present, decayed or decadent trees if present, and the following species if present: western larch, ponderosa pine, Douglas-fir, cottonwood, aspen, birch, or western red cedar. This is designed to retain those trees with qualities that tend to provide high-quality snag habitat. Live snag replacement trees that are decayed or have broken tops may provide equal or even greater values than dead trees by providing nesting and feeding habitat both in the present and, because they are still alive, persisting for some time into the future. In some cases, depending upon the condition of the live snag replacement trees, they may have the potential to grow into larger-diameter trees that would ultimately become larger-diameter snags once they eventually die.

In addition to the presence of larger-diameter trees, there is also evidence that the condition of larger trees prior to their death is an important factor in their value and persistence once they become snags. For example, repeated low-severity fire and the age of the trees appear to be factors in the long-term persistence of ponderosa pine snags. The injury and resulting pitch flow to the base of the trees, in addition to the advanced age of the trees and their dense wood characteristics, appear to contribute to the long-term persistence of these trees once they die and become snags (H. Y. Smith, 1999). Emphasis on the use of fire under all the action alternatives to maintain desired stand conditions, particularly in the warm-dry potential vegetation type, may contribute the the desirable snag habitat conditions as well.

Another forestwide guideline, FW-GDL-TE&V-09, requires the retention of a minimum of three live reserve trees within regeneration harvest areas. Although the primary intent of this reserve tree guideline is to contribute to the maintenance and/or development over time of very large trees of desired species, the reserve trees would also serve as future snag recruitment trees. The reserve tree guideline specifies that reserve trees should be western larch or ponderosa pine trees greater than 17 inches d.b.h. where present, which are also the size and species that would potentially create the more desired and persistent snag habitat. These species and size classes are more resistant to fire and other disturbances. They would tend to have more potential than snag replacement trees to grow into even larger-diameter trees, perhaps to become the “legacy trees” that persist through multiple fires and eventually become very large snags when they finally die. Where western larch or ponderosa pine greater than 17 inches d.b.h. are not present, the direction requires consideration of alternative species, sizes, and conditions. These alternatives may be smaller-sized western larch or ponderosa pine, or other species, such as Douglas-fir, that might also become desired future snags. The live tree reserve guideline thus is expected to contribute substantially to the long-term development of future snag habitat in harvest areas.

For both the snag retention standards and for FW-GDL-TE&V-09, snag replacements or reserve trees that would cause unacceptable impacts to regeneration (e.g., dwarf mistletoe infection or a potential dysgenic seed source) are not required to be left. This acknowledges that there are other desired conditions in these landscapes that are important to achieve for both ecological and socioeconomic reasons, such as creating stands that are healthy and resilient, as well as providing for the sustainable and desired production of timber products (refer to Trechsel, 2017i).

Modeled comparison—Future snag conditions by alternative

Wildfire, insects, and diseases will provide the main source of snags and downed wood into the future on the Forest. Figure 58 in section 3.8.3 displays the minimum, maximum, and average acres per decade of fire as modeled over a five-decade future period by alternative. Appendix 2 and Trechsel (2017g) also provide information on fire and insects and disease as modeled. The amount of disturbances is similar among all the alternatives, linked closely to climatic conditions. It is apparent that abundant amounts of snags would be available through the natural processes of fire, primarily, but also of insects and disease, as discussed earlier (see the “Affected environment” and “Environmental consequences” sections). Because of its high susceptibility to insect and disease and its abundance as a species across the Forest, Douglas-fir is expected to make up a large portion of the larger-diameter snags (e.g., greater than 15 inches d.b.h.) in the future under all alternatives.

Quantified estimates of future snag densities (of snags greater than 10 inches d.b.h.) and change over time were derived using the Spectrum model (refer to appendix 2). Snag levels were calculated for each model cover type and size class (the prescriptions for regeneration harvest provided for the retention of trees as future snags). The yield tables then tracked the snag amounts as they changed over time, primarily driven by fire, insects, and disease but also to a smaller degree by harvest and prescribed burning treatments. See appendix 2 for details on the Spectrum model and analysis and Trechsel (2017i) for a table showing the change in snag conditions over a five-decade future model period. Modeled changes are summarized below.

Spectrum provided information on future trends for two size class categories of snags: 10 to 20 inches d.b.h. and greater than 20 inches d.b.h. The modeling indicated that all alternatives have a similar trend in the densities of snags over the five-decade model period. For areas with 10-to-20-inch-d.b.h. snags, the proportion of the Forest with less than 10 snags per acre decreases and the proportion with 10 or more snags per acre increases. For areas with snags greater than 20 inches d.b.h., the proportion of the Forest with 1 to 3.9 snags per acre decreases and the proportion of the

Forest with less than one or more than 3.9 snags per acre increases. Essentially, the amount of area with a higher density of snags increases over time to a level that is fairly similar among the alternatives. At the fifth decade, modeling suggests that about 30 percent of the Forest has greater than 10 snags per acre in the 10-inches-and-larger size class, and about 9 percent of Forest has greater than 4 snags per acre in the 20-inches-and-larger size class. Refer to Trechsel (2017i), attachment 2, for more details on these results. These model results suggest that snag amounts would increase over time, in response mainly to fire and other natural disturbances, and there does not appear there will be a decline or a shortage of this ecosystem component under any alternative.

The models provide no quantitative estimate of change in downed woody material over time. However, based on the amount of natural disturbances expected and the changes in snags modeled to occur over time, it is likely that downed woody material would also be available and sufficient to meet desired conditions.

Summary of effects

In all action alternatives, the forest plan desired conditions that emphasize the important ecological values of snags. The forestwide effects to snags and snag habitat would be similar under all the action alternatives, primarily because the great majority of lands on the Forest in all the alternatives are identified as unsuitable for timber production (see section 3.21) and thus would be influenced mostly by natural ecological processes and disturbances that would add and remove snags. These lands include the extensive network of riparian management zones across the Forest, particularly within the management areas where more active vegetation management may occur. The amount of disturbances as modeled into the future are similar among all the alternatives, linked closely to climatic conditions. It is apparent that abundant amounts of snags forestwide would be available through the natural processes of fire, primarily, but also of insects and disease.

The amount and distribution of lands across the Forest where active vegetation management is expected to occur (particularly timber harvest) would potentially influence the distribution of snags across the Forest. There might be small differences between the alternatives based on this factor. Alternative C has the most lands identified as unsuitable for timber production across the forest, with the least amount of expected timber harvest. Generally, with less harvest there would be less areas that would have snags and live trees (potential future snags) removed for economic value or other resource reasons, compared to alternatives A, B modified, and D. However, the standards and guidelines that provide for snag retention within the harvest areas are expected to provide for desired snag densities and distribution across the Forest, both in the present and in the future, and contribute to the habitat needs of species associated with snags (see section 3.7).

3.3.8 Landscape pattern

The general pattern of forest structural patches across the landscape is discussed in this section. Forest pattern as related to the connectivity of wildlife habitat, including connectivity associated with riparian areas, is discussed in section 3.7 of this EIS. For example, smaller but more numerous and discontinuous patches of forest structural types across a landscape, as opposed to fewer but larger, contiguous patches, influences wildlife habitat connectivity. Different wildlife species are associated with different forest conditions, for example, grass/forb/shrub communities, riparian areas, or dense coniferous forest communities. In the wildlife section of this EIS, changes in landscape connectivity associated with mature forest patches is analyzed and discussed (see section 3.7.4, subsection "Coniferous forest habitat" and section 3.7.6, Wildlife habitat connectivity). In the section below, forest connectivity is discussed more broadly and qualitatively, with a quantitative analysis of forest openings (seedling/sapling-dominated forests) patch sizes.

Affected environment

The numerous ecological, social, and economic values that forests provide are heavily influenced by the spatial patterns that exist on the landscape (Turner, Donato, & Romme, 2013). The spatial pattern of forest conditions across a landscape can affect ecological processes, including wildlife and plant habitat and dispersal; disturbance risk, spread, and size; and human aesthetic values.

Connectivity in terms of wildlife habitat refers to the abundance and spatial pattern of habitat and to the ability of animals to move from patch to patch of similar habitat. Corridors are a means by which connectivity can be provided. Contiguous patches of forest in similar conditions (e.g., size of trees, density) can facilitate the ability of animals to move across the landscape to more fully utilize available habitat. Refer to section 3.7 of the final EIS for a full discussion of landscape patterns in relation to their effects on wildlife.

Landscape patterns characterized by large areas of densely stocked forests and widespread, broad-scale homogeneity can increase the potential for large, high-severity fire. Research has shown that the spread of wildfires and the potential for large fire growth across a landscape can be limited by reducing fuel continuity (Ager, Valliant, & Finney, 2010; Collins et al., 2008; Finney, 2007; Finney & Cohen, 2003; Hessburg, Salter, & James, 2007; Safford, Schmidt, & Carlson, 2009; Scott L. Stephens et al., 2009). In addition, large landscapes (e.g., wilderness areas) where wildfires have been allowed to burn can develop fuel heterogeneity; therefore, future fires could be limited in size relative to other landscapes that have more homogeneity in fuel conditions (Bollenbacher, 2010; Collins et al., 2008; Rollins, Morgan, & Swetnam, 2002; Van Wagtendonk, 2004). Also, patterns of old burns can delay and detour the spread of new fires.

Large expanses of forest with fairly homogeneous conditions of host species of susceptible characteristics can create increase the potential of bark beetle outbreaks (Fettig et al., 2007; Samman & Logan, 2000). For bark beetles (as well as other insects or diseases), the severity of outbreaks and tree mortality can be reduced in extent by increasing the diversity of stand ages, size classes, and tree species in landscapes that are homogeneous (Bollenbacher, 2010).

Forest patterns are influenced by a number of factors, including physical site conditions (e.g., soil productivity, moisture, topography), forest characteristics (e.g., densities, species compositions, and different rates of growth and change over time), and disturbances (e.g., type, severity, and size of area affected). Disturbances are a primary factor on the Forest; they influence landscape patterns, particularly the more severe ones that dramatically alter existing forest densities, species, size classes, and other characteristics. Fire is one of the more dominant agents of change under the stand-replacement fire regimes common across the Forest. A typical scenario within the Flathead ecosystems occurs when stand-replacement fire resets forests back to the early-successional stage, creating openings dominated by grass, forbs, shrubs, and seedlings/saplings for a period of time (up to 30 years or so on most sites on the Forest). Periodic episodes of large-scale and widespread fire, typically associated with extended periods of warmer climatic conditions and abundant forest fuels, create very large openings across the landscape. The forests recover, and as they grow into small and larger forest size classes, variability in densities, species compositions, and structures will create diversity in the pattern of forest conditions within the original fire boundaries. Smaller and/or more mixed-severity fires may also occur, creating smaller new openings of early-successional forest and adding to the diversity of forest conditions and patterns. Eventually, climatic conditions and weather will combine with forest fuel conditions to create another period when fires are more extensive and severe, resetting portions of the landscape back to early-successional conditions once again.

For broadscale analysis of landscape patterns at the scale of the Forest and the development of forest plan components based on the natural variation in patterns, the size and distribution of patches in the early-successional seedling/sapling forest size class form the basis of the analysis and description of forest pattern and connectivity. As described earlier in section 3.3.1, subsection "Vegetation succession," this is the stage where a distinct opening exists, where grass, forbs, and shrubs are more dominant than tree canopies. This creates a patch that forms a strong contrast with and is distinctly different from adjacent forests in the small, medium, or larger size classes (e.g., the patch creates a forest "edge"). Not only does this allow for more accurate detection and measurement of the patch and resulting landscape patterns (for analysis of both current and historical conditions), but the early-successional forest patch type is particularly meaningful when evaluating wildlife habitat conditions, forest cover, and connectivity. The larger trees and denser forest cover present in the mid- and late-successional forests between the patches of early-successional open areas provide the connectivity of habitat important to many wildlife species (see section 3.7.6 for more detail on forest connectivity for wildlife species). Early-successional stages also represent a crucial initiation point of forest development, and forest conditions and landscape patterns created at this early stage greatly influence the conditions and patterns of forest compositions and structure in the future (Bentz et al., 2010).

The Flathead National Forest's assessment (USDA, 2014a) provided a summary of key findings related to current and historical conditions of forest patterns. This came from a historical range of variation analysis conducted on the Forest in the late 1990s by Hessburg et al. (for more information, see USDA, 2013d). That historical range of variation analysis for the Forest noted significant departures from historical conditions in patch sizes and density for nearly all forest structural classes forestwide. This trend mirrored that occurring in the larger northern Rocky Mountain ecoregion (Hessburg et al., 1999; Hessburg, Smith, Salter, Ottmar, & Alvarado, 2000; USDA, 1996b), where drastically increased forest fragmentation was noted. The Hessburg et al. analysis found a decrease in patch size and a corresponding increase in patch density for most of the forest structure classes (generally equating to forest size classes), resulting in a trend of increasing forest fragmentation. This change was most dramatic for the early-successional forest patches (e.g., seedling/sapling forest size class), and the pattern for the early-successional forests was found to be outside the range of historical variability. Also of concern was the pattern for forests in a closed-canopy, single-storied stand structure (which generally equates to the small and medium forest size classes as used in this EIS), which were found to have more and much larger patches across the Forest. This appeared to be attributable to the transition of historical large, early-successional forest patches created by fire to densely stocked mid-successional forest structures.

For this EIS, an updated analysis of historical, or natural, range of variation in early-successional forest patches was conducted because large areas of the Forest have experienced fire since the earlier Flathead historical range of variation analysis was completed. The natural range of variation in fire disturbance formed the basis of this analysis because it is primarily fire that creates the most distinctive openings on the landscape. Figure 34 displays the natural range of variation in fire for the Forest, as modeled using the SIMPPLLE model. Refer to Henderson (2017), USDA (2017f), and USDA (2017k) for details related to this analysis.

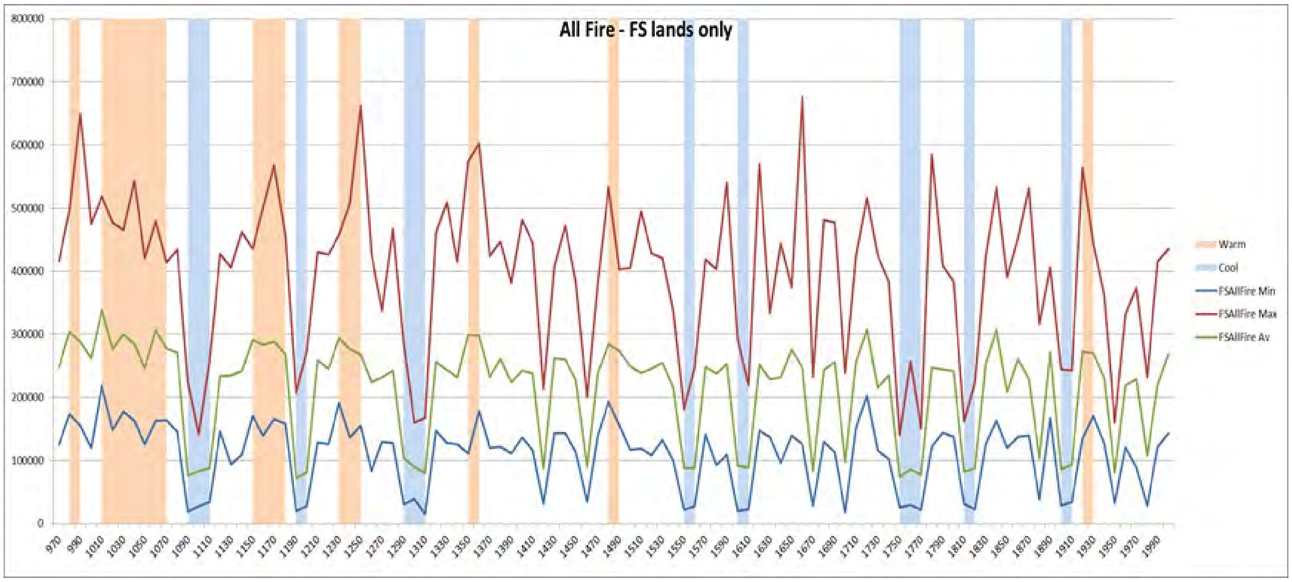

Figure 34. Estimated natural range of variation in total acres of fire (all severities) by decade on Flathead National Forest land over the past 1,200 years. Warm, cool, and normal climatic periods are displayed. Source: SIMPPLE model.

The natural range in variation of the early-successional forests created by this historical pattern of fire is displayed in table 38. Refer also to the summary of early-successional and seedling/sapling patch size analysis for the Forest (Trechsel, 2017k).

Table 38. Natural range of variation in early-successional forest patch size (acres) created by stand-replacement fire, forestwide and by potential vegetation type, on all land ownerships within the administrative boundaries of the Forest.

	Arithmetic average patch size (acres)			Area weighted mean[a] patch size (acres)		
Potential vegetation type	**Global average**	**Minimum**	**Maximum**	**Global average**	**Minimum**	**Maximum**
Forestwide	288	171	442	37,668	14,523	68,933
Warm-dry	102	84	134	15,972	6,131	41,685
Warm-moist	103	74	128	4,126	1,791	7,042
Cool-moist	188	133	247	16,924	7,812	27,117
Cold	83	70	102	963	646	1,498

Source: SIMPPLLE model, wildfire events as simulated over the past 103 decades, average of 30 repetitions.

a. Area weighted mean: Each patch gets a weight based on the size of the patch; the bigger patches get more weight.

The natural range of variation analysis for early-successional patch sizes indicates that there was rarely if ever a decade historically when no openings or early-successional forest were created by fire somewhere across the Forest and within each potential vegetation type. The great majority were relatively small (as indicated by the arithmetic average), indicating that over most of the time period the disturbances (mainly fire) that created these patches were not very large scale. More mixed-severity fires tended to occur in between the infrequent but dramatic periods of large-scale stand-replacement fires (Trechsel, 2017f). However, when the big fires did occur, they were very large indeed (as indicated by the area weighted mean). These large fires, or series of fires within a one- or two-decade period, would typically be associated with extended warm climatic periods and drought conditions.

To determine the current patch size of early-successional forest openings, forests that had been burned with wildland fire or harvested within the past 25 years were included in the analysis. Total acres, mean patch size, range in patch sizes, and number of patches currently existing across Forest lands were determined using up-to-date (as of 2013) fire and harvest maps (Trechsel, 2017k). The data sources and methods used to determine the current patch size of early-successional openings are quite different from those used to determine the natural range of variation. In addition, the natural range of variation analysis considered all lands, not just Flathead National Forest lands. Therefore, direct comparison and results need to be interpreted carefully and in that context. However, this information does provide some insight into the present conditions and pattern of these early-successional forest openings across the Flathead in the context of historical variation. The results are displayed in table 39.

Table 39. Current condition of early-successional forest patch size (acres), forestwide and by potential vegetation type, on Flathead National Forest lands

Potential vegetation type	Arithmetic average size of patch	Minimum size of patch (acres)	Maximum size of patch (acres)	Count of patches	Sum of acres in early-successional forest patches
Forestwide	108	5	41,781	4,028	437,390
Warm-dry	57	5	5480	969	55,223
Warm-moist	28	5	363	364	10,158
Cool-moist	185	5	41,782	1,734	320,844
Cold	72	5	3,000	611	43,844

Source: Forest Service Activity Tracking System (FACTS) database and spatial GIS layers in the Flathead National Forest GIS library.

Recent fires (i.e., within the past 25 years), burning about 17 percent of Forest lands, have created the majority of current early-successional forest acres. Timber harvest comprises a much smaller portion of the total acres of the current early-successional forest patches, with an estimated 72,000 acres, or 3 percent of Forest lands, harvested with regeneration cuts during the past 25 years. Comparing the current average in table 39 to the historical global average it appears that current patch sizes forestwide and as distributed across the Forest in the potential vegetation types is not dramatically different from an expected historical condition. In addition, the maximum size of patch appears consistent with historical conditions at the forestwide scale, although the acres vary substantially when considered at the potential vegetation type scale. Very large patch sizes appear to occur historically in the warm-dry type, whereas the largest patch sizes currently are within the cool-moist type. This is likely due to the fact that the historical analysis considered lands in all ownerships, and the warm-dry potential vegetation type occupied a much larger area historically, including most of the main Flathead Valley and lower-elevation foothill lands surrounding the valley. These areas are nearly all in non-NFS ownership currently and are not included in the totals provided in table 39.

In summary, in the ecosystems of the Forest, fire has been and continues to be the primary process that creates early-successional forest patches and their size and distribution within the larger matrix of mid- and late-successional forests. Fires occurred historically with regularity, with hardly (if ever) a decade passing without a fire occurring somewhere on the landscape. During wetter climate cycles, these fires might be relatively small, scattered, and less severe; during drier climate cycles, large fires thousands of acres in size could occur. The pattern of forest openings intermixed with areas of denser mid- and late-successional forest would thus always be changing over time and space, influenced by

disturbances and the continuous process of succession. There would be periods of time when relatively large portions of the landscape would consist of a large open area with very little forest in the mid- and later successional stages. This is similar to the pattern that currently exists in parts of the Flathead National Forest due to the recent large amount of fire. Variation in forest structures would occur even within the boundaries of these large fires, including patches of unburned forest or forest burned at a lower severity and individuals and clumps of trees that survived the fire, which would contribute to a diversity of forest patterns over time.

Environmental consequences

Effects common to all alternatives

The existing 1986 forest plan and the forest plan include plan components that address the desire to manage for landscape patterns similar to those expected under natural disturbance and succession regimes. Under all alternatives, the majority of the Forest is primarily influenced by natural disturbance processes rather than by timber harvest activities (see table 20). Moderate- and high-severity fire (both wildfire and prescribed fire) is a major disturbance process that would be expected to occur within these areas, creating future early-successional forest patches as well as diversity in other forest structural conditions (density, size class). The amount of fire that potentially could occur in future years (refer to figure 58 in section 3.8.3) and the resulting amounts of seedling/sapling size class, as well as lower-density forests (such as those created by fires of low or moderate severity) that would be created over time, would have the potential to create a pattern and patch size across most of the landscape that would be similar to natural disturbance and succession regimes. In areas where fire is aggressively suppressed, early-successional patches will likely be smaller in size on average. However, even in these areas larger patches of early-successional forest will also likely occur, as recent experience has indicated that not all fire is likely to be eliminated under even the most aggressive suppression strategies.

Warming climates may alter this scenario in the future. It is expected that extended periods of warm (and associated dry) conditions may increase both fire size and severity (Rachel A. Loehman et al., in press), and this may create patterns that would deviate from historical conditions. Refer also to discussions in section 3.8 about climate and future fire projections.

Effects common to alternatives B modified, C, and D

The forest plan recognizes the importance of forest patterns in contributing to overall ecosystem and landscape resilience. The action alternatives emphasize managing for resilient landscape patterns and for the connectivity of forest conditions that provide for the needs of wildlife species (refer to section 3.7 for details on wildlife effects). Specific forest plan components are provided that describe desired conditions for forest patterns forestwide and by potential vegetation types (FW-DC-TE&V-03 and 18). The desired condition is for the pattern of forest structures across the landscape to be consistent with the spatial and temporal arrangement that would occur under natural disturbance regimes. Describing and measuring forest patterns can be convoluted and complex. As described under the “Affected environment” section, the size and distribution of patches in the early-successional seedling/sapling forest size class form distinct openings within the denser forest landscape and are used to evaluate pattern and connectivity at the forestwide scale. As would occur under the natural fire regimes, it is desired that early-successional patches vary widely in size, shape, and conditions (such as tree density and number of canopy layers). The majority of seedling/sapling patches are less than 300 acres in size, but very large patches (i.e., those greater than 30,000 acres) are expected to occur, although less commonly (e.g., they may exist for one 20-year period over a 100-year time span). Largest patch sizes are desired to occur predominantly within wilderness and large unroaded areas, and smaller patch sizes (less than 300 acres) occur mostly outside these areas. In addition,

each potential vegetation type has its own unique desired patch and pattern characteristics, as described in the forest plan (FW-DC-TE&V-18).

The forest plan recognizes that the forest conditions created by fire are a critical component of the ecosystems of the Flathead National Forest and of the life cycles of numerous native plant and animal species that evolved under these natural disturbance regimes. Desired conditions for fire as an ecological process and for forests that have experienced recent fire are components in the forest plan (FW-DC-TE&V-24, 25; FW-DC-FIRE-03, 04). This would contribute to maintaining and creating landscape patterns consistent with the natural range of variation.

Fire suppression and past forest management activities alter forest patterns. In some cases, these practices can create landscape patterns that are outside the natural range of variation, as suggested by the study of the historical range of variation conducted in the 1990s on the Flathead discussed earlier in this section. Generally, large stand-replacing fires are not desired in areas of the Forest where adverse effects to social, economic, or other values might occur. In these areas, a more active management approach in managing for landscape patterns within the natural range of variation is emphasized. Active management tools would include both fire and treatments such as thinning and timber harvest. The forest plan includes components that provide direction for the use of fire across the Forest consistent with its natural role (FW-GDL-FIRE-02). The forest plan has guidance for the maximum size of regeneration harvest units that is more consistent than existing direction in regard to the size of early-successional forest patches under natural disturbance regimes (FW-STD-TIMB-07). Refer to Trechsel (2017d) for the analysis associated with the development of this standard. The inclusion of forest plan components that recognize and address landscape patterns and connectivity ensures that the desired conditions are more likely to be achieved under the action alternatives, both on lands where fire and other natural disturbances will be primary and on lands suitable for timber production, where harvest will be a more dominant disturbance.

Modeled comparison of alternatives

Patch analysis and the modeling of changes in wildlife corridor areas was conducted for wildlife species associated with coniferous forests. Refer to section 3.7.4 and to the discussion on marten under the subsection “Coniferous forest habitat.”

3.3.9 Summary of modeling results and environmental consequences related to forest resilience

Promoting resilience is one of the most commonly suggested management options for addressing future uncertainties associated with stressors on the ecosystem, including climate changes and potential effects to disturbance regimes (Dale et al., 2001; Price & Neville, 2003; Spittlehouse & Stewart, 2003). Resilient forests are those that not only accommodate gradual changes related to climate but tend to return towards the prior condition after the disturbance ends, either naturally or with management assistance (Millar et al., 2007).

In the above sections on vegetation composition, forest size class, and forest densities, a discussion and comparison of future anticipated vegetation conditions as modeled for the alternatives was provided for each of the individual vegetation key ecosystem characteristics. Effects over time were discussed in the context of how they contribute to the overall goal to maintain or achieve resilient and resistant forest conditions on the Flathead National Forest. This goal, or desired condition, is a foundation of the Forest’s adaptation strategy to address current stressors and future uncertainties, such as those associated with climate change and related disturbances. In combination, the changes over time as modeled for each of these individual vegetation components contribute to achieving the desired species and forest structural diversity at both the stand and landscape scale. This section

provides a summary of effects by alternative that integrates the effects of the individual vegetation components that were addressed in the earlier sections of this final EIS. Refer to section 3.3.1, subsection "Climate," for further discussion on the adaptation strategy and the approach at the programmatic level that the Forest is employing to address climate change. Also refer to section 3.3.1, subsection "Modeled disturbance processes and treatments," under the modeling portion and to appendix 2 for more details on the modeling process and the outputs of the modeling. See appendix 7 for a table that displays features of the climate change adaptation strategy of the Flathead.

The primary modeled vegetation conditions and desired changes that are key to forest resilience over time are listed below.

Vegetation composition

- Increased presence and dominance of ponderosa pine
- Increased presence and dominance of western larch
- Increased presence and dominance of whitebark pine
- Increased presence of western white pine
- Limited dominance of Douglas-fir, particularly in the warm-dry potential vegetation type
- Limited dominance of subalpine fir, particularly in the overstory layers and in the cold potential vegetation type (whitebark pine habitat)
- Maintained uncommon species or vegetation types, specifically hardwood and persistent grass/forb/shrub communities

Forest size class

- Decreased proportion of small and medium size classes (on all but the warm-dry potential vegetation type)
- Increased proportion of large size class
- Increased proportion of very large size class and presence of very large trees (> 20 inches d.b.h.), particularly species resistant to fire, insects, and disease

Forest density

- Reduced high-density forest conditions where appropriate, focusing on the wildland-urban interface and the warm-dry and cold potential vegetation types

Environmental consequences

There are more similarities than there are differences in the modeled results and changes in vegetation conditions over time between the alternatives. Generally, the alternatives almost always follow similar trends, with variation mostly limited to the rate and degree of change over the five-decade model period.

Considering all the vegetation components listed above and the trends compared to desired conditions, all alternatives result in an overall improved condition on the Forest related to the resilience and resistance of the forests of the Flathead over the five-decade model period. This suggests that the management of the Forest (as guided by forest plan direction), in combination with natural ecological processes and disturbances, will maintain ecological integrity and contribute to social and economic sustainability.

Increased proportions of western larch, ponderosa pine, and western white pine, in combination with increases in proportions of large and very large size classes suggest that forests would be better able to recovery rapidly after fire and to reestablish more desired species compositions in the post-fire

landscape. The higher proportion of ponderosa pine in combination with less Douglas-fir on the warm-dry type, associated with increase in forest size classes and decreases in forest density, suggests that forests on this type are becoming much more resilient and are shifting to conditions that would occur under the lower- and more moderate-severity fire regimes that occurred historically on these sites. Increases in western white pine as well as western larch on the warm-moist type suggests that the forests on these most productive sites are becoming more diverse and that species compositions may be moving closer to natural conditions where western white pine played an important role. Subalpine fir is still a dominant species, which is consistent with natural variation, although the increase in this type in some parts of the Forest is likely to continue to contribute to the risk of large higher-severity fire. This is not unnatural on the Forest and is an accepted and expected natural disturbance process, but there may be areas where treatments (mainly prescribed fire) would help to break up the homogeneity of the landscape and reduce the severity of impacts from fires. An overall decrease in high-density forests is generally positive from the standpoint of forest resilience in that it suggest that competition and associated moisture stress are reduced and tree vigor and growth are improved, which contributes to the development of large and very large trees. Improved tree vigor reduces impacts due to insects and disease, particularly if resistant species, such as western larch and ponderosa pine, are dominant. Reduced densities create less forest fuels and reduce the potential severity of fires when they do occur, increasing the probability that some trees will survive.

Comparing alternatives, the model results suggest that, overall, alternative B modified is the best at maintaining or achieving desired conditions and trends related to forest resilience, particularly in regards to species compositions. Alternative D is not far behind, followed by alternative C, which is particularly favorable in regards to an increase in the very large forest size class. Alternative A has the least favorable results overall. However, this should all be put in the context that most of the trends were favorable under all the alternatives and that the difference between alternatives was usually minor, as modeled.

All the alternatives have similar amounts of modeled natural disturbances, such as fire and insects or disease activity, which would influence vegetation conditions (including snags and downed wood) and landscape patterns over time similarly between the alternatives (refer to discussions in earlier sections of this chapter). The only difference is with alternative A, which does not have any prescribed fire in the model. The differences among alternatives suggest that active vegetation management, with the objective of achieving desired conditions for the resilience components, is of some importance to improving the rate of desired changes in vegetation over time, particularly associated with tree species diversity, promotion of early-successional species, and the effects to the very large tree size class. Timber harvest treatments (with associated reforestation) and prescribed fire can be designed and strategically located to treat forest types and sites in ways that promote desired species compositions. Areas where active vegetation management, particularly regulated timber harvest, can occur comprises 17 to 30 percent of the Forest area (varies depending upon alternative), so the ability to influence vegetation with these activities is limited (see section 3.3.2).

3.3.10 Consequences to vegetation and terrestrial ecosystems from forest plan components associated with other resource programs or management activities

Effects from access and infrastructure

In all alternatives, limits related to road access on existing roads as well as construction of new roads (both permanent and temporary) could have a substantial impact on the ability to conduct vegetation treatments that require road access, particularly mechanical treatments and timber harvest, across lands suitable for timber production. This is because lack of road access increases the costs

associated with vegetation treatments. This occurs both with treatments that are most efficiently accomplished through the use of mechanical methods (such as use of rubber-tired skidders and logging trucks to remove trees from the woods) and with hand treatments (such as the ease and distance of walk-ins to treatment areas). To achieve the direction in the existing 1986 forest plan (alternative A), an estimated 518 miles of existing roads would need to be reclaimed and either left on the transportation system as reclaimed or taken off the transportation system as decommissioned. Alternatives B modified and D would maintain existing road density and management. Alternative C would reduce the amount of existing wheeled motorized trail use by an estimated 75 miles and decommission (take off the transportation system) 48 miles of currently closed roads. These limits are largely associated with grizzly bear conservation direction, recommended wilderness allocation, and wildlife security. In addition, all alternatives would apply access and road use limitations within areas identified as grizzly bear secure core. Limited access to conduct desired vegetation treatments would affect the ability to achieve desired vegetation conditions. The reduction in access under alternative A would limit vegetation treatment the most, followed by alternative C. Although there are restrictions on access and road management in alternatives B modified and D, they would be the least limiting of the four alternatives.

Certain vegetation treatments in areas of higher scenic values may also be limited due to incompatibility with forest plan components related to scenic integrity. The effect to scenery is typically localized and would be determined during project-level analysis.

Effects from timber management

Timber harvest is one of the tools available to change vegetation conditions for the purposes of maintaining or moving towards desired vegetation conditions. Plan components discussed in section 3.21 provide direction regarding this purpose for harvest, including desired conditions (FW-DC-TIMB-01, 05, 06) and a standard that ensures the restocking of trees in harvest areas (FW-STD-TIMB-02).

Forest plan direction guiding timber harvest activities is provided in a number of other sections of the forest plan to protect other values associated with vegetation conditions, such as harvest in riparian areas, in areas with known plant or animal species of conservation concern, or in areas with threatened and endangered species (refer to the relevant sections of the plan for direction). Timber harvest also has other purposes in addition to contributing towards vegetation desired conditions. These include providing jobs and income to local economies and contributing to economic and social sustainability. In areas that are suitable for timber production, these values associated with economics and timber products are equal to the values associated with ecological sustainability and the achievement of vegetation desired conditions.

The forest plan includes components for burned forest conditions (FS-DC-TE&V-25) and the habitat it provides for associated species. Salvage harvest may occur in burned areas, removing some of the snags for their economic value as timber products. The plan contains direction to ensure that snags and downed wood would be retained within salvage areas at levels that would provide for snag-associated wildlife species (FW-GDL-TIMB-01, 02, 03). The majority of the Flathead National Forest is in wilderness, recommended wilderness, or inventoried roadless areas, where harvest, including salvage, would be prohibited or greatly limited and where natural disturbances would be predominant, including fire that creates abundant burned forest conditions.

The forest plan includes direction in the Forest Vegetation Products: Timber section that increases the maximum opening size that may be created through regeneration harvesting in order to be more consistent with the natural range of variation for early-successional forest in this ecosystem. This is a

positive effect in regard to the Forest's management flexibility and the ability to maintain or trend towards desired conditions for vegetation patterns across the landscape.

Effects from wildlife management

The effects of grizzly bear standards that limit road access were discussed above under "Effects from access and infrastructure."

For the most part, desired conditions and associated standards and guidelines for vegetation conditions and management would benefit from and provide for the wildlife habitat conditions that support the many native species on the Flathead. This is the coarse-filter approach to providing ecological integrity, as discussed in the introductory sections of this chapter. However, there are potential impacts under all alternatives resulting from forest plan standards associated with the Northern Rockies Lynx Management Direction (NRLMD). Two standards in particular within the NRLMD might potentially impact the effectiveness of maintaining or moving towards achieving desired vegetation conditions across portions of the landscape within Canada lynx habitat, which covers an estimated 1.8 million acres (about 75 percent) of the Forest. An exception to the standards occurs within wildland-urban interface areas. Approximately 402,000 acres of NFS lands lie within wildland-urban interface areas, and approximately 239,000 of these acres (59 percent) is potential lynx habitat. These standards are designed to benefit the Canada lynx, a species listed as threatened under the Endangered Species Act. However, ecological conditions and management efforts that may be beneficial and supportive to the recovery of Canada lynx may result in less beneficial or negative impacts to other species or to other resources, including those related to social or economic conditions.

A very brief and paraphrased summation of the content of these two standards is listed below; refer to appendix A and to the section 3.7.5, subsection "Canada lynx," for full details related to plan direction and management in lynx habitat.

> *NRLMD Standard VEG S5* does not allow precommercial thinning projects that reduce snowshoe hare habitat in seedling/sapling size stands (outside the wildland-urban interface, see figure 1-13), except in very limited situations.
>
> *NRLMD Standard VEG S6* does not allow vegetation management that would reduce winter snowshoe hare habitat in "mature multi-story forests" (outside the wildland-urban interface, see figure 1-13), except in very limited situations.

VEG S5 reduces the ability and effectiveness of achieving desired vegetation conditions across portions of the Forest by restricting the use of precommercial thinning, which is one of the most effective tools available to trend forests towards desired composition, densities, size classes (e.g., large and very large trees, promotion of desired species), and improved resilience over time. Large portions of the Forest have been recently impacted by stand-replacement fire, and fire is expected to be a common disturbance in the future. Of greatest concern related to restrictions on precommercial thinning is the potential impact on western larch and its contribution to forest resilience and desired wildlife habitat conditions (refer to section 3.3 for more details on the role of western larch). Western larch grows very poorly in high-density conditions and can be outcompeted in the early stages of succession by other species more able to cope well with high densities, such as lodgepole pine.

Effects related to VEG S5 restrictions would be most evident in the areas outside the wildland-urban interface and suitable for timber production. These are areas where active forest management, particularly mechanical treatments, would typically be a primary tool to influence stand conditions and achieve desired ecological, social, and economic conditions. The estimated area suitable for

timber production that is currently in the seedling/sapling size class, within lynx habitat and outside the wildland-urban interface, is estimated to be nearly 97,000 acres under alternative B modified and D and slightly less under alternative C (Trechsel, 2017j). Not all of these young stands are in a condition that is feasible or beneficial to thin at this time, nor would current or anticipated budget levels support thinning all these acres. Assuming current budget levels, there would be the opportunity to precommercially thin up to 2,700 acres per year over the life of the plan (15 years) in lynx habitat outside the wildland-urban interface (USDA, 2016b) under all the alternatives. These are thinning acres that would not qualify for thinning under VEG S5 exceptions #1, 2, 4, 5 or 6, but they have the potential to qualify under VEG S5 exception #3, which allows some thinning to occur based on new information that has gone through an approval process (see appendix A). This documentation and approval process has not yet occurred.

Restrictions on treatments in “mature multi-story forests” (VEG S6) also would potentially reduce the ability to effectively achieve desired vegetation conditions and maintain and improve forest resilience across portions of the Forest, particularly in areas outside the wildland-urban interface. There are no forestwide estimates of the current area that provides this multistory winter snowshoe hare habitat because methods are not yet available to accurately determine this stand condition (refer to discussion in section 3.7.5, subsection “Canada lynx”). However, multistory forests that have the potential to provide this habitat commonly develop on the Flathead National Forest through the forest successional process on the cool-moist, cold, and warm-moist potential vegetation types. Although VEG S6 does not apply to wildfires, it does apply to planned ignitions, e.g., prescribed fire. Prescribed fire is an important management tool on the Flathead. In lieu of wildfire use, prescribed fire is essentially the only active management tool that is feasible to use across most areas outside the lands suitable for timber production (and outside wilderness), such as in management areas 5a, 5b, 5c, and 5d. Typically, the objective of prescribed fires is to reduce stand densities, alter forest compositions, and create more diverse forest structural patterns across the landscape by removing the smaller understory trees and, in some forest types (such as subalpine fir- and lodgepole pine-dominated forests), removing some of the larger overstory trees. Prescribed fire with these objectives would not be able to occur in multistory hare habitat.

As with VEG S5, VEG S6 direction would potentially have impacts on forest resilience in portions of the Forest. Advancing succession in the cool-moist forest types would result in an increased abundance and density of subalpine fir, Engelmann spruce, and, to a lesser extent, Douglas-fir. Vegetation modeling suggests that, forestwide, the subalpine fir/spruce dominance type and the presence of subalpine fir and spruce will most likely trend upward over the next five decades (refer to section 3.3.3 under modeling results), which could indicate an increase in multistory hare habitat. Multistory hare habitat is likely to have forest structures and densities that tend to be more susceptible to high-severity fire as well as to damage and mortality of the true firs and spruce from western spruce budworm, bark beetles, and other agents. As with VEG S5, the desired condition to increase early-successional species, specifically western larch and western white pine, may be most adversely affected by the Forest’s inability to actively manage to create open conditions across portions of the landscape, largely with the use of prescribed fire but also with harvest, and then to reforest with desired species. These effects may be most noticeable in the backcountry areas (management areas 5a-5d), where prescribed fire is the most effective and feasible tool that could be used to create the diversity of forest structures desired. However, wildfires will continue to occur whether they are planned or not and will likely burn mostly at high severity in these vegetation types. These fires will convert multistory hare habitat to open forest and/or early-successional stands, as they have under the natural disturbance regimes for millennia. Warming climate may increase the potential for high-severity fires or may increase the frequency of fire (see discussions of climate in sections 3.1.2 and 3.3.1).

In areas identified as suitable for timber production and where mechanical treatments such as timber harvest are important management tools, the VEG S6 standard would potentially reduce the ability to achieve desired conditions for vegetation in potential lynx habitat, particularly outside the wildland-urban interface (figure 1-13). Although timber harvest is not explicitly prohibited by VEG S6, in practice, adhering to the standard has resulted in harvest treatments rarely being feasible in multistory habitat, due to the impact on the understory trees that results from the yarding of overstory trees, even in a partial cut such as a commercial thinning. Understory trees are key components of the multistory forest. Under alternatives B modified and D, NFS lands outside the wildland-urban interface, within potential lynx habitat, and on lands suitable for timber production comprise approximately 66 percent of the total lands suitable for timber production (approximately 307,000 acres in alternative B modified and 322,000 acres in alternative D). In alternative C, approximately 170,000 acres meet this criteria, or 55 percent of the total lands suitable for timber production).

Sites that support whitebark pine also occur in lynx habitat and would be subject to the same restrictions on vegetation treatments discussed above. Because whitebark pine is listed as a species of concern by the USFWS, lynx standards provide for somewhat greater flexibility for restoration treatments in whitebark pine, and restrictions on vegetation treatments due to lynx direction would have minimal impact on whitebark pine restoration. Refer to appendix A and to the effects on whitebark pine in section 3.5.1 for detailed discussion.

Western white pine is another species that is affected by management restrictions in lynx habitat. It too is a focus species for restoration efforts, and there is some flexibility provided in the current lynx habitat management direction for restoration treatments, particularly with thinning in young sapling stands, which would benefit restoration efforts for western white pine. However, open forest conditions are required for the most successful regeneration and perpetuation of this species, particularly by the planting of rust-resistant seedlings. VEG S6 restrictions would affect the Forest's ability to conduct regeneration restoration treatments for western white pine within lynx habitat and outside the wildland-urban interface. The most suitable sites for western white pine occur on the warm-moist potential vegetation type, which is mostly (70 percent) within the wildland-urban interface. There is greater management flexibility in lynx habitat within the wildland urban interface; therefore opportunities to harvest and plant rust-resistant western white pine would be greater than in areas outside the wildland urban interface. This would be beneficial in regards to achieving desired conditions for western white pine under all alternatives. However, approximately 30 percent (60,000 acres) of lands outside the wildland-urban interface are suitable habitat for western white pine. Standard VEG S6 would restrict the Forest's ability to apply restoration treatments for this species, specifically by limiting the creation of openings within multistory hare habitat where the establishment and growth of western white pine would be most likely to succeed.

Effects from fire and fuels management

Fire management that uses prescribed burning and natural, unplanned ignitions to meet resource objectives generally has a positive effect on vegetation condition. Management direction in the forest plan under all action alternatives emphasizes and provides greater flexibility in the use of both prescribed and natural, unplanned ignitions to improve vegetative conditions. As discussed earlier in this section, fire is an important tool in moving vegetation towards desired condition, especially where desired species can be established in the burned area, either through natural regeneration from on-site seed sources or through planting. Compared to alternative A, all of the action alternatives would utilize fire (both prescribed and natural, unplanned ignitions) to a greater degree, and that tool would improve the overall condition of the forest vegetation. However, as described above in the "Effects from wildlife management" section, direction related to protecting Canada lynx habitat

would likely reduce the Forest's flexibility and ability to use prescribed fire in some areas of the Forest.

In lands within the wildland-urban interface and near communities, mechanical treatment methods are likely to be most commonly used to reduce hazardous fuels and trend vegetation towards desired conditions. To achieve desired fuel conditions, there might be situations and areas where forest conditions are created and maintained over the long term at lower densities, i.e., with very open and park-like conditions, than would occur under natural disturbance regimes. Sites on the Flathead are mostly moist and support relatively densely stocked forest conditions under natural disturbance and succession regimes. There may be times when forest densities are naturally reduced through mortality agents such as beetle outbreaks or lower intensity fire events. However, this mortality simply creates new growing space, and the dead trees are soon replaced with new regeneration. Only on portions of the warm-dry potential vegetation type and the coldest sites would forests on the Flathead National Forest be naturally open, historically maintained in that condition by frequent fire or harsh site conditions. Creating long-term park-like forest conditions on the warm-moist and cool-moist types, as well as portions of the warm-dry and cold types, would be considered outside the range of natural variation. However, forest conditions would be consistent with plan direction, which provides for management of forest fuels to reduce expected fire behavior in areas where communities and community assets might be threatened (FW-DC-FIRE-02). Lower forest densities are expected and desired in portions of the wildland-urban interface (FW-DC-TE&V-13), and maintaining these low densities over the long term is anticipated (FW-DC-FIRE-07). This effect is common to all alternatives.

Effects from watershed, soil, riparian, and aquatic habitat management

All alternatives contain direction that protects watershed integrity, soil productivity, riparian values, and aquatic habitat management. This direction limits and guides the type, amount, and location of vegetation treatment activities that have the potential to impact these resources, as well as the roads needed to access treatment areas. Forest plan direction under alternatives B modified, C, and D recognizes that vegetation treatments, including prescribed fire, within riparian management zones may be beneficial and needed to achieve desired conditions. The plan provides direction to increase efficiency and flexibility for managing in certain areas within riparian management zones, as determined through site-specific analysis. Although vegetation treatments in riparian management zones are not prohibited in the existing forest plan, alternative A does not provide as clear direction and flexibility as the action alternative and thus could be more limiting on the Forest's ability to trend the Forest towards desired conditions.

Effects from recommended wilderness area allocation

Recommended wilderness areas are characterized by a natural environment where ecological processes such as natural succession, wildfire, avalanches, insects, and disease function with a limited amount of human influence. Recommended wilderness areas are not suitable for timber production, and timber harvest is not allowed in these areas. The desired conditions for recommended wilderness are to preserve their opportunities for inclusion in the National Wilderness Preservation System by maintaining and protecting the ecological and social characteristics that provide the basis for wilderness recommendation. All the action alternatives have forest plan direction stipulating that recommended wilderness areas are suitable for restoration activities where the outcomes will protect the wilderness characteristics of the areas, as long as the ecological and social characteristics that provide the basis for each area's suitability for wilderness recommendation are maintained and protected (MA1b-SUIT-03). Restoration vegetation treatments are expected to be very limited. Anticipated vegetation treatment activities would largely be associated with the

restoration of high-elevation ecosystems, particularly whitebark pine forest communities. Refer to section 3.5.1, subsection “Whitebark pine,” for detailed documentation of the effects related to the whitebark pine restoration objectives and recommended wilderness allocation. In addition to restoration activities associated with whitebark pine communities, in some of the recommended wilderness areas there may be other treatments occurring to achieve restoration objectives outlined in the plan components. The most likely treatment would be prescribed burning (planned ignition), in some cases followed by limited planting of conifer seedlings. Goals would include restoration of desired forest structure and composition (for example, to promote western larch) and desired landscape patterns.

Future wilderness designation of recommended wilderness areas is anticipated. Designation as wilderness would likely result in reduced flexibility and options for vegetation management to achieve desired conditions. The use of prescribed fire is typically very restricted within designated wilderness areas, and the ability to use unplanned ignitions (wildfire) as a tool would also be limited within some of the recommended wilderness areas. This is because of their small size and/or their locations; most wildfires would likely have to be aggressively suppressed to protect identified values (i.e., private lands). The loss of the ability to use prescribed fire treatments would limit the Forest’s ability to achieve desired vegetation conditions across portions of the landscape, such as to create openings where desired species, such as western larch or western white pine, would have the opportunity to establish. Refer also to the discussion in section 3.5.1, subsection “Whitebark pine,” for detailed information on these potential effects.

Effects from air quality management

The consequences to forest vegetation from forest plan direction related to air quality are the same for all the alternatives. All the alternatives have direction to meet the air quality standards established by Federal and State agencies and the meet the requirements of State implementation plans and smoke management plans. The direction limits the use of prescribed fire to manage forest vegetation by limiting how much can be burned and when and where prescribed fire can take place. The costs of conducting prescribed fires increases as a result of the burning regulations, which affect how much is burned. Limiting the use of prescribed fire adversely affects the Forest’s ability to move vegetation towards desired condition under all the alternatives.

3.3.11 Cumulative effects

The effects that past activities have had on all of the components of forest vegetation (e.g., forest composition and structure, landscape pattern) are discussed in the “Affected environment” section and are reflected in the current condition of the forest vegetation. Therefore, unless otherwise noted, past activities are not carried forward into the following cumulative effects analysis. In addition, the section above that discusses consequences to vegetation from forest plan components associated with other resource programs or management activities is a form of cumulative effects analysis.

Present and foreseeable future activities that could affect forest vegetation are summarized below:

Climate change

Climate is integrated into the SIMPPLLE model and is a major driver of vegetation change and effects of the alternatives over time, as discussed in the earlier sections on vegetation composition and structure. Potential effects considerations associated with climate change are described in both section 3.1.2 and in the introduction to section 3.3. As mentioned, there is a great deal of uncertainty surrounding climate change and its potential effects on vegetation conditions. However, the best available science was used to guide both the integration of future climate conditions into the

SIMPPLLE model and the evaluation of the vegetation change related to direct and indirect effects of climate change. Whether it is invasive species (e.g., white pine blister rust), drought, uncharacteristic wildfires, elevated native insect and disease levels, unusually high forest densities, or some other agent or combination of agents that serves to stress trees and forest ecosystems, recent research suggests that climate change will likely exacerbate those stressors and that “stress complexes” will continue to manifest (Robert E. Keane et al., in press).

Increasing human population

Additional stressors that may increase in the future are increasing population levels, both locally and nationally, with resulting increasing demands and pressures on public lands. As related to forest and vegetation conditions, these changes may lead to increased demands for commercial and noncommercial forest products, the elevated importance of public lands in providing for the habitat needs of wildlife species, and changing societal desires related to the mix of uses public lands should provide.

Increased regulation and concern over smoke emissions

The ability to implement the vegetation treatments that would occur under the alternatives is highly dependent upon prescribed burning (both associated with timber harvesting and without it) as well as the use of natural, unplanned ignitions to meet resource objectives. Therefore, to the extent that air quality regulations may become more stringent in regard to the quantity and timing of smoke emissions, there could be substantial effects in terms of limiting vegetation treatments using prescribed burning.

Shared border with Canada

The northern portion of the North Fork geographic area shares an international border with Canada. As such, there may be some impacts regarding the management of wildfires and whether or not the use of natural, unplanned ignitions is appropriate on the Forest when wildfires occur near the United States-Canadian border. As noted in section 3.8, the general impact might be that some natural, unplanned ignitions that ignite on the Flathead National Forest that the Forest might have allowed to burn to meet resource objectives might be suppressed as a result of objectives or concerns raised by Canadian agencies. This could have a small negative impact on the trend of the forest vegetation on the Forest towards desired conditions, but the degree of this effect is unknown.

Adjacent non-National Forest System lands

Harvesting or conversion of forests on private and state lands adjacent to the Flathead National Forest will affect vegetation conditions at the landscape level, changing forest composition and structures. Forest pattern (patch sizes, shapes) would potentially be affected by treatments on non-NFS lands immediately adjacent to NFS lands. Old-growth forest or very large trees may be removed on non-NFS lands, increasing the importance of their retention on NFS lands. Snags on adjacent private and other non-NFS lands are likely to be less abundant. Forest conditions on adjacent lands may influence the pattern, extent, or intensity of natural disturbances within forests on NFS lands, such as fuel conditions, fire hazard, or the potential spread of insect and disease populations. Forest conditions on NFS lands will be important for their contribution to maintaining the desired biodiversity at the broad landscape scale.

Adjacent State forest lands contain thousands of acres suitable for the growth of western white pine, and restoration activities for this species are occurring on these State lands, including planting and precommercial thinning. The Stillwater State Forest (approximately 93,000 acres) and Swan River State Forest (approximately 56,000 acres) are especially conducive to growth of western white pine,

due to their lower elevations and presence of warm-moist potential vegetation type. Activities to benefit western white pine on State lands contribute to those occurring on NFS lands and support the recovery of this species.

Effects from mineral extraction

Mining undergoes site-specific NEPA analysis to determine effects and required mitigation, and effects to vegetation from mining is determined at the project level. Generally, the impacts to terrestrial vegetation from mineral extraction on the Forest are very localized, and at the forestwide scale they would be insignificant.

3.4 Carbon Sequestration

3.4.1 Introduction

Carbon sequestration (storage) and associated climate regulation has been identified as a key ecosystem service provided by the Forest. This section of the final EIS addresses and compares the existing conditions and expected trends of carbon pools on the Forest, specifically the aboveground carbon pool. The potential effects of alternatives are analyzed relative to carbon storage (sequestration) potential.

The movement of carbon between the earth and its atmosphere controls the concentration of carbon dioxide in the air. Carbon dioxide is important because it is a greenhouse gas, meaning it traps heat radiation given off when the sun warms the earth. The current levels of carbon dioxide in the atmosphere far exceed the concentrations found over the past 650,000 years (M. G. Ryan et al., 2010). As a result, global surface temperatures have increased since the late 1800s, with the rate of warming increasing substantially. This warming earth will have an impact on the earth's climate, climate variability, and ecosystems. Refer to section 3.1.2 for a summary of possible climate trends and projections relevant to the Forest's ecosystems.

Regulatory framework

There are no applicable legal or regulatory requirements or established thresholds concerning management of forest carbon or greenhouse gas emissions. The 2012 planning rule and regulations require an assessment of baseline carbon stocks and a consideration of this information in management of the national forests (Forest Service Handbook 1909.12.4). Forests play an active role in controlling the concentration of carbon dioxide in the atmosphere. Forests store large amounts of carbon in their live and dead wood and soil and are an important carbon sink, removing more carbon from the atmosphere than they are emitting (Pan et al., 2011).

Methodology and analysis process

Key indicators

- Carbon pools (carbon stocks): sequestration and storage
- Natural and human-caused changes to landscape that influence carbon storage and sequestration (i.e., vegetation succession, vegetation treatments, fire, insect outbreaks, disease): influence on carbon pools

Analysis process and information sources

Existing regional-scale climate projections were used to understand the type and magnitude of climate change effects that could occur. See section 3.1.2 for a reference to the information sources related to climate changes over time and a summary of projections and expected changes related to the Flathead National Forest.

The most recent national greenhouse gas inventory (EPA, 2015) provided information at the national level on forest contributions and conditions related to carbon sequestration. The update to the Forest Service's 2010 Resources Planning Act Assessment (USDA, in review) also provided summary information on recent findings related to forest carbon conditions on all forested lands in the United States as well as projected future carbon stocks and flows.

Three models are used to assess forest ecosystem carbon (which does not include carbon estimates from harvested wood products). These are the carbon calculation tool, the Forest Carbon Management Framework (Healey et al., 2016; Healey, Urbanski, Patterson, & Garrard, 2014), and the integrated terrestrial ecosystem carbon-budget (InTEC) model (W. J. Chen, Chen, & Cihlar, 2000; F. M. Zhang et al., 2012).

The carbon calculation tool uses Forest Inventory and Analysis program data (see vegetation section 3.3, subsection “Information sources”) to estimate baseline carbon stocks and carbon stock change from 1990 to 2013, based on data from two or more years of inventories conducted since 1990 (Woodall, Smith, & Nichols, 2013). Carbon stocks are estimated by linear interpolation between survey years. Recent estimates of baseline carbon stocks and trends for forests and harvested wood products are available for forestlands on national forest land in the United States (USDA, 2015c, 2016c).

The forest carbon management framework uses Forest Inventory and Analysis program data in addition to remote-sensing data (Landsat) to identify disturbances and estimate how much more carbon would be stored in the Forest if those disturbances had not occurred. The integrated terrestrial ecosystem carbon-budget model uses Forest Inventory and Analysis program data, Landsat disturbance data, plus environmental data (climate, atmospheric concentrations) to determine whether a forest is accumulating carbon (a sink) or losing carbon (a source). The integrated terrestrial ecosystem carbon-budget model and the carbon calculation tool produce very similar results (i.e., sink vs. source) but use different data sets and modeling approaches, so results may vary. Forest carbon disturbance assessments expand upon the earlier assessment of baseline carbon stocks across national forests by assessing how stocks are affected by timber harvesting, natural disturbances, land-use change, climate variability, increasing atmospheric carbon dioxide concentration, and nitrogen deposition (USDA, in review). The assessment integrates the forest carbon management framework and integrated terrestrial ecosystem carbon-budget models to calculate the relative impacts of disturbance (e.g., fires, harvests, insect outbreaks, disease) and non-disturbance factors (e.g.,climate, nitrogen deposition, carbon dioxide concentrations) on carbon stocks. The assessment assists in the evaluation of the effects of broad forest management strategies and potential disturbance factors on carbon flux in the plan area.

These data sources and assessments contain detailed discussions of models, analysis tools, and methodology used to provide the estimates of carbon stocks, as well as the limitations and uncertainties associated with the estimates.

Analysis area and scale

The importance of the carbon storage capacity of the world’s forests is tied to their role in the removal and storage of carbon from the atmosphere at the global scale. The influence and contribution of the Flathead National Forest to carbon flux at the global scale is infinitesimal in relation to the role the world’s forests play in ameliorating climate change, and a meaningful analysis at the global scale is not practicable. However, global research has indicated the world’s climate is warming and that most of the observed 20th-century increase in global average temperatures is very likely due to increased human-caused greenhouse gas emissions. In response, the Forest has identified carbon sequestration (storage) and associated climate regulation as a key ecosystem service and describes potential effects of the proposed action and alternatives at the scale of the Forest. National and regional factors related to forests’ influence on carbon sequestration are also included to provide context for understanding the nature of the local Forest effects.

The temporal scale for analyzing carbon stocks and emissions is the life of the plan (15 to 20 years), with some analysis occurring across the longer term (50 years), consistent with the analysis period for other key ecosystem characteristics associated with the terrestrial vegetation (see section 3.3).

Incomplete and unavailable information

Estimates of future carbon stocks (e.g., stored carbon) and their trajectory over time will remain uncertain due to the uncertainty associated with the multiple interacting factors that influence carbon stocks and fluxes. This includes climate change and its effects on vegetation. Although advances have been made in accounting and documenting the relationship between greenhouse gases and global climate change, difficulties remain in reliably simulating and attributing observed temperature changes to natural or human causes at smaller than continental scales (IPCC, 2007b, p. 72).

Notable changes between draft and final EIS

The analysis has been expanded in response to comments on the draft EIS requesting improved and increased information related to the role of the Flathead National Forest in addressing and influencing climate change.

3.4.2 Affected environment

Introduction

Forests cycle carbon. Forests are in a continual carbon flux, emitting carbon into the atmosphere and removing it, i.e., storing it as biomass (sequestration). Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by vegetation through photosynthesis and stored as carbon in forest biomass (plant stems, branches, foliage, and roots) and forest soils. Forests add carbon through establishment and growth of trees. Forests release carbon dioxide into the atmosphere when they die and decomposition also releases carbon to the atmosphere through respiration by micro-organisms or transfers carbon into the forest floor and soils. In addition, forest fires release some stored carbon into the atmosphere in the combustion process.

Interest in carbon sequestration is increasing, related to efforts to find ways to mitigate for climate change worldwide by reducing atmospheric levels of greenhouse gases (including carbon dioxide). The top three anthropogenic (human-caused) contributors to greenhouse gas emissions (from 1970-2004) are fossil fuel combustion, deforestation, and agriculture (IPCC, 2007b, p. 36). Land use change, primarily the conversion of forests to other land uses (deforestation), is the second leading source of human-caused greenhouse gas emissions globally (Denman et al., 2007, p. 512). Loss of tropical forests of South America, Africa, and Southeast Asia is the largest source of land-use change emissions (Denman et al., 2007, p. 518; Houghton, 2005). Deforestation is not a consideration on national forest lands because reforestation of harvested areas will occur, as required under the National Forest Management Act (1976). Forests and other ecosystems are carbon sinks because, through photosynthesis, growing plants remove carbon dioxide from the atmosphere and store it in their bodies. Sequestering, or storing, carbon in forest ecosystems can help to offset sources of carbon dioxide to the atmosphere, such as from fossil fuel combustion, deforestation, and agriculture.

Carbon stocks and trends

National level

U.S. forests (all land ownerships) are a strong net carbon sink, absorbing more carbon than they emit (EPA, 2015; Heath, Smith, Woodall, Azuma, & Waddell, 2011; Houghton, 2003). The NFS constitutes one fifth (22 percent) of the nation’s total forest land area and contains one fourth (24

percent) of the total carbon stored in all U.S. forests, excluding interior Alaska (USDA, 2015a). The NFS forest carbon resource has been growing since 1990, according to Forest Inventory and Analysis data. The 2.4 million acres of the Flathead National Forest is about 1.2 percent of the nearly 190 million acres of national forest lands in the United States. In the most recent National Greenhouse Gas Inventory (EPA, 2015), current annual forest (public and private ownership) carbon sequestration (including harvested wood products) was reported at 211.5 teragrams of carbon, offsetting approximately 11.6 percent of U.S. greenhouse gas emissions in 2013. The update to the Forest Service 2010 Resources Planning Act Assessment (USDA, 2016c, pp. 8-1 to 8-12) provides a summary of recent findings related to forest carbon conditions on all forest lands in the United States from 1990 to 2015 as well as projected future carbon stocks and flows. Highlights from this summary are discussed below.

At the national level, forest carbon increased from 86,064 teragrams of carbon in 1990 to 91,262 teragrams of carbon in 2015. The rate of change between 2010 and 2015 was an estimated 222 teragrams of carbon per year, reflecting both the annual accumulation of new forested area (about 1.03 million acres per year) and the growth of existing forests. Growth of existing forests accounted for the majority of this increase, with a net sequestration of 132 teragrams of carbon per year during this period. The Eastern United States has the largest share of forests (444 million acres) and the highest forest carbon stocks (66 percent of the total) compared to the western United States (239 million acres of forests). The Rocky Mountain region (within which lies the Flathead National Forest) was the only region where the net sequestration of forestlands declined between 1990 and 2015. This likely reflects the effects of lower growth rates in aging forests (the dominant age class is over 100 years on both public and private lands) and the disturbances, particularly wildfire, during that time period.

Future projections of carbon inventory from forestlands from the updated assessment suggest that net carbon sequestration in the United States will continue to increase at similar rates as in the past up until about 2025, when it will begin to gradually decline, mainly due to transfers of private forestlands to other land uses due to changing socioeconomic environments. Within the United States, land use conversion from forest to other uses (primarily for development or agriculture) are identified as the primary human activities exerting negative pressure on the carbon sink that currently exists in U.S. forests (McKinley et al., 2011; M. G. Ryan et al., 2010). However, national forest lands are not subject to conversion to other land uses, such as agriculture or development. Thus, carbon storage alterations from land use conversions is not a major factor for the forestlands within national forests, including the Flathead.

Regional level

The Northern Region of the Forest Service covers an area stretching from northern Idaho (plus a small portion of eastern Washington) across to North and South Dakota. A nationally consistent carbon assessment framework has been developed for NFS lands in every region and individual national forest to deliver information on carbon stocks and on forest carbon as influenced by disturbances (USDA, 2015a, in review). The forest carbon assessment framework consists of varying modeling approaches and input data sets. Each of these models and data sources have strengths on their own, but integrating results in them a more comprehensive assessment of carbon dynamics. Although these models complement one another, they utilize different data sources and modeling approaches (see section 3.4.1), and therefore results may differ. Information and assessments may be found here: https://www.fs.fed.us/climatechange/advisor/products.html. Methodology, limitations, and uncertainties associated with the carbon calculations and analysis are described within the assessments. This section of the final EIS summarizes key information within the assessments for the

USDA Forest Service Northern Region and is relevant to the analysis of carbon sequestration for the Flathead National Forest.

Baseline carbon pool estimates have been calculated for national forest lands across the Northern Region and for each individual forest for the time period 1990 to 2013 for seven different forest ecosystem carbon pools—aboveground live tree, belowground live tree, standing dead, understory plants, downed dead wood, forest floor, and soil organic carbon (USDA, 2015a). The carbon calculation tool, which summarizes the available Forest Inventory and Analysis data, uses measurements of tree volume from the available data and allometric equations to estimate baseline carbon stocks and stock changes from 1990-2013 (Woodall et al., 2013). Figure 35 displays these carbon pool estimates for 1990 and 2013. The aboveground live biomass and soil organics constitute the largest proportion of the total forest ecosystem carbon. Aboveground live biomass is usually the most rapidly changing pool and is more easily and directly estimated quantitatively from Forest Inventory and Analysis data than other pools. Other pools are less easily detected and estimated and/or are subject to high spatial variability that is hard to quantify. Estimates of carbon stored in harvested wood products have also been calculated in regional assessments.

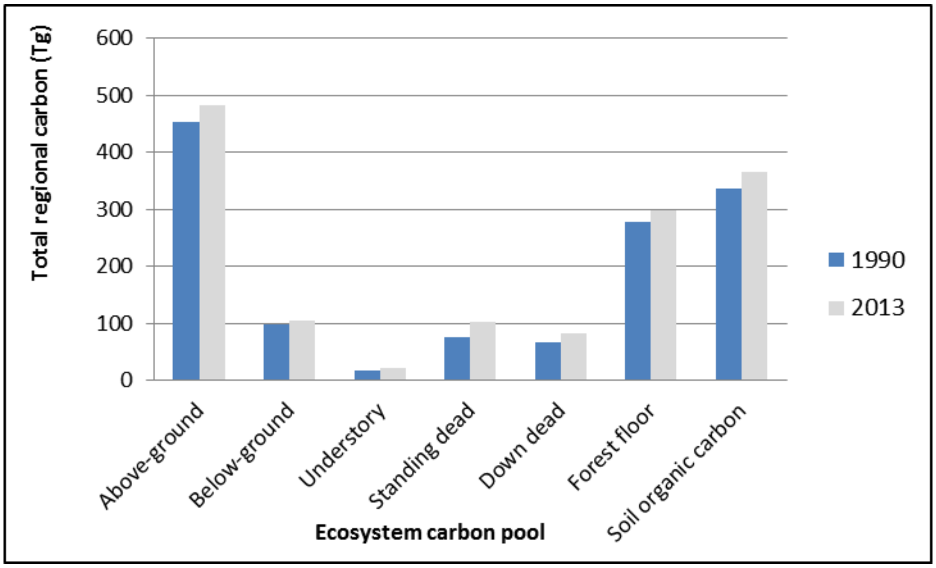

Figure 35. Carbon stocks in the seven forest ecosystem pools in national forest lands of the Northern Region for the years 1990 and 2013 (USDA, 2015a)

According to the forest inventory data as summarized by the carbon calculation tool model, total forest ecosystem carbon (in all seven pools) stored in the Northern Region has steadily increased between 1990 and 2013, beginning with 1,324 teragrams in 1990 and reaching 1,458 teragrams in 2013. The Flathead National Forest, along with seven other national forests in the region, increased in forest carbon stocks. Forest carbon density (carbon stocks per unit area) increased slightly in the Northern Region from 1990 to 2013, from 64 tonnes/acre in 1990 to 65 tonnes/acre in 2013. Factors such as disturbances (i.e., fire) and site quality may be responsible for these observed trends. However changes in the forest inventory sampling design, protocols, and methodologies (USDA, 2013a) including the definitions of what constitutes forest land also influenced these trends (Woodall et al., 2013).

Total forest carbon (forest ecosystem and harvested wood products) stock change is estimated at 5.83 teragrams of carbon per year for the Northern Region for the baseline period 1990 to 2013. This value represents the net sequestration rate of carbon by national forests in this region (USDA,

2015a). Carbon stock change is the change in carbon stocks over time, calculated by taking the difference between successive inventories and dividing by the number of years between these inventories for each national forest (Woodall et al., 2013). Stock change for a given year is the change between that year and the following year (thus, for example, the stock change for 2012 is the change between 2012 and 2013).

Harvested wood products

Carbon stored in harvested wood products contributes to the total forest carbon storage associated with national forests in the Northern Region. Harvest treatments that generate long-lived wood products, such as lumber and furniture, transfer ecosystem carbon to the harvested wood products carbon pool, where carbon remains stored and does not contribute to net greenhouse gas emissions. Some of the fastest-growing carbon pools in the United States are landfills, where paper and construction waste break down very slowly (Miner & Perez-Garcia, 2007; Skog, 2008). The substitution of wood for building materials that result in much higher greenhouse gas emissions, such as concrete, steel, or plastic, has a distinct carbon emissions benefit. Forest vegetation treatments also generate excess material (woody biomass) that, if utilized, can be a renewable energy substitute for fossil fuels. One study indicated that allowing a harvested stand to grow and sequester carbon resulted in less emission of CO_2 than did that from harvest of that stand and storage in wood products. However, when the effect of substituting wood for concrete and steel was also accounted for, then harvest scenarios resulted in less CO_2 emission than the no-harvest scenario (Perez-Garcia, Lippke, Comnick, & Manriquez, 2005).

The variation over time in carbon stored in harvested wood products is influenced primarily by changes in timber harvest levels. The cumulative carbon stored in the Northern Region harvested wood products began to accelerate substantially around 1955 and continued to increase at a steady rate until peaking in 1995 (figure 36). Carbon in harvested wood products are displayed on the graph for products that are still in use and for carbon stored at solid waste disposal sites, including landfills and dumps. Since 2000, carbon stocks in the harvested wood product pool for the Northern Region have been in a slow decline as a consequence of timber harvest reductions on national forests. The Northern Region harvested wood products pool is now in a period of negative net annual stock because the decay of products harvested between 1906 and 2012 exceeds the additions of carbon to the harvested wood products pool through harvest.

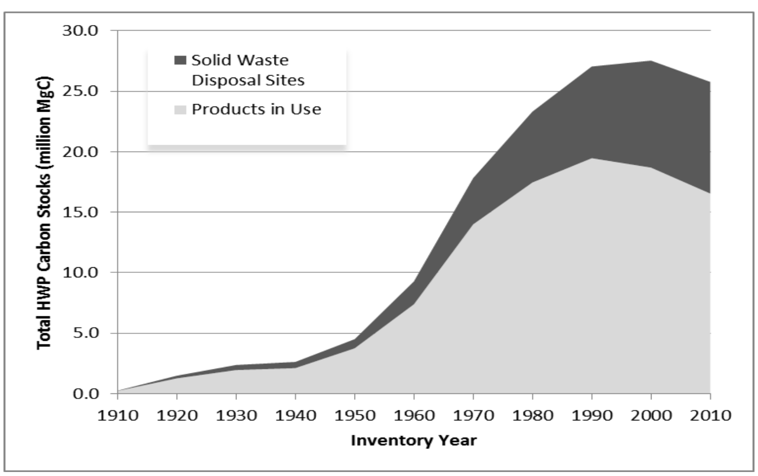

Figure 36. Cumulative total carbon stored in harvested wood products (products still in use and products at solid waste disposal sites) manufactured from Northern Region timber, in million megagrams of carbon (Stockmann et al., 2014)

Forest level—Flathead National Forest

Total carbon stock estimates and trends since 1990 are displayed in figure 37 (USDA, 2015a). These estimates are based on Forest Inventory and Analysis data and are summarized using the carbon calculation tool model for the Flathead National Forest.

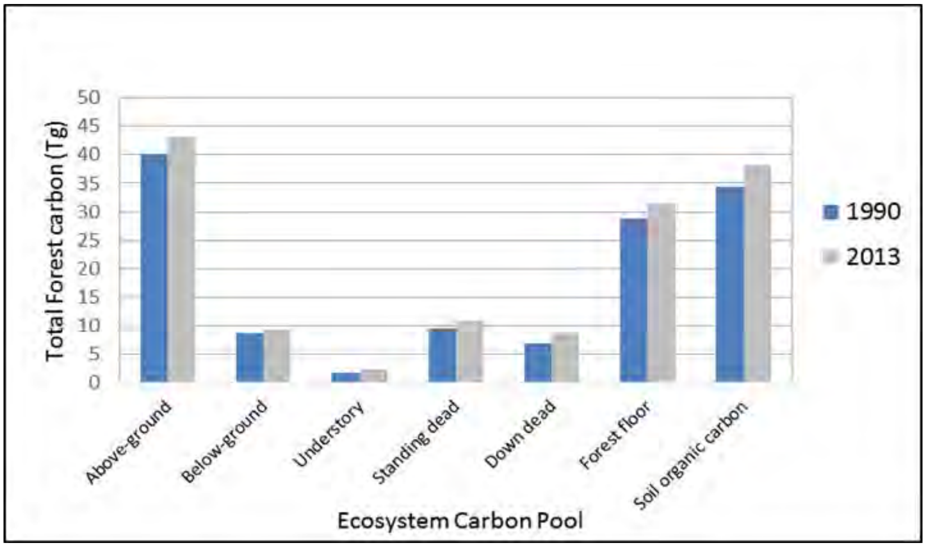

Figure 37. Carbon stocks in the seven forest ecosystem pools on the Flathead National Forest for the years 1990 and 2013, as estimated using the carbon calculation tool (USDA, 2015b)

According to this data, forest carbon stocks on the Flathead National Forest have been on a steady upward trend over the past 20 or more years (figure 37), with all of the forest ecosystem carbon pools following a similar increasing trend. The aboveground live tree pool is storing the highest amount, and the understory pool is storing the lowest. The relationship between the pools and the proportions on the Flathead National Forest are similar to the regional estimates (figure 35).

Carbon stock change (the change in carbon stocks over time between successive inventories) for the Flathead National Forest is displayed in figure 38, also according to Forest Inventory and Analysis data as summarized with the carbon calculation tool. A negative change in the graph means carbon is being removed from the atmosphere and sequestered by the forests (i.e., carbon sink), and a positive change means carbon is added to the atmosphere by forest-related emissions (i.e., carbon source). Data suggests that the Flathead National Forest has consistently functioned as a carbon sink over the inventory period, although the uncertainty around this estimate makes it impossible to conclude with certainty whether the Forest is a sink or a small carbon source.

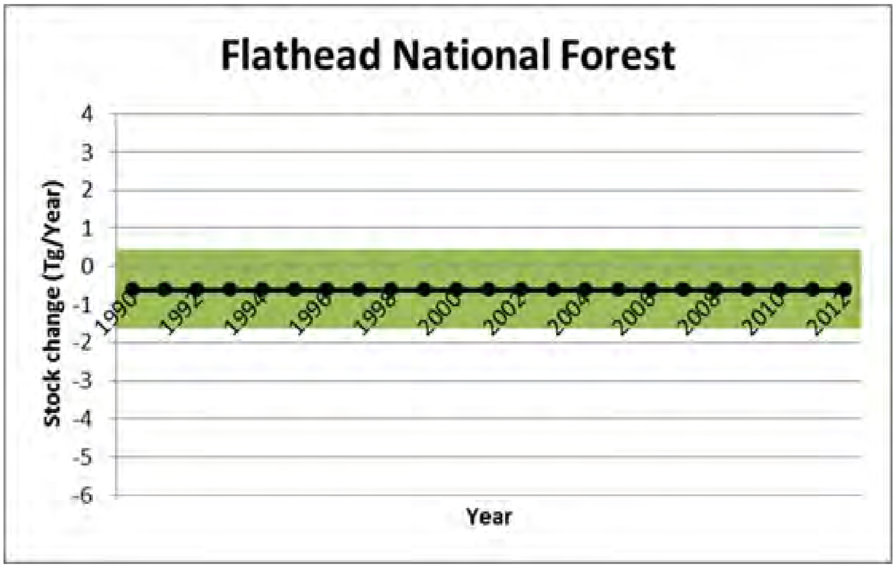

Figure 38. Carbon stock change on the Flathead for 1990 through 2013, bounded by uncertainty values (95 percent confidence level) (USDA, 2015a)

Harvested wood products

Carbon has been removed from the Forest through the harvest of trees over the past 100 or more years. Some of this carbon is stored in wood products or in landfills and contributes to the total forest carbon storage on the Forest. Carbon stored in harvested wood products has been estimated for the Flathead National Forest spanning a 100-year period from 1910 to 2010 (N. Anderson et al., 2013) (Figure 39).

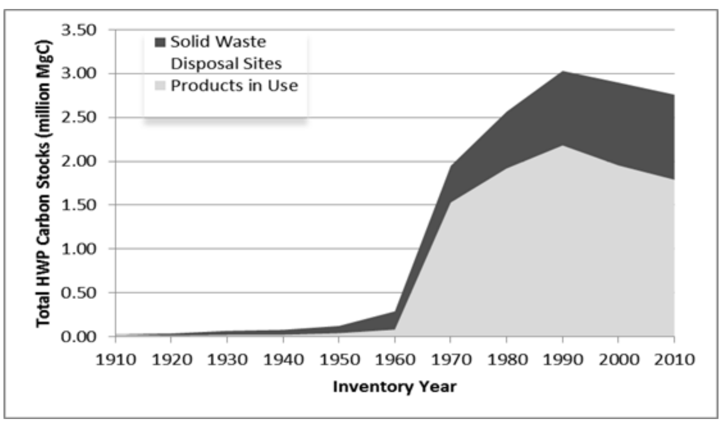

Figure 39. Cumulative total carbon stored in harvested wood products manufactured from Flathead National Forest timber from the period 1910 through 2010, in million megagrams of carbon (N. Anderson et al., 2013)

Relatively little timber harvesting occurred on the Forest in the first half of the 20th century. Annual timber production began to increase notably in the 1940s, hitting a maximum point over the 100-year time period in the late 1960s and producing 276,375 megagrams of carbon emission in 1969. Over the 40 years from 1969 to 2010, timber production followed a downward trend, with some interannual peaks and valleys, reaching its lowest point since 1940 in the year 2002 when 89,617 megagrams of carbon was emitted. The minimum in average carbon storage occurred in 1932, with a total of 2,940 megagrams of carbon, and the maximum occurred in 1969 with a total of 105,437 megagrams of carbon. In 2009, average carbon storage was 20,457 megagrams. The cumulative

effect of this harvest activity over time for carbon that is stored in harvested wood products produced from the Flathead National Forest is displayed in figure 39. In 2010, there was an estimated total of approximately 2.7 million megagrams of carbon (2.7 teragrams) stored in harvested wood products from the accumulation of harvesting over the previous 100-year period.

Influences on carbon stocks

An understanding of how disturbances and environmental factors affect carbon flux is necessary to assess potential future changes in carbon stocks and how forest management may influence them. The information that follows discusses and provides estimates of impacts on carbon pools from disturbance, management activities, and environmental factors, referencing the regional disturbance assessment (USDA, in review). This assessment was conducted using two different modeling approaches that use similar data sets but seek to answer different questions. First, the forest carbon management framework estimates the effects of individual disturbances such as fires, insects, harvests, and weather on non-soil carbon storage from 1990-2011 by integrating remotely sensed disturbance maps (Healey et al., 2014) along with Forest Inventory and Analysis data and a growth and yield model (Healey et al., 2016; Raymond, Healey, Peduzzi, & Patterson, 2015). The forest carbon management framework essentially estimates how much more carbon would be on each national forest if disturbances that took place from 1990 to 2011 had not occurred. It provides information on the patterns of disturbance and how disturbances have impacted carbon storage.

The second part of the disturbance assessment uses the process-based ecosystem model known as the integrated terrestrial ecosystem carbon-budget model. This model, along with Forest Inventory and Analysis data, the remotely sensed disturbance maps (also used in the forest carbon management framework), and several other data sets, are used to determine the relative effects of disturbances (e.g., fire, insects, harvests) and environmental or non-disturbance factors (climate, atmospheric CO_2 concentration, and nitrogen deposition) on the changes in carbon stocks and the accumulation of carbon from 1950 through 2010 (W. J. Chen et al., 2000). This analysis puts the effects of disturbance and management activities into the context of broader environmental and climatic processes. Although these two models use some of the same data sets (Forest Inventory and Analysis data) as other models used in baseline carbon assessments and in calculating existing carbon stocks, the results are not 100 percent compatible with other results. This is because these models also integrate high-resolution remotely sensed disturbance maps from Landsat (satellite) imagery, the models report different carbon pools, there are differences in the timing of data sources (remotely sensed data is more up-to-date than Forest Inventory and Analysis data), and the models themselves are different and take different approaches to achieve estimates. Refer to the sections on methodology, uncertainties, and interpretation of model result within the regional disturbance assessment (USDA, in review) for detailed information regarding appropriate interpretation of model results and comparison of results to other estimates.

Forests are highly dynamic systems that are continuously repeating the natural progression of establishment, growth, death, decay, and recovery while cycling carbon throughout the ecosystem and the atmosphere. Natural and human-related disturbances, such as wildfires, insect and disease activity, timber harvesting, and weather events, can cause both immediate and gradual changes in forest structure that in turn affect forest carbon dynamics by transferring carbon between the different ecosystem and atmospheric carbon pools.

Regional level

Figure 40 displays the percent of forest area in the Northern Region affected over time by main disturbance factors, as derived from the remotely sensed (Landsat) disturbance maps along with various ancillary data sources, including monitoring trends in burn severity (Eidenshink et al., 2007),

aerial detection surveys (E. W. Johnson & Wittwer, 2008), and agency harvest records, to attribute the disturbance types. The years from 2000 to 2011 show elevated levels of fire and insect disturbance compared to the 1990s, with the year 2007 experiencing the highest impact, in total affecting over 1.5 percent of the total forested area in the region. Harvest affected less than 0.25 percent throughout the monitoring period. Not shown in figure 40 is the rate of infection due to root disease.

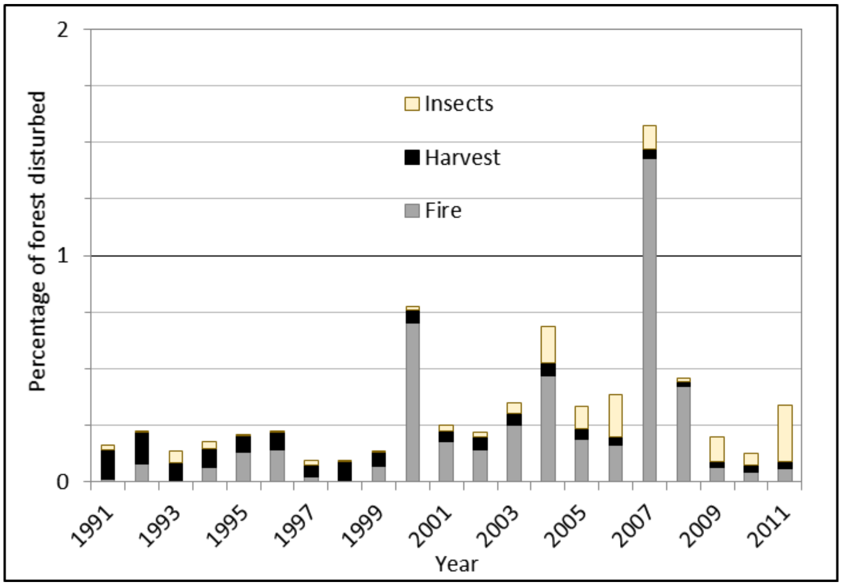

Figure 40. Northern Region rates of disturbance mapped using visual interpretation of several independent data sets and summarized as the percentage of forested areas disturbed by insects, fire, and harvest from 1991 to 2011 (USDA, in review)

Figure 41 displays the proportional importance and effects to carbon of each type of disturbance occurring in the region as accumulated from 1990 to 2011 and measured in 2011, according to results of the forest carbon management framework model. Root disease is included in this figure, as estimated from the Forest Inventory and Analysis root disease severity variable (Healey et al., 2016). Fire and disease are clearly the dominant processes. The importance of insect activity, which is currently relatively small, was not detectable through the 1990s.

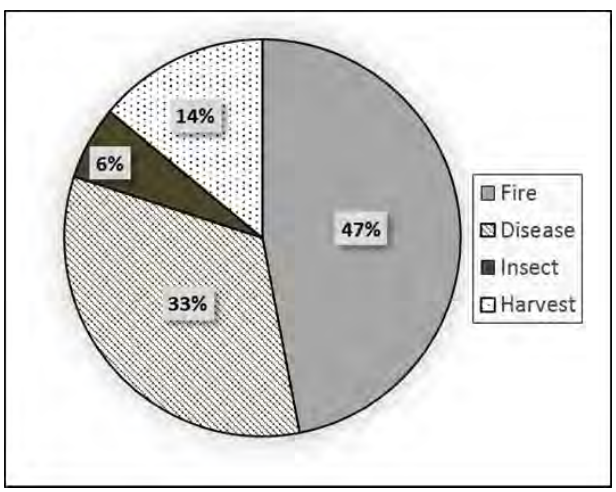

Figure 41. The proportional effects of fire, insects, disease, and harvest on carbon storage on national forest lands of the Northern Region for the period 1990 to 2011 (USDA, in review)

Environmental factors, including climate, atmospheric concentrations of carbon dioxide, and nitrogen deposition, also influence rates of growth and productivity and, therefore, forest carbon stocks and trends. Tree growth and associated forest age is one of the key factors influencing the rate of carbon sequestration and carbon density. Growth adds live tree biomass, which results in increased carbon accumulation. Stand-level growth rates generally follow a biological yield function, with more rapid growth and thus carbon accumulation occurring in young forests through middle age, when productivity generally peaks (He, Chen, Pan, Birdsey, & Kattge, 2012). Productivity gradually declines as the stands age and forest densities increase. As displayed in Figure 42, the Northern Region's forest stand age distribution in 2010 shows that the majority of the stands in the region are older (greater than 80 years old), with a distinctive pulse of stands that were established between roughly 80-110 years ago (from 1900 to 1930), according to Forest Inventory and Analysis data. The early 1900s pulse in stand establishment may be the result of regeneration after the last major fires before fire suppression, such as those in 1889 or 1910, or after timber harvests that intensified in the early 1900s (R. D. Baker, Burt, Maxwell, Treat, & Dethloff, 1993). Fire suppression, which began in the early 1900s, would have allowed more of these young, regenerating stands to survive and continue regrowing rather than being disturbed at a more typical historical rate of fire (Pyne, 1982). Depending on the forest dominance type, which is mostly Douglas-fir and subalpine fir at the regional scale, this pulse of establishment would have reached maximum productivity between 30-60 years of age (Figure 43), or throughout the mid- to late-20th century. (USDA, 2016c). Figure 42 shows another pulse of young stands (less than 20 years old) that established between 1990 and 2010, suggestive of regeneration after recent large and often severe disturbances, mostly wildfires.

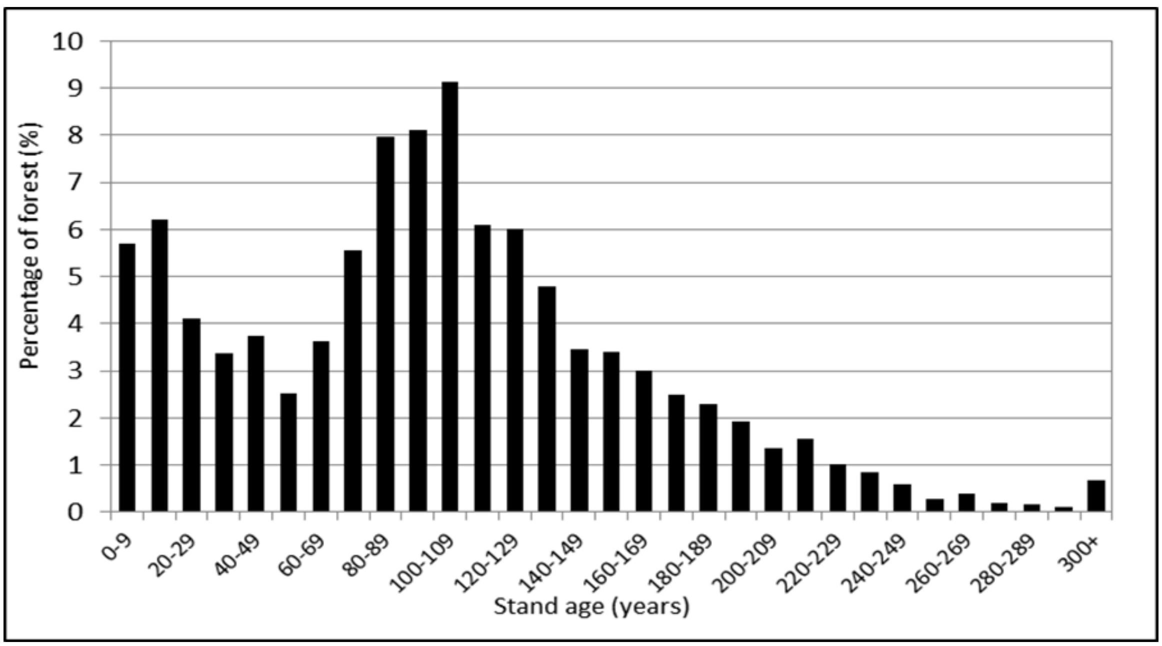

Figure 42. Age class distribution in 2010, displaying the percentage of forest land in 10-year age classes summed across all national forests in the Northern Region (USDA, in review)

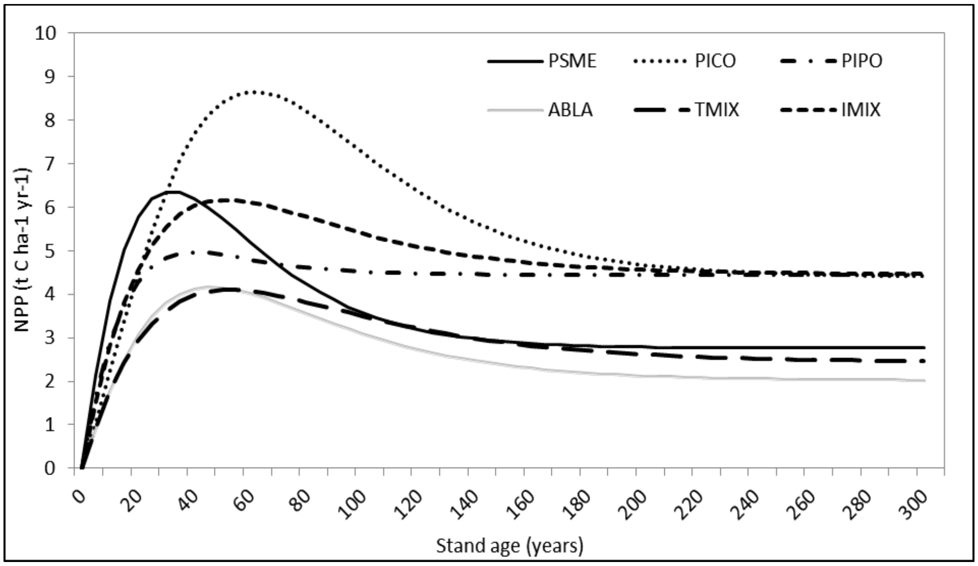

Figure 43. Relationship between net primary productivity (NPP) and stand age for each forest dominance type averaged across all national forests in the Northern Region. Dominance types include Douglas-fir (PSME), subalpine fir (ABLA), lodgepole pine (PICO), ponderosa pine (PIPO), shade-tolerant mixed conifer (TMIX), and shade-intolerant mixed conifer (IMIX) (USDA, in review)

Figure 44 shows the carbon stock changes across the national forests in the Northern Region. It suggests that together the forests have generally experienced a switch from a carbon sink to a carbon source and a decline in accumulated carbon, according to results from the process-based integrated terrestrial ecosystem carbon-budget model.

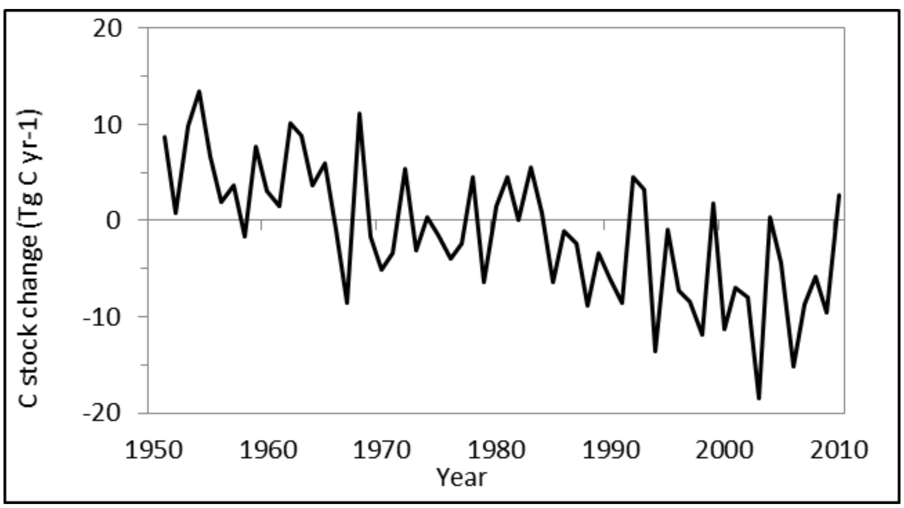

Figure 44. Estimated forest carbon changes due to all factors combined (disturbance/aging and non-disturbance effects) as summed across the national forests of the Northern Region and derived from the integrated terrestrial ecosystem carbon-budget model (USDA, in review)

Changes in carbon stocks are attributed to non-disturbance factors (i.e., climate variability, atmospheric CO_2 concentration, and nitrogen deposition) and disturbance and aging factors (i.e., fire, harvest, insects, and the regrowth and aging of forests). Although a few national forests in the Northern Region experienced a net gain of total forest carbon, most forests experienced a loss from 1950 to 2010, resulting in a region-wide loss of approximately 74 teragrams of total ecosystem

carbon. Disturbance and aging effects have been mostly responsible for the decline, which corresponds to the disturbances that created the forest age structures (Figure 42) and the increasing disturbances (i.e., wildfire) in recent years (figure 40). For instance, from 1950 to around 1980, the national forests were mostly a carbon sink, according to the results of the integrated terrestrial ecosystem carbon-budget process model, due to positive disturbance and aging effects from the forests that initiated after the disturbances in the early 1900s and were growing at peak productivity by the mid-20th century. As these forests further aged, productivity declined (figure 43), causing the rate of carbon accumulation to decline (Figure 45). Meanwhile, the effects of the disturbances were increasing to the point where carbon emissions due to decomposition, decay, and disturbances exceeded carbon gains, and as a result the forests became a carbon source (Figure 44). This decline was coupled with lower rates of stand establishment in the mid-1900s.

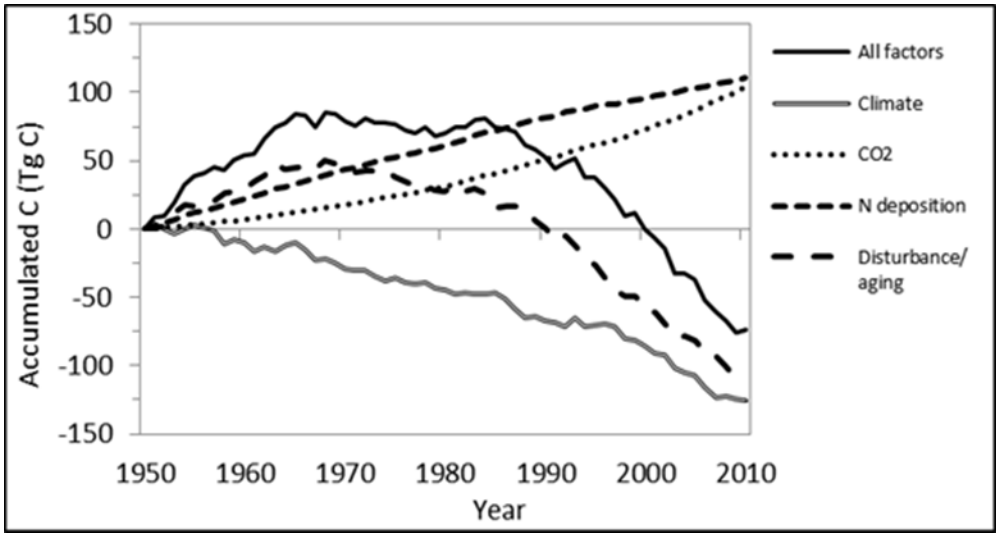

Figure 45. Estimated forest carbon accumulations due to individual factors and for all factors combined, summed across the national forests of the Northern Region and derived from the integrated terrestrial ecosystem carbon-budget model (USDA, in review)

Climate variability and the recent warming trend has had a mostly negative effect on carbon stocks, also contributing to the switch to being a carbon source and the loss of carbon. Future warming may result in an intensification of these already negative climatic effects. Although recent disturbances (Figure 40) initially caused increases in carbon emissions during the year of the disturbance events, they also promoted regrowth and recovery, converting older stands to young stands (ages 1 to 20 years). As these young stands recover and reach middle age in the coming decades, they will be growing at maximum productivity (Figure 43), and national forests will have the potential to accumulate more carbon and become carbon sinks again.

The effects on carbon due to disturbances discussed in this section and displayed in the figures do not tell the complete story, for a number of reasons outlined in the disturbance assessment publication (USDA, in review). Some types of disturbances that may have substantial impact are not covered due to lack usable data, such as root disease for some parts of the region. Also, the assessment did not consider storage of carbon in harvested wood products, which defers emissions of the associated carbon until they decay or are disposed by burning. Furthermore, it is important to emphasize that the results of the disturbance assessment may differ from the baseline forest carbon assessment, which relied only on Forest Inventory and Analysis data and which may be missing some of the more recent disturbances or smaller disturbances that occurred outside of the inventory

plots. Integrating high-resolution, remotely sensed Landsat disturbance maps reveals slightly different trends.

To generate these forest carbon and disturbance assessments at the regional scale, the analyses and models were carried out for the individual national forests and summarized across the Northern Region. Thus, the analyses for the national forest scale use the same modeling framework and tools.

Forest level

The types and pattern of major disturbances affecting carbon stores over a 20-year period on the Flathead National Forest are displayed in figure 46. Disturbances on the Forest follow a similar pattern and proportion as those that occurred regionwide (figure 40), with significant fire impact in 2002 through 2004 and in 2007. Insect activity comprised a smaller portion of the total percentage of disturbance than was observed regionally. Not shown in figure 46 is the rate of infection due to root disease, which affects a large proportion of the forests on the Flathead (see section 3.3.1, subsection "Insects and disease"). Timber harvest affected approximately 0.25 percent of the forested area in the early 1990s and declined slightly throughout the monitoring period.

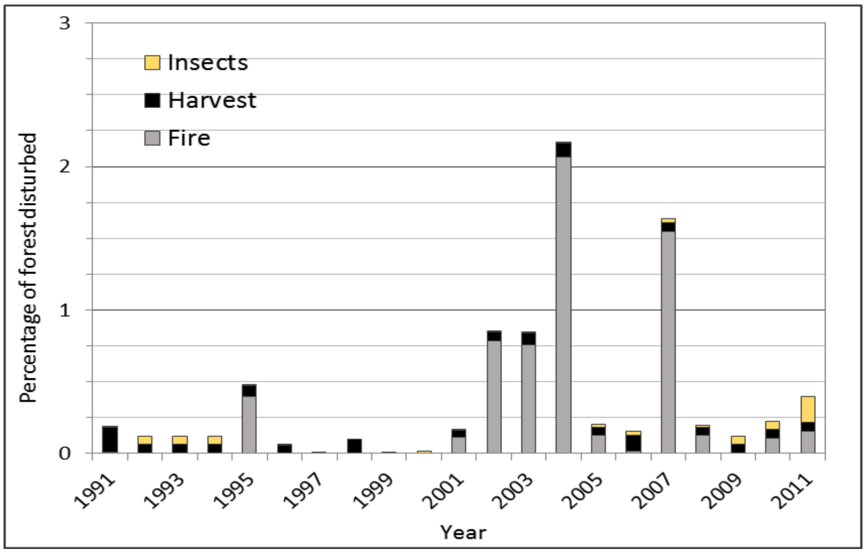

Figure 46. The percentage of forested areas disturbed on the Flathead National Forest from 1991 to 2011 by individual disturbance type, based on visual remotely sensed data (Landsat) and the interpretation of several independent datasets (USDA, in review)

Figure 47 displays the estimated effects of the various disturbances on carbon storage for the Flathead National Forest. Root disease is included in this figure, which was estimated from the forest inventory and analysis root disease severity attribute.

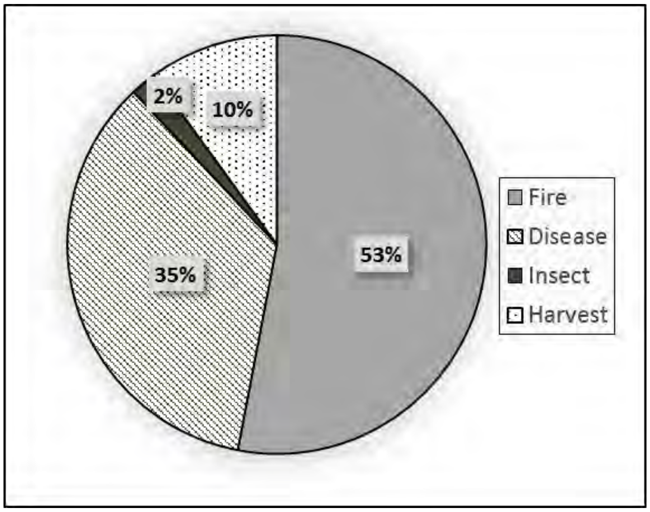

Figure 47. The proportional effect of fire, insects, disease, and harvest on carbon storage on the Flathead National Forest, according to the results of the forest carbon monitoring framework model (USDA, in review)

Fire, which disturbed the greatest amount of forest area (figure 46), also had the greatest impact on carbon storage on the Flathead national Forest, according to results of the forest carbon management framework model (figure 47). Among the different disturbances, fire and disease together are responsible for 88 percent of the carbon stock change (loss) over the period 1991 to 2011. Lost carbon storage through harvest accounts for a substantially smaller amount, at 10 percent of the total over this period. In the context of the total picture, loss due to insect activity during this period is negligible.

Figure 48 displays the estimated impact of the different disturbances (as assessed through the forest carbon management framework) as expressed in relation to the amount of carbon that would have been stored in the absence of the particular disturbance. Specifically, the difference in storage for each year is shown between a “no-disturbance” scenario and a scenario that includes only observed amounts of the specified type of disturbance. Error bars represent 95 percent confidence intervals. One hundred grams per square meter equals one metric tonne (or megagram) per hectare (USDA, in review).

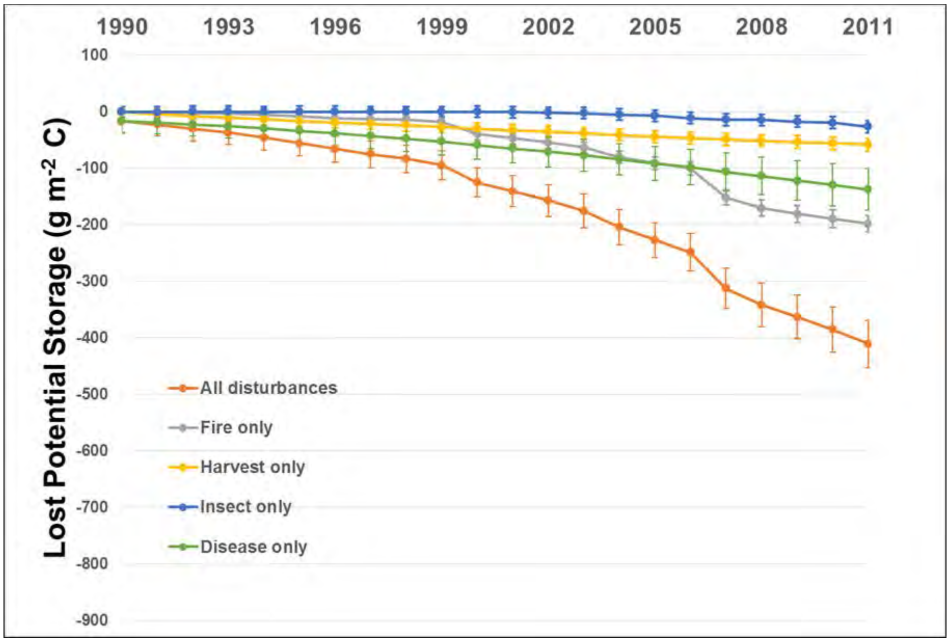

Figure 48. Lost potential storage of carbon as a result of fire, insects, harvest, and disease on the Flathead National Forest for the period 1990 to 2011 (USDA, in review)

The impact of a disturbance is felt beyond the year it happens. For example, a fire event will release carbon stored in forests in the year the event occurs. Even if the stands affected by fire are no longer carbon sources, their net carbon storage in the subsequent years is likely to be less than if the fire had not occurred, and the curve will continue to diverge from baseline for a time. Thus, Figure 48 reflects the long-term impact of disturbance on the forest's ability to store carbon. The increased impact on carbon stocks from the effect of increased wildfire activity in the years since 2000 is reflected in the figure. The effects of these fires will likely continue through future decades, both because carbon added through growth and recovery may not equal carbon that would have been added through continued growth and because decaying material killed by the fire will mitigate carbon added through recovery. The long-term impact on carbon storage from timber harvest disturbance is also noticeable, although much less so than from fire, even though harvest levels have decreased since the 1990s. However, it is important to note that these patterns do not account for off-site storage of carbon in wood products. Root disease is a dominant disturbance factor on the Flathead National Forest, and its steady suppression of growth and regeneration represent a chronic limitation on affected stands relative to their ability to sequester carbon. Sections 3.3.1 and 3.8 provide more detailed information on these major disturbance factors on the Forest.

As discussed in the previous section, tree growth and associated forest ages influence the rate of carbon sequestration and carbon density on the Forest. The forestwide forest stand age distribution in 2010 (figure 49) shows a pattern similar to the regional pattern (Figure 42), with a pulse of stands established between roughly 80 to 130 years ago (from 1880 to 1930) (USDA, 2016c), as well as a more recent pulse (higher proportionally than the region-wide pulse) over the last 30 to 40 years. The early pulse represents forests that regenerated after wildfires, which burned large portions of the Forest between about 1889 and 1930 (see figure 56 in section 3.8.1). The more recent pulse is also largely due to regeneration after the large area that burned in wildfires between the years 1988 and 2010. Regeneration after timber harvest also contributed to this latter pulse, with peak harvest years on the Flathead occurring between 1960 and 1989 (see table 18).

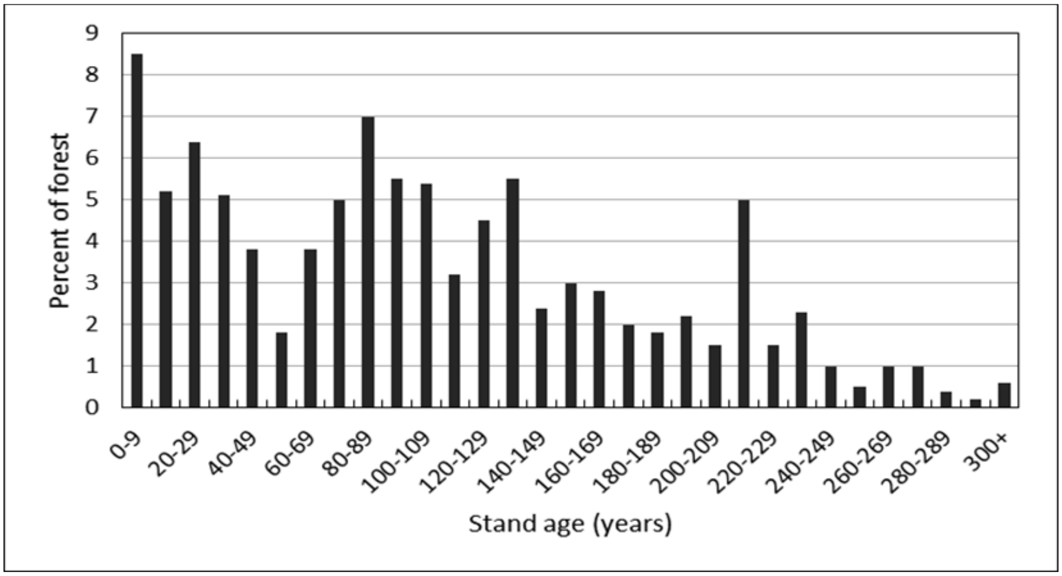

Figure 49. Age class distribution across the Flathead National Forest in 2010 displaying the percentage of forested area in 10-year age classes (USDA, in review)

About one third of the forests on the Flathead National Forest are less than 60 years old and thus are still in a period of generally more rapid growth (Figure 43) and increased carbon sequestration. About one third of the forests on the Flathead National Forest are greater than 130 years old and in a period of relative low productivity and lower rates of carbon sequestration. The remainder are mature forests from 60 to 130 years old, with carbon sequestration rates still somewhat increased but in a gradual decline.

3.4.3 Environmental consequences

Forests are biological systems that continually gain and lose carbon. Disturbances and forest management can affect net carbon stores both by changing the amount of carbon stored in various pools and by altering the rate at which carbon accumulates in the ecosystem (net ecosystem productivity) (Fahey et al., 2010). Whether forests show a net gain (sink) or net loss (source) depends on the balance of these processes and must be interpreted in light of the long development trajectories of forests in the northern Rockies. A general understanding of forest conditions and their carbon storage dynamics and capacity, as well as estimates as to how different disturbances may impact carbon stores, are discussed in the “Affected environment” section. However, carbon sequestration and emission dynamics from forested ecosystems can be very complex and imbued with uncertainties. Therefore, rather than focus on a strict quantification of potential future changes in carbon stores and emissions for the Flathead National Forest under each alternative, this analysis of potential effects focuses on future expected trends of carbon stocks and the forest carbon flux (i.e., carbon source vs. sink), plus the potential influence of various strategies and approaches to the management of the Flathead National Forest.

Effects common to all alternatives

Natural ecosystem processes on the Flathead National Forest, including forest growth (succession) and disturbances (i.e., fire, disease) will result in a continual flux in carbon storage and emission into the future over the short and long term, in response to the complex interactions between climate and disturbances, successional processes, and resulting changes in forest conditions and patterns.

Figure 50 displays the projected percent of Forest area affected by natural disturbances (fire, insects, disease) and timber harvest over a five-decade future period, as modeled (refer to section 3.3 and to appendix 2 for details). From the standpoint of effects to carbon and the purposes of this analysis, projections of these natural disturbances and of timber harvest are very similar for all alternatives and the figure displays the mean annual percent area as averaged between the four alternatives. It is important to note that the estimated range in the future amount of natural disturbances is actually quite wide, especially for wildfire. The future estimated variation in the amount of wildfire ranges from a low of 0.4 percent (approximately 8,600 average annual acres) to a high of 1.5 percent (approximately 36,000 average annual acres). This amount is consistent with the natural range of variation for the amount of wildfire on the Flathead National Forest (Trechsel, 2017f). Under all alternatives, vegetation change across the Forest over the life of the plan will be the result primarily of natural disturbance processes and fire use (i.e., prescribed fire). The great majority of the Forest (at least 71 percent) occurs within areas not suitable for timber production and largely unroaded (refer to table 20 and associated discussion in section 3.3). Mechanical treatments (i.e., timber harvest) would occur across a limited portion of the Forest, with a very small amount of acres estimated to be harvested annually over the next 50 years compared to the amount of fire and other disturbances (Figure 50).Thus, natural disturbance processes (fire, insects, and disease) and natural forest growth (succession) are expected to continue have the greatest influence on carbon storage on the Forest into the future, similarly to the recent past when 90 percent of carbon stock change between 1991 and 2011 was attributed to fire, insects, and disease processes. Carbon storage in these landscapes that are subject primarily to natural processes is not necessarily at an equilibrium but can increase and decrease over time (Luyssaert et al., 2008; Smithwick, Harmon, Remillard, Acker, & Franklin, 2002), with the risk of large pulses of carbon loss due to disturbance in large areas of mature forest (Fahey et al., 2010).

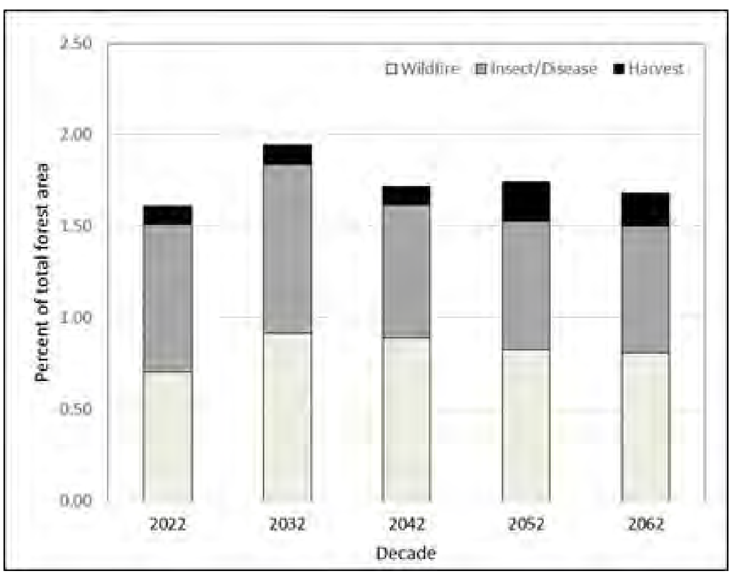

Figure 50**. Projected mean annual percent of area affected by wildfire, insects, disease, and harvest activity on the Flathead National Forest over a five-decade future modeling period (source: Spectrum model for harvest; SIMPPLLE model for wildfire and insect and disease activity)**

Modeling of future disturbances suggests that natural disturbances would not be outside the range of natural variation in the next 20 to 50 years, although there is an inherent level of uncertainty which increases the further into the future the model goes. Under all the alternatives, the estimated modeled acres of fire over the next five decades range from 7,500 to 37,500 average acres per year (0.3 to 1.6

percent of the Flathead National Forest), with an additional estimated 16,500 average acres per year of insect and disease activity (figure 14). These average amounts are within the natural range of variation for disturbance processes on the Forest (Figure 34) and are consistent with those the Forest has experienced in the recent past (figure 46). Most of the key ecosystem characteristics associated with vegetation (i.e., forest size classes, species compositions, and forest densities) are projected to either remain within desired conditions (which are based on natural range of variation) or trend towards the desired conditions (refer to section 3.3.9, subsection "Summary of vegetation modeling results," and to appendix 2). This modeling reflects our best estimates of a future condition based on potentially warmer climatic conditions.

Harvest levels over the next 20 years are also expected to be similar to the amounts experienced over the past 20 years (Table 18), estimated at 2,100 to 3,100 acres of treatment per year, depending upon alternative (table 19). Thus, as has occurred in the recent past, the projected impacts of fire, insects, and disease on forest cover and potential loss of carbon for the Flathead National Forest is many times greater than the projected amount of timber harvest activity (Figure 46 through figure 48).

The Forest Inventory and Analysis data (using the carbon calculation tool) indicates that the Flathead National Forest has consistently functioned as a carbon sink over the inventory period (Figure 38). Considering the past and expected future conditions and disturbances and their influence on carbon dynamics as discussed above, it is anticipated that carbon storage and sequestration fluctuations on the Flathead National Forest over the next 20 to 50 years would be similar to those experienced in the recent past. Although disturbances would result in an immediate carbon loss, forest establishment and growth would recover that loss over several decades, and the Forest would likely continue to function as a net carbon sink. Modeling of potential carbon sequestration on the Forest projected into the future using the Spectrum model suggests that this recovery and upward trend would occur. See the section below on Spectrum model projections. For additional detailed information on modeled disturbance processes and treatments, and for potential changes in vegetation conditions over the next 50 years, refer to sections 3.8 and 3.3.3 and also to appendix 2, which discusses the Spectrum model and the SIMPPLLE model process and outputs.

Although Forest Inventory and Analysis data indicate that the Forest has been a net carbon sink since 1990, there is uncertainty regarding that past status as well as uncertainty associated with the status of the Forest over the next 20 to 50 years. Other models and studies (such as the integrated terrestrial ecosystem carbon-budget model) show that some national forests, including the Flathead, may have recently functioned as a carbon source. In addition, the literature currently suggests that the long-term ability of western U.S. forests to persist as a net carbon sink is uncertain due to the uncertainty associated with the multiple interacting factors that influence carbon stocks and fluxes (Galik & Jackson, 2009; Lenihan, Bachelet, Neilson, & Drapek, 2008; Pan et al., 2011; M. G. Ryan et al., 2008). These factors include climate variability and change; potential positive effects of increased atmospheric CO_2 concentrations on plant productivity; the frequency, duration, and severity of moisture stress; changes in the rate and severity of natural disturbances; and land management practices (Canadell et al., 2007). Drought stress, forest fires, insect outbreaks, and other disturbances may substantially reduce existing carbon stock (Galik & Jackson, 2009; Hicke et al., 2012). Climate change threatens to amplify risks to forest carbon stocks by increasing the frequency, size, and severity of these disturbances (Barton, 2002; Boisvenue & Running, 2010; Breshears & Allen, 2002; Dale et al., 2001; Littell et al., 2009; Running, 2006; Westerling & Bryant, 2008; Westerling, Hidalgo, Cayan, & Swetnam, 2006) (see also the introduction to chapter 3, "Climate change considerations"). Recent research indicates that these risks may be particularly acute for some forest types and in some areas of the country, including the Rocky Mountain forests (Boisvenue &

Running, 2010). Some of the more severe impacts occur in drier forest types, particularly those in transition areas where forest meets grassland vegetation types. Increases in the severity of disturbances, combined with projected climatic changes, may limit post-disturbance forest regeneration, shift forests to grass or shrublands, and possibly convert large areas from an existing carbon sinks to carbon sources (C. D. Allen, 2007; Barton, 2002; Galik & Jackson, 2009; Kurz, Dymond, et al., 2008; Kurz, Stinson, Rampley, Dymond, & Neilson, 2008; Savage & Mast, 2005; Strom & Fule, 2007).

In regards to the Flathead National Forest and future uncertainties associated with disturbances, if an exceptionally high amount of fire occurs across successive decades or if fires are more severe and larger than they were historically, forest conditions may be affected to the point where carbon balances are substantially altered. For example, there may be an overly large amount of forest in early-successional stages, recovering from recent disturbances, and an uncharacteristically low amount of acres in mature and older forest stages. This may cause a shift in the carbon balance, with the Forest functioning as a carbon sink instead of a carbon source for a time. For the near future (i.e., the next 20 to 50 years), it is expected that a full recovery of forest conditions would occur after disturbances on the predominantly moist sites of the Forest, although there may be species shifts, and recovery may be prolonged in some areas compared to historical conditions. In addition, there is the possibility that forest productivity and density may increase in some areas with warming climates, such as in higher-elevation forests (Robert E. Keane et al., in press). This may offset some of the loss of carbon at the local scale.

Timber harvest

Under all the alternatives, the amount of timber harvest projected over the next 20 years is expected to be similar to current amounts. Harvest would have little impact overall on the potential scenario of carbon loss due to the low proportion of acres affected by harvest compared to the overwhelming impact of fire, insects, and disease. If carbon stored in harvested wood products is factored in, this would offset some of the proportion of carbon lost to tree removal. Carbon storage in long-lasting wood products, as well as in waste held in landfills, are important components of the carbon balance. Current additions of carbon to these carbon pools from trees harvested in the United States are greater than decomposition losses from these pools, so carbon stored in these pools is increasing (M. G. Ryan et al., 2010). The Flathead contributes to this storage of carbon in harvested wood products, and under the projected harvest levels it would continue to contribute to this carbon pool at amounts and rates similar to the past 20 years.

Effects of alternative A

The existing forest plan contains no plan components or direct acknowledgment related to carbon stocks, sequestration, or use of various management approaches as a mitigation for greenhouse gas emissions and climate change. Management would continue similarly to the recent past, resulting in a similar pattern of carbon storage and flux as discussed in the “Affected environment” section. The current 1986 forest plan contains some direction incorporating strategies for maintaining resilient forests into the future (forestwide objectives under section A(6)-Vegetation and forestwide standards under (H)-Vegetation (USDA, 1986, pp. II-47 to II-48). Although not as comprehensive as in the action alternatives, this direction would tend to trend the Forest towards greater resilience at both the stand and landscape scales, which would increase the likelihood of sustaining the forests’ ability to sequester carbon over both the short and long term.

Effects of alternatives B modified, C, and D

The forest plan recognizes the importance of the role of the Forest related to carbon storage and sequestration, establishing a desired condition that directly addresses carbon sequestration. FW-DC-TE&V-06 focuses on sustaining this key ecosystem service through the maintenance or enhancement of ecosystem biodiversity and function and managing for resilient forests adapted to natural disturbance processes and changing climates. This approach to the management of forests for the purpose of contributing to climate change mitigation is supported by a number of scientific sources (Hurteau, Koch, & Hungate, 2008; North & Hurteau, 2011; Reinhardt & Holsinger, 2010; Ruddell et al., 2007; M. G. Ryan et al., 2010; Schaedel et al., 2017; Wiedinmyer & Hurteau, 2010).

The forest management strategies incorporated into the forest plan direction under all action alternatives are centered on the goal of maintaining or increasing forest resilience and resistance in the face of future uncertainties. This means that desired conditions for forest vegetation are designed to sustain and create forests with the composition and structure that are able to accommodate gradual changes related to climate and with the capacity to return towards the prior condition after disturbances (refer to section 3.3, subsection "Methodology and analysis process"; and to section 3.3.2 for greater detail). Increasing forest resistance and resilience to fire, drought, insects, and disease slows the release of carbon and retains larger portions in forest carbon pools, which is important considering that natural disturbances of fire and insects and disease has accounted for an estimated 90 percent of carbon stock loss over the past 20 years. All action alternatives generally result in a similar and desirable trend towards improved forest resilience over the next five-decade period and would thus have a potential beneficial effect on sustaining or improving the natural carbon sequestration potential of the forest lands. Refer to section 3.3 for full discussion of changes in vegetation conditions under the alternatives, and specifically to section 3.3.9 for detailed discussion of effects to forest resilience due to changes in vegetation conditions. Examples of the management strategies that are incorporated into forest plan direction that would contribute to carbon sequestration potential include the following (Harmon & Marks, 2002; Kobziar & Stephens, 2006; Krankina & Harmon, 2006; Millar et al., 2007):

- manipulating forests to favor rapid growth;
- increasing abundance and distribution of large-diameter trees of fire-resistant species;
- lowering forest densities and forest fuel conditions;
- rapidly regenerating to forested conditions after disturbances;
- maintaining healthy, vigorous trees;
- minimizing severe disturbance by fire, insects, and disease;
- keeping sites fully occupied with trees with minimal spatial or temporal gaps in non-forested conditions;
- sequestering carbon after harvest in wood products; and
- providing wood and biomass for fuel.

Some forest management treatments may reduce carbon at the stand level in the short term but result in maintaining or improving carbon sequestration potential in the long term. Some examples of this include precommercial thinning in young sapling stands and prescribed fire and other fuel reduction treatments. Thinning in young forests is an especially beneficial treatment to achieve forest conditions that improve resistance and resilience (such as desired species, tree sizes, and densities) and to achieve climate change mitigation through carbon sequestration. Although thinning reduces carbon stores in the short term, there may be no discernible difference in thinned vs. unthinned stands in total aboveground carbon stores several decades after thinning due to the larger trees and to differences in understory and woody material (Schaedel et al., 2017). Similarly, there are short-term

losses of carbon stores with prescribed burning or other fuel treatments, but some studies suggest there may be long-term benefits of these treatments in the event of a future wildfire. , For example, a lower severity of wildfire may occur in the treated stands, resulting in less consumption of live and dead tree biomass, higher tree survival, and shortened recovery times (Hurteau et al., 2008; North & Hurteau, 2011; Reinhardt & Holsinger, 2010; Wiedinmyer & Hurteau, 2010). This fuel reduction effect is most pronounced in dry forest types that historically experienced low or mixed severity fire.

Spectrum model projections of future carbon sequestration

To provide additional insight into the change in carbon storage and the relative relationship between carbon stored in aboveground pools projected for the Flathead National Forest, the Spectrum model was used to estimate future carbon stored in aboveground live, growing trees ("forest live inventory"), aboveground decaying dead wood, and harvested forest products. The Spectrum model was used to model potential vegetation treatments over time under the different alternatives. The impact of fire and insects and disease disturbances was factored into the model. Objectives included achieving the desired forest conditions in the forest plan while factoring in constraints related to wildlife habitat needs as well as budget limitations. A simple approach was developed using existing literature (J. E. Smith, Heath, Skog, & Birdsey, 2006) and the forest vegetation simulator as the source for estimating carbon coefficients used in the Spectrum model. Refer to appendix 2 of the final EIS for detailed discussion of the Spectrum modeling process and to Trechsel (2017c) for the data and outputs of the carbon modeling process in Spectrum.

Table 40 displays the estimated amount of carbon sequestered in the three pools over the next 100 years on the Flathead. Displaying outputs over 100 years allows for evaluation of forest recovery in response to the recent extensive amount of fire on the Flathead National Forest. Absolute values of the carbon amounts are less important than the relative comparison of the different carbon storage pools and the trends over time. These model results, although they do not represent the complete picture of carbon storage and loss over time, do provide insight into the relative proportion of carbon stored in different sources on the Forest and into the rate and relative nature of carbon changes over time with anticipated disturbances.

Table 40. Estimated carbon sequestration (in thousand metric tons per decade) for three carbon pools on the Flathead National Forest as projected over the next 10 decades (source: Spectrum model)

Carbon storage pool	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5	Decade 6	Decade 7	Decade 8	Decade 9	Decade 10
Live forest inventory	117,232	118,050	121,929	125,990	128,147	130,520	133,324	134,976	137,125	137,448
Harvested forest products	—[a]	181	341	478	616	780	947	1,109	1,302	1,498
Decaying dead trees after prescribed fire	—[a]	584	711	827	951	764	846	1,047	835	1,284
Decaying dead trees after natural fire	—[a]	95	299	607	805	907	892	895	874	873
TOTAL carbon	117,232	118,910	123,281	127,902	130,519	132,971	136,009	138,026	140,136	141,104

[a] Calculation of carbon occurs after the fact, so values associated with the first decade are not calculated until the beginning of the second decade.

Although fire disturbances occur every decade in the Spectrum model and would cause a drop in carbon immediately after the disturbance, the amount of fire as modeled does not appear to cause live inventory carbon stores to shift to a downward trend. Fire would cause short-term carbon losses, but the high productivity of the developing early-successional forests might increase sequestration for decades (Robert E. Keane et al., in press), which appears to be reflected in the modeling results. Under the anticipated levels of fire disturbance, harvest treatments, and growth rates of the forests in the Flathead National Forest, the model suggests that there would be a continuing general upward trend in total carbon sequestration over the 10-decade period, consistent with the upward trend estimated in the recent past from forest inventory and analysis data (Figure 38). The live forest inventory contributes vastly more carbon sequestration values than other sources (98-99 percent of the total contribution) and has the greatest rate of increase over time. A large area of the forest has been recently affected by wildfire (1994 through 2011), and the growth and increasing productivity of the young recovering forests on these disturbed sites is likely the primary reason for the projected increase in carbon sequestration over time. Also, recovery of forests harvested during past decades, when harvested area was higher than the current or expected future amount, is also contributing to this continuing upward trend on the Forest. The rate of carbon sequestration appears to level out after about 80 to 100 years, which would coincide with a point in these recovering forests when net productivity would be slowing due to age (refer to figure 43).

Carbon removed by harvest treatments at future anticipated levels does not appear to adversely impact the live forest inventory carbon stores. This reflects the relatively small portion of the live forest inventory expected to be harvested in the future (i.e., less than 1 percent of total forest area annually). Carbon storage in harvested wood products would continue to steadily contribute carbon to the total carbon pool, consistent with what has occurred in the recent past (figure 39).

Conclusion

The Flathead National Forest and other national forests are especially important for the persistent long-term contribution to greenhouse gas mitigation they are capable of providing. This is because land use conversion from forest to other uses is a primary human activity affecting carbon stores both globally and nationally, and forests on NFS lands are not subject to conversion to non-forest uses (except in extremely limited and local situations, such as road construction). Although Forest Inventory and Analysis data indicate that the Forest has functioned as a carbon sink over the past 20 or more years, there is uncertainty around this estimate, and it is not possible to conclude this with certainty.

Natural ecosystem processes and disturbances on the Flathead will continue to be the primary influence by far on carbon storage, accumulation and emission patterns for the Flathead, with harvest accounting for only a very small portion of the effect (likely less than 10 percent) of carbon loss. Forest plan direction for vegetation management is designed to maintain and increase forest resistance and resilience to fire, drought, insects, and disease. All action alternatives are expected to result in a similar and desirable trend towards improved forest resilience over the next five-decade period. This would be beneficial because it would help sustain or improve the natural carbon sequestration potential of the forest lands.

Considering past and projected future conditions and disturbances and their influence on carbon dynamics, it is anticipated that carbon storage and sequestration fluctuations on the Flathead National Forest over the next 20 to 50 years would be similar to patterns estimated in the recent past from Forest Inventory and Analysis data. Disturbances resulting in the immediate loss of carbon would continue to occur; forest establishment and growth would recover that loss over several decades; and the Forest would likely continue to function as a net carbon sink. Fluctuation in carbon

stores and accumulation into the near future (i.e., 20 to 50 years) would continue to occur, consistent with the natural variation that would be expected in an ecosystem influenced mostly by natural disturbance regimes and ecosystem processes. Projected impacts of fire and insects and disease on forest cover and the potential loss of carbon are up to 15 times greater than the projected impacts due to timber harvest activity, so timber harvest would have little impact overall on the potential future scenario of carbon accumulation and loss.

Uncertainties in the amount of future disturbances exist, especially related to factors associated with climate changes and to trying to project changes further into the future, i.e., beyond five decades. If changes in natural fire regimes occur in the future, perhaps to a regime of more frequent, more severe, and/or more extensive areas burned over shorter time periods, then the relationship between carbon sequestered in live forest inventory and that within decaying dead trees after fire could shift.

3.4.4 Cumulative effects

Within the United States, land use conversions from forest to other uses (primarily for land development or agriculture) are identified as the primary human activities exerting negative pressure on the carbon sink that currently exists in this country's forests (McKinley et al., 2011; M. G. Ryan et al., 2010). The Flathead Valley population is growing, and the conversion of forested lands to non-forest purposes is likely to occur to some degree on private lands adjacent to and near the Forest. However, the Flathead National Forest's lands under all alternatives would remain forests; they would not be converted to other land uses, and long-term forest services and benefits would be maintained. The impact of the alternatives and forest plan direction on atmospheric concentrations of greenhouse gasses or global warming is not likely to be large at the global scale, considering the global scale of the atmospheric greenhouse gas pool and the multitude of natural events and human activities contributing globally to that pool.

Federally owned forest lands are managed to ensure sustainable timber yields and, unlike in other parts of the world, the overharvesting of timber is not a primary concern as a cause of decreased carbon sequestration (Robert E. Keane et al., in press). Sustainable management practices and the promotion of healthy, resilient forest ecosystems would increase the ability of the forest to provide long-term carbon sequestering services (Robert E. Keane et al., in press).

An area of vulnerability to forest resilience and associated carbon sequestration and storage values is the increased risk of uncharacteristic fire, insect, and disease activity that might occur with warming climatic conditions. Large, high-severity fires or large-scale insect outbreaks can affect forest regrowth and vegetation types, which may influence the capacity of the Forest for carbon sequestration, with the potential for converting carbon sinks to carbon sources (Kurz, Dymond, et al., 2008; Kurz, Stinson, & Rampley, 2008; Kurz, Stinson, Rampley, et al., 2008). This effect would be small in relation to the global capacity to sequester carbon (Robert E. Keane et al., in press). The net effects on forest health and carbon sequestration have a high degree of uncertainty, primarily because of uncertainty related to the magnitude of future climate change and the complex interactions of forests with disturbances, climate, and ecological processes.

3.5 Plant Species

3.5.1 Threatened, endangered, proposed, or candidate plant species

Introduction

This section covers plant species that are federally recognized under the Endangered Species Act as threatened, endangered, proposed, or candidate species. The Flathead National Forest has two plant species that are listed as threatened and one species with candidate status.

Regulatory framework

Endangered Species Act of 1973: Federal agencies are directed to conserve threatened and endangered species and to ensure that actions authorized, funded, or carried out by agencies are not likely to jeopardize the continued existence of these species or result in the destruction or adverse modification of their critical habitats.

2012 planning rule (36 CFR § 219.9(b)(1)): States that the responsible official will evaluate whether the plan components provide the ecological conditions necessary to contribute to the recovery of federally listed species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern in the plan area. Evaluation would consider components that provide for ecosystem integrity and diversity (coarse-filter approach) and species-specific components (fine-filter approach).

Methodology and analysis process

The USFWS is responsible for determining species recognized under the Endangered Species Act as threatened, endangered, proposed, or candidate. Once identified, the Forest Service is responsible to manage for the ecological conditions that would contribute to the recovery of the listed species and to conserve proposed and candidate species where they occur on national forest lands. Determining effects to federally recognized species by alternative considers the degree to which management activities or natural conditions may pose potential stress or threat to the species.

Information sources and incomplete/unavailable information

Species federally recognized as threatened, endangered, proposed, or candidate species for the Forest are those designated by the USFWS (USFWS, 2017b). Federally recognized species often have published information on species population trends, viability, threats, and conservation strategies. Although there may be uncertainties and gaps in data and knowledge about rare plant species, the best available information is utilized in this analysis to assess the existing condition and determine potential effects of the alternatives. Primary sources for information on plant species and their occurrences on the Forest are the Forest Service's Natural Resource Manager and the Montana Natural Heritage Program's Element Occurrence databases, which include the NatureServe database and the Montana Natural Heritage Program online Montana Field Guide. Information gaps may be filled in through future inventories, plan monitoring program results, or research, and this information will be integrated into the databases as it becomes available.

Analysis area

The geographic scope of the analysis for effects to the threatened and candidate plant species in the planning area is the lands administered by the Forest. The range of a species may extend beyond the Forest; however, the lands administered by the Forest represent the area where changes may occur to these species or their habitats from activities that might be allowed under the alternatives.

Affected environment

On the Forest, the two federally listed plant species that occur or are suspected to occur are water howellia and Spalding's catchfly, respectively. The candidate species is whitebark pine. An abbreviated discussion of the habitat, threats, and population trends of these three species is documented below; additional detail can be found in the assessment.

Water howellia

Water howellia (*Howellia aquatilis*), a vascular plant species in the family Campanulaceae, was listed as threatened under the Endangered Species Act by the USFWS on July 14, 1994 (Federal Register 59(134):35860-35864) (USFWS, 1994). The USFWS drafted a recovery plan for the species (Shelly & Gamon, 1996), but it has not been finalized. Therefore, there are no recovery goals officially identified for the species. A conservation strategy for water howellia on the Forest was completed (USDA, 1996a), incorporating strategies from the draft recovery plan and providing management direction to guide the conservation of the species. This strategy was incorporated into the current forest plan as amendment 20 (USDA, 1996a) and will be carried forward into the forest plan.

The USFWS has completed a five-year review of water howellia (USFWS, 2013b). Existing Federal regulatory mechanisms have protected water howellia habitat from adverse human-caused impacts. Due to these actions and continuing existing conservation practices, the water howellia has been recommended for delisting (USFWS, 2013b).

Habitat

Water howellia is an aquatic plant restricted to small pothole ponds, or oxbows, long since isolated from the flowing surface waters of the adjacent river. These wetland habitats are generally shallow (approximately 20-40 inches deep during the early summer months). All of the howellia occurrences in the Swan Valley are in glacially formed ponds or retired river oxbows, usually surrounded in part by deciduous trees and a diverse matrix of coniferous forests (Lesica, 1990).

Occurrence

Currently, there are 220 known populations of water howellia in the Swan Valley (MNHP-MFWP, 2016; NatureServe, 2015). Of these, 177 (80 percent) occur wholly (167) or partially (10) on Flathead National Forest lands. These 220 populations represent 72 percent of the known 304 global occurrences.

General surveys for water howellia in the Swan Valley have been conducted since 1987 and have continued to the present. The Flathead National Forest, with the cooperation of the Montana Natural Heritage Program and The Nature Conservancy, has surveyed the majority of identifiable potential water howellia ponds in the Swan Valley. Many ponds that contain suitable habitat but are unoccupied by water howellia have been found in the Swan Valley. Some initially identified suitable but unoccupied ponds have been later found to contain water howellia. Other identified suitable unoccupied ponds could harbor water howellia at some point in the future.

Threats

The Montana Natural Heritage Program Network has ranked this species as G3, meaning that it is at a moderate risk of extinction due to its restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors (NatureServe, 2015). The Montana Natural Heritage Program has ranked the species as S3, which means potentially at risk in the state because

of limited and/or declining numbers, range, and/or habitat, even though it may be abundant in some areas. Water howellia is currently listed as threatened by the USFWS.

Water howellia habitat has been subject to various management activities, including dredging, draining, road construction, logging, and grazing (Shelly, 1988; USDA, 1996a). These activities could alter hydrological conditions by removal of vegetation or impacting soils adjacent to ponds. The resulting increased pond evaporation, changes in interception and transpiration of water by plants, and alteration of water flow in soils may influence pond water levels. These changes may be detrimental or beneficial to water howellia depending on the site-specific situation and annual variations in precipitation and temperature since the plant requires water for growth and flowering early in the season followed by a sufficient drying of ponds in the fall for seed germination to take place (Lesica, 1990).

The non-native variety of reed canary grass (*Phalaris arundinacea*) has threatened some populations across its range but has not impacted other populations (Lesica, 1997b; USFWS, 2013b). One howellia site in Montana, the Swan River Oxbow (a Nature Conservancy preserve), does have documented encroachment of reed canary grass that is likely an introduced cultivar from the adjacent national wildlife refuge, and impacts to that site have been published by Lesica (1997b). The small isolated populations of reed canary grass that occur in many of the howellia ponds in the Swan Valley may be native (Merigliano & Lesica, 1998), and a 10-year monitoring study (USDA, 2010a) did not show much expansion of reed canary grass in these ponds.

Additional human-caused threats to water howellia include potential drift from chemical spraying of invasive species near ponds. The effects of chemical controls conducted by the State and on private lands near water howellia ponds are unknown. The effects of herbicides at or near water howellia ponds on the Forest were analyzed in the Flathead National Forest Noxious and Invasive Weed Control Environmental Assessment and Decision Notice (USDA, 2001b). No chemical controls have been conducted at or near howellia ponds on the Forest. Surveys for at-risk plant species are required before conducting chemical control of invasive weeds on the Forest.

Natural stressors that may affect water howellia include climate change, aquatic vegetation succession, and wildland fire. Changing climate patterns may affect the seasonal fluctuations in pond water levels that influence water howellia populations. Successive years of either dry, hot growing seasons or very wet, cool growing seasons could affect the annual filling and drying regime that is important to persistence of the populations. Vegetation succession in ponds could lead to extirpation of a population, if shifting from a pond to a sedge meadow. Wildland fire could have beneficial and detrimental effects to water howellia, depending on the situation. A hot fire late in the season could burn over seeds that are in shallow soil. Fire’s removal of trees and other vegetation surrounding ponds could have hydrological effects that alter water levels, with site-specific effects similar to the discussion on management activities above.

Trends

In 1998, a 10-year monitoring plan was initiated by the Forest to detect changes in water howellia distribution and abundance, and this was completed in 2007 (USDA, 2010a). This study assisted in evaluating whether current management prescriptions for water howellia are sufficient for continued viability of the Swan Valley metapopulation. Approximately 65 occupied ponds were monitored annually over the ten-year period. Although population levels were reduced in two of the ten years due to yearly variation in precipitation and temperature, the species is adapted to such fluctuations, and overall the monitored populations in both disturbed and undisturbed settings were stable throughout the study. Additional survey work has increased the total number of documented

populations in the Swan Valley, including the discovery of occurrences of water howellia in previously unoccupied yet suitable ponds. Population levels of water howellia are primarily influenced by annual fluctuations in precipitation and pond drying, with reduced population sizes often occurring during years following cooler, wetter summers. This is because the latter conditions inhibit fall seed germination (Lesica, 1992).

The USFWS concluded their five-year review of water howellia in 2013 (USFWS, 2013b). Their conclusion was that the threats identified at the time of listing have been mitigated through regulatory mechanisms such as the conservation strategy and incorporation of project design features that remove or minimize disturbance to populations, such as the 300-foot minimum management buffer around ponds for project-level decisions. Other regulatory direction, such as buffers that limit ground-disturbing activities around wetlands not occupied by water howellia, have also contributed to the conservation of water howellia habitat. Reed canary grass threatening ponds has been successfully treated in some states (USFWS, 2013b) and does not seem to be invading other habitat as previously thought (USDA, 2010a). Grazing has been removed from water howellia habitat as well.

In addition to management changes to water howellia habitat, there have been almost 200 additional populations documented rangewide since the time of listing, including sites previously believed to be extirpated in Oregon and California. Because of all of these factors, the USFWS is recommending delisting water howellia while maintaining current conservation measures (USFWS, 2013b).

Spalding's catchfly

Spalding's catchfly (*Silene spaldingii*), sometimes called Spalding's campion, is a perennial herb in the pink family (Caryophyllaceae). It was listed as threatened under the Endangered Species Act by the USFWS on November 9, 2001 (66 FR 51598) (USFWS, 2001). Although the USFWS intends to identify critical habitat for this species, critical habitat designation was precluded at the time of listing due to a lack of funding. The recovery plan for Spalding's catchfly (USFWS, 2007) outlines the recovery strategy, recovery goals, objectives and delisting criteria. A five-year review was conducted by USFWS (USFWS, 2009b). No change in listing was recommended due to lack of changes in the species status.

Habitat

Spalding's catchfly habitat is primarily dry grasslands and grassland inclusions typically dominated by rough fescue (*Festuca campestris*) or Idaho fescue (*Festuca idahoensis*), blue bunch wheat grass (*Agropyron spicatum*), and other bunchgrasses. There may be scattered ponderosa pine trees, forming an open canopy. Plant communities dominated by these grass species are exceedingly rare on the Forest. A few patches of suitable habitat exist along the North Fork of the Flathead River floodplain from the Canadian border to Polebridge, in the Swan Valley, and in larger open fescue bunchgrass prairies in the South Fork of the Flathead and Danaher Creek drainages within the Bob Marshall Wilderness. However, these areas have been surveyed extensively in the past and Spalding's catchfly was not found. There may be suitable grasslands in the Hog Heaven Range west of Flathead Lake and on the south slopes near Ashley Lake as well. None of these areas are specifically mapped; even so, they would comprise less than 1 percent of the land base of the Forest.

Occurrence

Spalding's catchfly is a Palouse Prairie endemic that is currently known from 109 populations across its range in Montana, Idaho, Oregon, Washington, and British Columbia (USFWS, 2009b). Populations are often small and isolated. Sixty-eight occurrences are known from Montana (MNHP-MFWP, 2016), all in grassland plant communities located in the northwestern portion of the state.

The number of individuals at most of these occurrences is very low. No populations are known from the Forest, although four occurrences are within 3, 10, and 15 air miles from the Forest.

Threats

This species has suffered considerable habitat loss and fragmentation due to agricultural and urban development, grazing, herbicide treatment, and exotic weed invasion (Lichthardt, 1997; Schassberger, 1988). Disturbances such as grazing or fire may be important to the long-term persistence of this species in northwest Montana as a result of reduced competition with the large, litter-producing native bunchgrasses, primarily rough fescue, with which it co-occurs (Lesica, 1997a). Invasion by exotic species threatens nearly all populations. The threat of herbicide drift is a factor affecting Idaho populations, but this is not a threat in Montana because the few known Montana occurrences are geographically removed from agricultural treatments.

Trends

Populations of Spalding's catchfly have been extirpated in some portions of its range and are stable in others, depending on the particular threats to each population (USFWS, 2007). Due to aspects of the species' life history, population numbers vary from year to year. Many plants go dormant depending on climatic conditions. Some years exhibit tens of thousands of plants, but in other years, only a few hundred plants will be observed (USFWS, 2007).

Whitebark pine

Whitebark pine (*Pinus albicaulis*), in the family Pinaceae, was determined by the USFWS to be a species warranted for federal listing but precluded under the Endangered Species Act on July 19, 2011 (76 FR 76 42631) (USFWS, 2011a). This makes the species a candidate for federal listing as threatened or endangered.

Range and occurrence

Whitebark pine is widely distributed throughout the coastal and Rocky Mountain ranges of the western United States and Canada, although populations tend to be scattered and spotty because of the often discontinuous distribution of favorable high mountain habitat. It grows at the highest elevation of any western tree species. More than 90 percent of whitebark pine forests exist on public lands, including those managed by the Forest Service and the National Park Service in the United States and by provincial and Federal agencies in Canada (R. E. Keane et al., 2012).

On the Forest, sites capable of supporting whitebark pine are abundant in the upper slopes and ridges of the mountain ranges. The species grows on a wide variety of site conditions and forest settings, from mid- and upper-elevation moist slopes to cold, windswept, high-elevation ridgetops. It tends to grow most successfully at the higher elevations and on exposed, harsh sites where there is little competition from other species. Although it is most commonly found within the cold potential vegetation type, it also grows successfully in the coldest sites at upper-elevation zones within the cool-moist potential vegetation type, where it occurs in mixed species stands that often include lodgepole pine and subalpine fir. Refer to section 3.3, subsection "Methodology and analysis process," of the final EIS and to appendix D of the forest plan for a description of potential vegetation types.

Natural range of variation and current condition

The cold potential vegetation type contains the most suitable whitebark pine habitat. The natural range of variation for the presence of whitebark pine in this cold type on the Forest is estimated at 55 to 85 percent of the area, which is also the desired condition for the presence of this species set forth in the forest plan (refer to Trechsel, 2017f and section 3.3.4 of this final EIS). The total area within

the cold potential vegetation type on the Flathead is approximately 400,000 acres, or about 14 percent of the Forest, and therefore whitebark pine historically occurred on an estimated 220,000 to 340,000 acres within the cold potential vegetation type. Using the Forest Inventory and Analysis database (refer to section 3.3, subsection "Information Sources," and to Trechsel, 2016c for information on this database), whitebark pine is currently present on an estimated 154,701 acres of this type, or about 38 percent of the area (see also Trechsel, 2017e). This amount is below the desired condition and reflects the influence of various stressors of this species that are described later in this section.

In the cool-moist potential vegetation type, the natural range of variation for whitebark pine presence is estimated at 6 to 16 percent of the area, or about 87,400 to 233,000 acres within this type. Whitebark pine is currently estimated to occur on about 7 percent of this type, or about 97,000 acres (refer to section 3.3.3). This is within the natural range, although at the low end, and the desired condition is for this species to trend upward in presence within this type.

Combining the above acres of the cold and cool-moist types natural range of variation for the presence of whitebark pine suggests that from 307,000 to 573,000 acres of the Forest supported whitebark pine historically.

An additional analysis was conducted to add to the Forest's understanding of how much whitebark pine habitat may occur on the Forest currently as well as where this species might be expected to occur. This whitebark pine single-species mapping project (Housman, Brown, Hamilton, & Fisk, 2014) utilized modeling methods developed and being tested by USDA Forest Service Northern Region remote-sensing specialists, using a combination of field methods and image, terrain, and climate variables. The Flathead National Forest was chosen as a representative pilot study area for this analysis. Depending upon the model threshold range that is applied, the estimate of the potential range of whitebark pine from this analysis suggests that from 390,600 to 527,800 acres, about 16 to 22 percent of the Forest, are currently suitable for the successful establishment and growth of whitebark pine. This is fairly consistent with the estimated natural range of variation for whitebark pine presence discussed above, where a range of 307,000 to 573,000 acres of the Forest could have supported whitebark pine historically.

The Housman et al. (2014) analysis also provides an estimate of the current occurrence of whitebark pine across the landscape. It suggests that the species is likely currently present (any size class) on most of these acres, although at exceedingly low densities (e.g., less than 3 percent of the total tree canopy cover on the site). This estimate is somewhat more generous than the current area of whitebark pine presence estimated using the Forest Inventory and Analysis database, which is 266,474 acres forestwide (refer to Trechsel, 2017e).

Additional information on the density of the whitebark pine in the areas where it is currently present was also derived using Forest Inventory and Analysis data. The average basal area of whitebark pine across the forest is currently estimated at 2.8 square feet per acre, and within the cold potential vegetation type the estimate is 11.4 square feet per acre. These are very low values, indicating that there are very few whitebark pine present on the site and/or the trees that are present are small in diameter (i.e., seedlings, saplings, or small trees less than 9 inches d.b.h.). Forest Inventory and Analysis estimates of the trees per acre of larger-diameter whitebark pine bear this out, with an average of only an estimated seven whitebark pine trees per acre greater than 10 inches d.b.h. on the cold type and only two trees per acre greater than 15 inches d.b.h. About 40 percent of the acres have only seedling or sapling size whitebark pine present (less than 5 inches d.b.h.).

Species and plant community characteristics

Whitebark pine is a long-lived species; it can live well over 400 years, with known individuals over 1,000 years old. It is moderately tolerant of shade—more tolerant than lodgepole pine but far less tolerant than other associates such as subalpine fir and spruce. Whitebark pine is slow growing in both height and diameter, reaching heights up to 60 feet or greater on the better sites and rarely growing faster than most of its competitors except on the most severe sites (Arno & Hoff, 1990).

Whitebark pine has fairly low resistance to fire damage due to its thin bark. However, it is more resistant than its associates, subalpine fir and Engelmann spruce. Its deeper roots and more open crown form also enhance its resistance to fire. Larger mature trees are able to survive low-intensity fires, but moderate-intensity fires will kill many of these trees. High-intensity fires are likely to kill even the largest whitebark pine (R. E. Keane & Arno, 1993). However, in areas with low fuel levels and more widely scattered trees, some whitebark pine may survive the higher-intensity fires (Lorenz, Aubry, & Shoal, 2008).

Whitebark pine has a unique method of seed dispersal and regeneration that involves a mutualistic relationship that has evolved between whitebark pine and the Clark's nutcracker (*Nucifraga columbiana*) for seed dissemination. Whitebark pine is entirely dependent on this bird to disperse and sow its seeds for regeneration of the species. Clark's nutcracker benefits from the high-quality food source provided by the large, nutritious seed of whitebark pine. The bird extracts the seed from the cones and, if they do not immediately consume it, they cache the seed in small stores often in the ground and sometimes many miles from their source. Unretrieved seeds that are buried in the soil and on sites suitable for seed germination and establishment, such as open or fire-burned areas, are able to germinate, thus establishing new whitebark pine seedlings. Because of features unique to the whitebark pine cone, it is believed that the regeneration of this species on a population-wide scale is dependent on these birds (Lorenz et al., 2008).

Whitebark pine grows in two types of high mountain forest settings: (1) as an early and mid-successional species on relatively moist sites, where it forms closed canopy forests and is eventually replaced through succession by more shade-tolerant tree species; and (2) as apparent climax species in pure or nearly pure stands on relatively dry, cold slopes where it is the only tree species capable of successfully reproducing and growing to maturity. On the Forest, this latter forest type is the least common, found only at the highest elevations and in the driest, coldest regions of the Swan and other mountain ranges in the upper reaches of the South Fork of the Flathead River watershed (in the Bob Marshall Wilderness). The majority of whitebark pine on the Forest occurs in the first type of high mountain settings, the mesic upper subalpine forests. On the best sites in these areas, whitebark pine grows in a straight, single-stem upright form, achieving heights of 60 or more feet. Stands may be densely stocked, forming closed or nearly closed canopy conditions. The lower range of whitebark pine overlaps with the upper elevational limit of lodgepole pine, and the two species may share dominance. Whitebark pine is an occasional species at even lower elevations within the subalpine forest type, where it may occur as a minor species within stands typically dominated by lodgepole pine and Douglas-fir.

Ecological role

Whitebark pine is considered a keystone species in upper subalpine forest ecosystems throughout its range. A keystone species performs an important ecological role or function, enabling other species to establish and persist and thus increasing the biodiversity of a community (Tomback, Arno, & Keane, 2001). Most keystone species play a single important role in an ecosystem. In contrast, whitebark pine assumes multiple important ecological roles due mainly to these key features: its large, nutritious seeds; its seed dispersal method; its hardy, robust seedlings; and its tolerance for

cold, inhospitable, and windy sites (S. T. McKinney, Tomback, & Fiedler, 2011). Whitebark pine has the largest seeds of all conifers at subalpine elevations throughout its range. They are a highly nutritious food source for small birds and small mammals.

Whitebark pine becomes established very early in succession after a disturbance such as fire due to its highly effective seed dispersal method, as described above. Whitebark pine seedlings are exceptionally hardy and are more tolerant of exposed sites and drought than are the seedlings of associated conifers. Thus, not only is whitebark pine frequently the first conifer to become established on disturbed sites, but it also has the greatest chance of survival in the often very harsh conditions within a burned area at higher elevations. The presence of whitebark pine facilitates the successional process by creating favorable microenvironments with shade, moisture, and shelter from wind for the establishment of other conifer species and understory vegetation.

Whitebark pine forests regulate runoff and reduce soil erosion because they are present at high elevations and on poor sites not tolerated by most other conifers (Tomback et al., 2001). In general, 35 to 60 percent of the annual precipitation at high elevations becomes runoff (Farnes, 1990). Forest communities at high elevations, and whitebark pine in particular, accumulate more snow, slow the progression of snowmelt, and result in later melt-off and higher stream flows in summer months. Tree roots physically stabilize soils and take up water, which also slows runoff rates and reduces soil erosion.

The structure and composition of whitebark pine communities vary considerably over its range and provide food, shelter, nesting sites, and a wide range of other values to a variety of animals. There are few animal species whose distribution is limited solely to whitebark pine communities, but the number of species that are found in whitebark pine communities as well as a wide variety of other community types represent important contributions to forest biodiversity (Tomback et al., 2001). As described earlier, whitebark pine has higher tolerance to fire than subalpine fir or spruce, its primary conifer associates. This fact, along with the typical discontinuous, patchy fuel matrix of higher-elevation forest, increases the probability that there will be surviving trees after a fire event in a whitebark pine community. These survivors facilitate more rapid reforestation of the landscape and also provide habitat for wildlife.

In addition to the ecological role of whitebark pine, it should be noted that this species has an important social role as well. It could be called the "quintessential" high mountain conifer of the western North American landscape (Tomback et al., 2001), contributing in a variety of ways to the enjoyment or spiritual experience of the high mountain recreationist or traveler: the aesthetic beauty of the gnarled and windswept form of the trees on the horizon; the pastoral nature of open, park-like stands of whitebark pine; the welcome shade along a harsh ridgetop provided by their large, spreading tree crowns; and the bird and squirrel activity they attract during the cone harvesting season.

Existing condition and threats

Several interrelated factors threaten the whitebark pine population, including (1) past and ongoing fire suppression and exclusion, (2) mortality due to several major mountain pine beetle epidemics over the last 80 years, (3) extensive infections of the exotic pathogen white pine blister rust fungus (*Cronartium ribicola*), and (4) effects of weather and climate, including climate change over time (R. E. Keane & Arno, 1993; K. C. Kendall & Keane, 2001; USFWS, 2011a). The effects and mortality caused by the interaction of these factors are variable across the range of the species. In general, the greatest mortality is found in the more mesic parts of the range where upper subalpine forests

experience a more maritime climate (R. E. Keane & Arno, 1993). The Forest lies within this mesic portion and has experienced extremely high mortality of whitebark pine over the past 40 years.

Fire exclusion and suppression

Prior to about 1930, the replacement of whitebark pine by later successional species such as spruce and subalpine fir was usually interrupted by naturally occurring fires. Whitebark pine is exceptionally well adapted to re-establishing after a fire event. However, decades of fire suppression have allowed subalpine fir and Engelmann spruce to achieve dominance in many forests that were historically dominated by whitebark pine. This conversion is particularly significant in the moist subalpine forests of the Forest. The loss of whitebark pine due to disease and bark beetles has greatly exacerbated this conversion. Forests where whitebark pine was once the dominant species in the main canopy layer and where shade-tolerant spruce and subalpine fir were mostly limited to the understory tree layers now have little or no whitebark pine and are moderately to densely stocked with multiple sizes of subalpine fir and spruce. When a fire does occur, it tends to be more severe due to the increase in tree density, ladder fuels and downed woody material as well as the overwhelming presence of non-fire-resistant species. Although open, burned, and favorable habitat for whitebark pine regeneration is created by the fire, the lack of cone-producing trees within caching distance severely limits the ability of this species to re-establish itself in areas where it historically was present or dominant. A recent study suggests that in highly damaged whitebark pine stands, most seeds produced are consumed by nutcrackers and red squirrels rather than dispersed (S. T. McKinney et al., 2011).

Insects and disease

Several large, widespread epidemics of mountain pine beetle caused high mortality of whitebark pine throughout the U.S. Rocky Mountains between 1909 and 1940 and again from the 1970s to the 1980s (Arno & Hoff, 1990). Drought and warmer temperatures in recent years have allowed large increases in beetle abundance and distribution, again resulting in high mortality of trees in portions of the range of whitebark pine.

White pine blister rust, a fungal disease caused by the pathogen *Cronartium ribicola*, is an introduced (non-native) disease that infects all five-needled pines, which includes whitebark pine, and usually kills them. In addition, whitebark pine trees stressed by blister rust are more susceptible to attack by mountain pine beetle. Whitebark pine mortality from the combination of blister rust and mountain pine beetle exceeds 50 percent in some areas of the U.S. intermountain northwest area, including the Flathead National Forest. The high levels of mortality from bark beetles and blister rust have not only decreased the whitebark pine population but have also reduced the ability of the species to successfully re-establish in areas it formerly occupied due to the loss of mature cone-producing trees. Since blister rust kills individual branches years before the death of a tree, cone and seed production can be significantly reduced even when the tree is still alive.

Climate change

The impact of projected climate change on whitebark pine is inconclusive, and there is an element of confusion in the research about the potential fate of the species (Robert E. Keane et al., in press). Some feel that the projected warmer conditions will severely reduce whitebark pine habitat and its distribution, perhaps restricting it to only the highest elevations (Belote, David-Chavez, Dietz, & Aplet, 2015; Lenoir, Gegout, Marquet, de Ruffray, & Brisse, 2008; Warwell, Rehfeldt, & Crookston, 2007). Others feel that climate-mediated changes in disturbance regimes, such as increased fire frequencies, will reduce whitebark pine populations but not alter its current range (R. A. Loehman, Corrow, & Keane, 2011). Anecdotal evidence suggests that some whitebark pine forests are experiencing abnormally high growth and more frequent cone crops with warmer summers and

longer growing seasons (Robert E. Keane et al., in press). The reality is complex because of the high uncertainty in regional climate change predictions, the high genetic diversity and resilience of the species, and the localized changes in disturbance regimes and interactions.

Long-lived whitebark pine forests have experienced great variation in past climate and clearly have broad amplitudes of resilience with respect to climate (Robert E. Keane et al., in press). Changes in disturbance regimes related to climate factors, and particularly the projected increase in number, area burned, and severity of fires, may remove even more whitebark pine individuals from the landscape, especially if the fires are more severe due to altered forest conditions (as discussed above). However, these changes in fire regimes may actually favor the regeneration of whitebark pine due to its fire adaptations and seedling resilience. Whitebark pine may be maintained on the future landscape if large, stand-replacement fires reduce competition (Robert E. Keane et al., in press). Seeds germinating within Clark's nutcracker caches will likely be from trees that have survived exposure to blister rust, and thus are more likely to have some level of natural resistance to the disease. However, within landscapes that have lost most of the cone-producing trees, the very low seed availability will slow this natural evolutionary process considerably. This seed availability is threatened even more by the susceptibility of the surviving trees that may have blister rust resistance to attack by mountain pine beetle. Unfortunately, warming temperatures may be beneficial to the survival and expansion of mountain pine beetles as well as of the white pine blister rust fungus. Overall, whitebark pine is not expected to do well under future climates, primarily because of the current threats and severely declined population, its confinement to upper subalpine environments, and its lack of ability to regenerate because of nutcracker consumption of seed in areas of low whitebark pine populations (Robert E. Keane et al., in press).

Trends

A severe and steep downward trend has been occurring in the whitebark pine population and health over the past few decades, especially in the northern Rocky Mountains (R. E. Keane et al., 2012). This decline is expected to continue into the foreseeable future, although the rate may lessen simply because there are fewer live trees left to be impacted by disease or other threats.

Studies in the 1990s that were specifically designed to document the presence and health of this species in western Montana estimated that an average of around half of the whitebark pine had died by that time (ranging from 30 to 90 percent), and up to 99 percent of the remaining trees were infected with blister rust (ranging from 20 to 99 percent) (R. E. Keane, Morgan, & Menakis, 1994). Recent remeasurement of a subset of these plots within the Bob Marshall Wilderness Complex show that the mortality of whitebark pine trees has more than doubled in the past two decades, primarily as a result of blister rust infection and to a lesser extent of mountain pine beetle and wildfire (Robert E. Keane et al., in press). Blister rust is now present in all surveyed stands, although infection rates have slowed since 1994. This could be due to a lack of living host trees coupled with some amount of natural rust resistance in the remaining trees.

A similar study conducted in Canada and northern Montana also showed significant increases in the proportion of trees infected by blister rust and in the mortality of whitebark pine (C. M. Smith et al., 2008). The rates of infection appeared to be slowing, however, compared to the previous decades, suggesting that some level of natural selection may be occurring. Fiedler and McKinney (2014) also reported a high mortality of whitebark pine in recent decades in the Northern Continental Divide Ecosystem (which includes the Flathead National Forest), with nearly three quarters of the whitebark pine trees dead and over 90 percent of the remaining live trees infected with blister rust. Even more ominous, there was a virtual absence of uninfected large (e.g., greater than 14 inch d.b.h.) cone-

bearing whitebark pine, which makes the sustainability of this whitebark pine ecosystem more tenuous.

There is substantial concern over the ability of whitebark pine to successfully sustain itself within the ecosystem through natural regeneration. Some natural selection for resistance to blister rust is likely occurring (Raymond J. Hoff, Ferguson, McDonald, & Keane, 2001), but the recovery of the species will be slow. Whitebark pine grows slowly and has a long generation time (trees need to be 60 to 80 years old before they produce sizable cone crops), and, as noted, there has been an especially dramatic decline in mature, cone-producing trees. The regeneration potential of the species is further exacerbated by evidence suggesting that stands with less than about 21 square feet per acre of live whitebark pine basal area provide too little cone production to reliably attract nutcracker seed dispersal (Shawn T. McKinney, Fiedler, & Tomback, 2009). In addition, in areas with only a few surviving cone-producing trees, there is the risk of inbreeding depression. Trees that cross with themselves or close relatives produce seedlings that grow slower, are less hardy, and often exhibit lethal genes (Wright, 1976). Recent monitoring of the impacts of blister rust on whitebark pine natural regeneration on mesic sites in Idaho indicate high rates of infection and mortality of the young trees, with the number of live trees dropping by about 26 percent over a 17 year period (Schwandt, Kearns, & Byler, 2013). More than 85 percent of the remaining live, infected trees are expected to die or be top-killed, removing any cone-producing potential, due to existing blister rust infections.

This data, combined with the results of modeling (as discussed in the "Range and occurrence" subsection above) and decades of field experience and observations by resource specialists on the Forest, substantiate the past and ongoing severe decline of whitebark pine in the planning area and the expectation that this decline will continue for some time into the future. There is an urgent need to focus on conservation and restoration efforts for this keystone species across the extent of its range and within the Forest (R. E. Keane et al., 2012).

Environmental consequences

Effects to water howellia and Spalding's catchfly

Alternatives A, B modified, C, and D

Forest plan components comply with the requirements of the Endangered Species Act of 1973. All Federally recognized threatened, endangered and candidate species would continue to be managed and protected across the forest in accordance with Forest Service policy, recommended protection measures in the recovery plans (if available) and all applicable State and Federal laws. Project-level analysis will evaluate site-specific impacts to these species, and consultation with the USFWS will take place for all projects potentially affecting threatened and endangered species. Additional design features or mitigation measures at the project level may be developed, if it is determined that they are needed.

All alternatives incorporate the elements from the conservation strategy for water howellia into forest plan direction, and these are designed to provide protection from potential detrimental impacts from management activities and to maintain or improve habitat for this species (USDA, 1996a).

The Condon Creek Botanical Special Area is recognized for its importance in protecting known populations of water howellia, and this special designation is retained under all the alternatives. In the existing 1986 forest plan, it is a "special interest area" (management area 3A), and under all the action alternatives it is a "special area" (management area 3b). Forest plan components in all the

alternatives provide protection for the wetland habitat as well as the adjacent upland forested habitat within the Condon Creek Botanical Area (refer to MA3b-Special Area-DC-01 through 04). Components emphasize retaining the natural condition of these areas, supporting sustainable and healthy populations of water howellia, and providing educational and research opportunities where appropriate.

Although there are no known populations of Spalding’s catchfly on the Forest, the dry grassland habitats where this species might occur would have low likelihood of notable impact from human activities. Timber harvest would not occur within this type; recreational use, such as hiking, may occur but has low likelihood of impact to the integrity of the plant community. Invasive plant species pose the greatest threat to integrity of the dry grassland communities. Plan components that emphasize protection of high-priority areas (including native grasslands) and treatments that focus on these areas provide protection to these rare plant communities that serve as potential habitat for Spalding’s catchfly (see FW-DC-NNIP-01 and FW-OBJ-NNIP-01).

Alternatives B modified, C, and D

Under the action alternatives, the conservation strategy for water howellia (USDA, 1997) would be retained, and it would represent the primary guidance for maintenance of suitable habitat for the species. The strategy requires a 300-foot minimum management buffer around all ponds that provide habitat for water howellia, including both occupied and suitable but unoccupied ponds (FW-DC-PLANT-02; FW-GDL-PLANT-01 and 02). Additional protection is provided to water howellia habitat by the designation of a 300-foot riparian management zone around all howellia ponds byy standard FW-STD-RMZ-01. This protection would include all known occupied water howellia sites as well as unoccupied potential habitat. Within these riparian management zones, plan components in the riparian management zone section would be applied around howellia ponds, wherever the riparian management zone direction is more restrictive than the conservation strategy direction. In general, this direction would permit activities within the 300-foot zone only where they maintain, restore, or enhance aquatic and riparian-associated resources, in this case, howellia habitat. Other direction applicable to howellia ponds that is within the riparian management zone section of the plan includes maintaining plant species composition, forest structural diversity, vegetative patterns, and ecological processes appropriate to the natural disturbance regimes of the area (FW-DC-RMZ-01 through 06). Standards and guidelines limit vegetation management or other activities (such as timber harvest or gravel extraction) and the use of herbicides, pesticides, and other toxic chemicals within riparian management zones (FW-STD-RMZ-02 through 05; FW-GDL-RMZ-01, 04, 06, and 08 through 15). Limits on activities within the riparian management zone associated with fire management, such as the aerial application of chemical retardant and the locations of fire-suppression facilities and refueling stations, are also incorporated into forest plan direction (FW-GDL-RMZ-02, 03, and 05, and FW-GDL-PLANT-03). Refer to the Riparian Management Zone section in the forest plan for all direction associated with the riparian resource. Direction related to the protection of aquatic and riparian resources for management activities associated with recreational uses, roads and other infrastructure is also provided in the forest plan. For example, FW-GDL-REC-02 requires location of any new waste facilities outside of the inner riparian management zone; FW-GDL-LSU-03 limits construction of certain new support facilities (such as work shops, housing, staging areas) and encourages the removal of existing support facilities within riparian management areas; and FW GDL-LSU-02 requires inclusion of best management practices into new special use permits, and restoration of in-stream and/or riparian conditions if necessary at the conclusion of the permit. FW-GDL-E&M-07 states that new authorization for mineral operations should not occur in riparian management zones. FW-STD-GR-07 and 08, and FW-GDL-GR-01 and 03 provide measures related to livestock grazing that protect aquatic and riparian habitat, such as locating livestock handling or management facilities outside riparian management zones and

requiring grazing permits and grazing practices to incorporate measures that reduce impacts to native fish and riparian habitat. Taken together, all these plan components are expected to support the long-term viability of the water howellia metapopulation in the Swan Valley because they will help buffer the pond habitats from changes that could negatively alter the hydrologic pattern of pond filling and drying that is required by the species.

Effects to whitebark pine common to all alternatives

Whitebark pine restoration strategy

Because the vast majority of whitebark pine forests occurs on public lands, government land management agencies play key roles in ensuring the survival of this ecologically valuable tree species (Robert E. Keane, 2000; Tomback & Achuff, 2010). To contribute to rangewide restoration efforts for whitebark pine, the design, planning, and implementation of whitebark pine treatments on the Forest would be guided by the principles within the restoration strategy briefly outlined below. To the degree possible at the forestwide scale, restoration efforts would be directed towards promoting rust resistance, conserving genetic diversity, saving seed sources, and implementing restoration treatments.

In the interest of developing a coordinated approach to whitebark pine restoration across its range, a strategy for conserving the species was developed based on integration of the latest scientific information (R. E. Keane et al., 2012). The hope is that this common plan could lead to more efficient use of scarce funds and expertise and more successful conservation and restoration of this species. The strategy consists of a set of four principles coupled with associated actions to guide restoration efforts throughout the species' range. Figure 51 provides a display of this strategy.

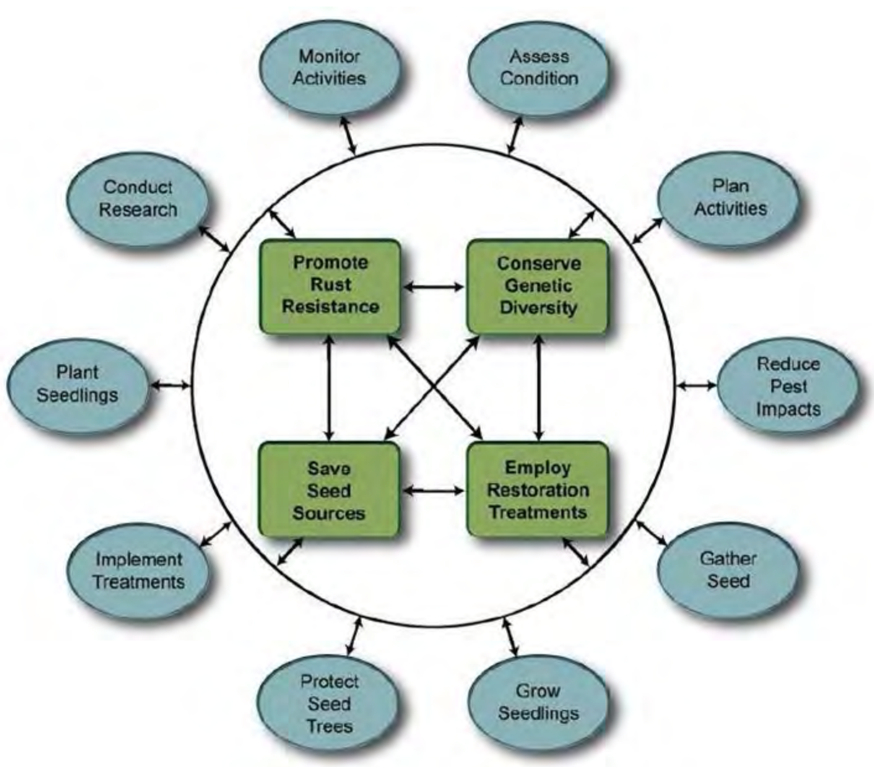

Figure 51. The whitebark pine species' range-wide restoration strategy (R. E. Keane et al., 2012).

Planting seedlings of rust resistant whitebark pine has been found to be an essential restoration activity for preventing local extirpation in some areas where high mortality has greatly reduced the number of mature seed-producing whitebark pine (Robert E Keane & Parsons, 2010). This condition occurs across much of the Forest. As described in the “Affected environment” section, the lack of seed in sufficient quantities to support Clark’s nutcracker has greatly reduced the natural regeneration potential of any remaining whitebark pine. The Flathead National Forest has identified a total of 156 mature whitebark pine trees that display resistance to blister rust from which cones, scions, and pollen are collected to contribute to the restoration of the species (for example, seed is sown in nurseries to grow seedlings for planting). The Forest has planted approximately 840 acres (about 168,000 seedlings) of whitebark pine across the Forest since planting began in the late 1990s.

Planting contributes to preserving the full genetic diversity across the range of whitebark pine (Mahalovich & Hipkins, 2011). It is also important to have good spatial distribution of planting and other restoration efforts (i.e., seeding, thinning) across the Forest for a number of reasons, including lessening the risk of losing treated stands and valued seed sources to a single large fire. Planted whitebark pine contribute to the natural recovery of the species by adding to the population individuals that are more likely to be rust-resistant and to survive to cone-producing age and pass on their resistance to future generations. Blister rust resistance may be particularly important to the survival of the species into the future if warming climate trends occur, which could favor blister rust.

The use of fire (prescribed fire and wildfire) is an important tool in restoration efforts for whitebark pine. Recently burned areas provide the best and sometimes the only areas where whitebark pine can be successfully planted and be expected to survive. This is because fire creates the best growing conditions with the least competition from other vegetation (particularly other conifers) (R. E. Keane et al., 2012). The Forest has conducted prescribed burns designed specifically to contribute to whitebark pine restoration across an estimated 9,700 acres since the late 1990s.

Thinning and fuel reduction in whitebark pine stands are important elements of the restoration strategy for whitebark pine, particularly in those areas where live, phenotypically rust-resistant whitebark pine trees still remain across the landscape. These activities remove competing tree species (i.e., subalpine fir, spruce), improve tree vigor and resistance to stressors, increase stand resistance to stand-replacing fire, and increase the probability that whitebark pine (particularly the mature, cone-producing trees) would survive a fire. Beginning in 2009, the Forest has conducted release and thinning projects to benefit whitebark pine across approximately one hundred acres.

Restoration of whitebark pine is a long-term undertaking. Through natural selection, resistance to blister rust will slowly increase in the whitebark pine population across the Forest over time. Planting (or seeding) will continue to establish small groups of trees with higher rust resistance scattered across the Forest. Because of the physiological and ecological limitations and the severe threats the species has been subjected to (as discussed above in the “Affected environment” section), rapid and substantial improvement in the conditions of whitebark pine would not be expected over the relatively short 15-year life of the plan. However, purposeful and aggressive adoption of the whitebark pine restoration strategy, including strong support for active restoration treatments and protection of existing healthy whitebark pine, would improve the outlook for the species and more fully support its conservation, persistence, and recovery in the ecosystem. Alternatives differ in the degree they facilitate active restoration efforts for whitebark pine, as described further in sections below.

Effects to whitebark pine by alternative

Refer to section 3.3.3, for the evaluation of effects to whitebark pine dominance type and species presence over time by alternative and for effects related to the resilience of forest ecosystems. The effects discussed in this section are related more directly to differences in management areas and forest plan direction that are relevant to whitebark pine management and restoration programs.

Forest plan components

Alternative A—No action

Because of the recent designation of the species as a candidate for federal listing, the 1986 forest plan does not provide much recognition or direction related to restoration of whitebark pine across the Forest. However, threats to its survival and the need to encourage blister-rust resistance in the species is acknowledged in the current 1986 forest plan in several objectives that are focused on promoting its regeneration on suitable sites. Under the stand-level guidance related to vegetation management (USDA, 1986, pp. II-10 to II-11), objectives within the late seral old-growth forest state that treatments "that affect existing old growth should be limited to those necessary to promote regeneration of blister rust-resistant whitebark pine." In this same section, objectives within the mid and early seral forests focus on encouraging the establishment and development of blister-rust resistant whitebark pine through use of prescribed fire, mechanical treatments, and planting of rust-resistant seedlings. Under Forest-level grizzly bear direction, a guideline states that habitat management schemes should be considered to reestablish and maintain whitebark pine as a component of suitable habitat (USDA, 1986, p. II-41).

Although there are not specific goals or desired conditions related to the desired presence of whitebark pine across the landscape because it has been elevated to candidate species status, the existing 1986 forest plan would provide some degree of additional attention and protection of whitebark pine compared to other tree species or forest types. Also, activities focused on whitebark pine restoration would continue to occur, guided by the rangewide restoration strategy described earlier.

Alternatives B modified, C, and D

The action alternatives provide support and specific direction that contribute to the protection and restoration of whitebark pine in the ecosystem. The action alternatives incorporate aspects of the rangewide conservation strategy described earlier in this section at the scale of the Forest. The plan components under all action alternatives would serve to increase the priority for restoration of whitebark pine on the Forest and for continuing implementation of restoration activities, aiding in the recovery of this species and of high-elevation whitebark pine plant communities. Forestwide direction associated with restoration of whitebark pine includes

- desired conditions that specifically strive to increase the presence and abundance of whitebark pine in the ecosystem and to create habitat conditions that support the long-term persistence of this species in the ecosystem (FW-DC-TE&V-07 and 08; FW-DC-PLANT-03);
- objectives to treat up to 19,000 acres over the planning period for the purpose of sustaining or restoring whitebark pine in the ecosystem and contributing to achieving desired conditions for the presence of this species across the landscape (FW-OBJ-PLANT-01);
- desired condition that provide protection of mature trees identified for cone collection purposes that are confirmed to have or display characteristics of blister rust resistance (FW-DC-PLANT-04);

- monitoring of restoration activities and ongoing assessment of conditions of whitebark pine populations over time and success of treatments (see chapter 5 of the forest plan); and
- an exception added to the Northern Rockies Lynx Management Direction standard VEG S6 that provides for "noncommercial felling of trees larger than sapling size within 200 feet of whitebark pine trees (in stands that contain trees identified for cone, scion, and pollen collection) to make whitebark pine more likely to survive wildfires, more resistant to mountain pine beetle attack, and more likely to persist in future environments" (FW-STD-TE&V-02).

Whitebark pine restoration opportunities

Because the sites most favorable for whitebark pine presence and successful development are high-elevation sites, most sites where whitebark pine exists are in the proposed management area designations of 5a-5d (backcountry), recommended wilderness (1b), or designated wilderness (1a). The extent, type, and other aspects of whitebark pine restoration efforts would differ within each of these management area designations, as would the potential ability of the Forest to contribute to the restoration of the species over the long term. Table 41 displays the estimated area of potential whitebark pine habitat across the Forest by management area group. These estimates represent the areas where physical and climatic conditions are currently suitable for whitebark pine communities. Future climate conditions may alter the area where whitebark pine is best suited to establish and successfully grow, but there is uncertainty in these predictions (see earlier discussion in the section on the affected environment).

Table 41. Acres and percent of area on Forest lands potentially capable of supporting whitebark pine within backcountry, designated and recommended wilderness areas by alternative[1]

Potential whitebark pine areas	Alternative A	Alternative B modified	Alternative C	Alternative D
Total acres potentially capable of supporting whitebark pine, forestwide	390,600-527,800	390,600-527,800	390,600-527,800	390,600-527,800
Acres of designated wilderness	1,072,040	1,072,040	1,072,040	1,072,040
Acres potentially capable of supporting whitebark pine within designated wilderness	273,500-367,400	273,500-367,400	273,500-367,400	273,500-367,400
Percent of total acres potentially capable of supporting whitebark pine that would occur within designated wilderness	70%	70%	70%	70%
Acres of recommended wilderness	98,388	190,403	506,905	0
Acres within recommended wilderness potentially capable of supporting whitebark pine	26,700-36,700	47,500-64,000	106,200-142,500	0
Percent of total acres potentially capable of supporting whitebark pine that would occur within recommended wilderness	7%	12%	27%	0
Acres in backcountry areas outside both designated and potential wilderness areas potentially capable of supporting whitebark pine	90,400-123,700	69,600-96,400	10,900-17,900	117,100-160,400
Percent of total acres potentially capable of supporting whitebark pine that would occur in backcountry areas outside both designated and recommended wilderness	23%	18%	3%	30%

1. Current potential whitebark pine habitat acres from Remote Sensing Applications Center analysis conducted on the Flathead National Forest (Housman et al., 2014).

Whitebark pine in backcountry areas (management areas 5a-5d)

Management flexibility would be highest within these management areas for conducting the full complement of restoration activities that might be desired to support the maintenance of whitebark pine and the associated high-elevation plant communities.

Whitebark pine in designated wilderness

The Forest contains about 1,072,040 acres of designated wilderness, about 45 percent of the total Forest acres. Based on the whitebark pine mapping project analysis (Housman et al., 2014), which is consistent with the natural range of variation analysis (refer to the earlier discussion under natural range of variation and current condition), the majority (about 70 percent) of lands capable of supporting whitebark pine on the Forest are estimated to occur within wilderness (see table 41). In general, Forest Service policy does not allow for vegetative manipulation or broad-scale restoration actions in wilderness except where the objectives cannot be met outside of wilderness, the loss is due to human influence, and there is no reasonable expectation that natural reforestation will occur. Currently, the only activities related to whitebark pine restoration that are occurring in designated wilderness areas on the Flathead National Forest are monitoring and inventory activities, as well as allowing unplanned fire ignitions to restore whitebark pine stands. Activities such as planting, direct seeding, mechanical thinning, or prescribed fire would involve manipulation that is typically not allowed in designated wilderness. There are no changes proposed under any of the action alternatives to the current management approach regarding whitebark pine restoration within designated wilderness areas on the Flathead. Therefore, it is likely that opportunities for active restoration efforts focused on whitebark pine restoration (such as planting or prescribed fire) would occur only outside designated wilderness areas.

There is a possibility that a different approach to whitebark pine restoration in wilderness areas might occur in the future. A “hands-off” approach to wilderness management is generally advocated currently for the Flathead National Forest and other wilderness areas, which means practicing restraint and not manipulating or interfering in the natural progression of ecological systems, even if some elements of the system may be lost. However, it is recognized that there may be valid exceptions to this approach in limited situations (Landres, 2010b). This may be an important consideration in the future if distribution of whitebark pine decreases substantially and higher proportions of whitebark pine habitat occur within designated wilderness, as has been suggested may occur (Belote et al., 2015). Decision frameworks have been suggested to help guide decisions on how to balance different values and address tradeoffs associated with the challenge of restoring whitebark pine populations in wilderness areas (Dietz, Belote, David-Chavez, & Aplet, 2015; Landres, 2010a). For the most part, logistical factors in the designated wilderness areas on the Forest, such as the difficulty of access and the prohibitions on motorized equipment and mechanical transport, currently limit the ability to conduct much in the way of active whitebark pine restoration, such as planting or cone caging and collection.

Whitebark pine in recommended wilderness

Alternatives A, B modified, and C propose areas for designation as recommended wilderness (no recommended wilderness is proposed in alternative D). Whitebark pine habitat occurs within most of the recommended wilderness areas, which varies by alternative. Table 41 displays the amount of whitebark pine habitat within both designated and recommended wilderness by alternative. There are potential effects to whitebark pine related to future designation as wilderness areas by Congress, which are discussed later under the section titled “Consequences to threatened and candidate plant species from forest plan components associated with other resource programs or management activities.”

Some of the existing whitebark pine restoration sites on the Flathead National Forest occur within recommended wilderness areas, specifically mature trees that have been identified for cone, scion, or pollen collection (collection trees) and sites where whitebark pine seedlings have been planted (plantations). The collection trees are trees that display resistance to blister rust and contribute to the restoration program by providing the seed and other plant material needed, for example, to grow seedlings in nurseries for planting. Alternative A has no whitebark pine collection trees within recommended wilderness areas. Alternative B modified has three whitebark pine collection trees within recommended wilderness areas (in the Slippery Bill-Puzzle and Tuchuck-Whale areas). Alternative C has 58 collection trees within recommended wilderness (in the Jewel Basin-Swan Crest, Limestone-Dean Ridge, Sky West, Slippery Bill-Puzzle, Coal, and Tuchuck-Whale areas). Alternative C also includes about 350 acres of whitebark pine plantations (nearly 40 percent of total acres planted) located in the Jewel Basin-Swan Crest and Slippery Bill-Puzzle recommended wilderness areas. Alternatives A and B modified include 150 acres of whitebark pine plantations (about 18 percent of total planted) in the Condon Creek area of the Swan Front recommended wilderness area.

Alternative A—No action

Recommended wilderness areas in the 1986 forest plan consist mostly of lands adjacent to the existing Bob Marshall Wilderness, expanding the size of this designated wilderness area. One additional recommended wilderness area of about 33,000 acres centers on the Jewel Basin Hiking Area. Alternative A does not include the Tuchuck-Whale area as recommended wilderness, which is a potentially desirable area for whitebark pine restoration (see discussion under alternative B modified below) and also contains whitebark pine collection trees.

Management direction directly applying to recommended wilderness in the existing 1986 forest plan is general and consists of a forestwide standard that directs management to be “consistent with the standards of the nonwilderness management area designation, except that no action can occur which will reduce the areas’ wilderness attributes” (p. II-23). When and if these areas are designated as wilderness by Congress, the 1986 forest plan directs the Forest to manage them similarly to current wilderness direction—except for the Jewel Basin area, which would continue with existing management until new direction is developed for this unique area.

As described earlier and displayed in table 41, alternative A includes a relatively low amount of whitebark pine habitat within the recommended wilderness areas and has one existing restoration site (a plantation). This plantation was established under and is consistent with current forest plan direction, which does not directly prohibit this type of activity. It would be assumed that the maintenance of this plantation (e.g., future tending) would continue to occur under existing forest plan direction. Large areas of whitebark pine habitat occur outside recommended wilderness under alternative A and would remain available for implementation of the full range of whitebark pine restoration activities. These areas are well distributed across the landscape. Primarily because of this, recommended wilderness designations would likely have minimal impact on whitebark pine restoration efforts on the Forest. Refer also to the discussion later under the section titled “Consequences to threatened and candidate plant species from forest plan components associated with other resource programs or management activities.”

Alternatives B modified and C

Desired conditions for recommended wilderness in alternatives B modified and C specify that these areas are to “preserve opportunities for inclusion in the National Wilderness Preservation System,” with the desire to “maintain and protect the ecological and social characteristics that provide the basis for each area’s suitability for wilderness recommendation.” (forest plan component MA1b-DC-01). These areas are characterized by a “natural environment where ecological processes such as

natural succession, wildfire, avalanches, insects, and disease function with a limited amount of human influence" (forest plan, management area 1b desired conditions). As evident in table 41, whitebark pine and associated high-elevation plant communities occur within many recommended wilderness areas. As described earlier, whitebark pine fills an important ecological role, and the dramatic decline of this species has had far-reaching impacts across the high-elevation ecosystems.

Alternatives B modified and C provide direction that explicitly states that recommended wilderness areas are "suitable for restoration activities where the outcomes will protect the wilderness characteristics of the areas, as long as the ecological and social characteristics that provide the basis for wilderness recommendation are maintained and protected" (forest plan component MA1b-SUIT-03). Part of the intent of this forest plan direction is to provide flexibility to address the need for whitebark pine restoration within recommended wilderness areas because of the amount of potential whitebark pine habitat on the Forest that lies within these areas. These areas also contain ongoing restoration sites as discussed earlier (plantations and cone collection trees). This direction would provide support for the application of whitebark pine restoration activities within the recommended wilderness areas, if determined through a site-specific analysis to be a necessary and important component of the forestwide and rangewide restoration strategy for the species.

The potential restoration activities that may be allowed within recommended wilderness (but are currently not allowed in designated wilderness) under forestwide direction in alternatives B modified and C include prescribed fire (e.g., to create sites for the regeneration of whitebark pine or reduce the competition from other conifers); planting (or seeding) of whitebark pine seedlings; hand thinning (e.g., use of chainsaws to daylight thin around seedling or sapling whitebark pine trees); and protecting phenotypically superior seed-producing whitebark pine trees from loss due to fire, bark beetles, or other stressors (e.g., the use of chainsaws to reduce fuels and encroaching trees around mature whitebark pine cone-producing trees).

The use of fire is anticipated to be an important tool in achieving desired vegetation conditions and maintaining natural ecological processes within some of the recommended wilderness areas. As mentioned earlier, recently burned areas provide the best sites to plant or seed whitebark pine. The use of unplanned ignitions (wildfire) to achieve desired conditions is feasible in large, continuous landscapes (such as the Bob Marshall and Great Bear Wilderness Areas) where fire has room to spread naturally and there is a lower level of threat to values at risk. However, the use of unplanned ignitions may be more difficult in smaller landscapes or in areas where prevailing winds and other factors would threaten private lands or other values at risk. This situation exists in some of the recommended wilderness areas in both alternatives B modified and C. Thus, the use of prescribed fire (planned ignitions) would be particularly important in maintaining and restoring whitebark pine in these recommended wilderness areas.

Both alternatives B modified and C would contribute positively towards the whitebark pine restoration efforts on the Forest, and thus to the recovery of the species, due to forest plan direction that allows for restoration activities to occur with appropriate site-specific analysis within recommended wilderness. Refer also to discussion later under the section titled "Consequences to threatened and candidate plant species from forest plan components associated with other resource programs or management activities."

Alternative D

This alternative has no recommended wilderness allocation and would have no effect on whitebark pine restoration efforts associated with this allocation.

Consequences to threatened and candidate plant species from forest plan components associated with other resource programs or management activities

Effects from access (motorized and nonmotorized) and recreational uses

Water howellia habitat could potentially be affected by recreational activities that could cause ground disturbance, such as hiking and trampling, biking, and dispersed camping, particularly during periods where pond water levels are low and the habitat is more vulnerable to disturbance. Roads and trails can contribute to the spread of noxious weeds. Most known water howellia habitat is located in the valley bottom areas of the Swan Valley; all alternatives are similar in the amount and type of recreational opportunities that could potentially occur in this area and thus have similar potential for recreational impacts to water howellia habitat. Recreational uses would have little to no effect on whitebark pine populations.

Effects from vegetation management and fire

Vegetation management treatments can have impacts to plants and plant habitat through canopy removal and soil disturbance. As discussed earlier in this section, forest canopy removal over very large areas could alter hydrological conditions, influencing water levels in water howellia ponds. Future vegetation management activities, including the use of prescribed fire, is not likely to result in widespread removal of forest canopy that would adversely affect hydrological conditions. Timber harvest and other treatments are limited by budget as well as by plan direction related to other resources, such as providing for wildlife habitat.

Vegetation treatment may require road building or maintenance. Roads increase access and provide an avenue for invasive plant species. Alternative C would have the least amount of vegetation treatments and thus the least potential for impacts to water howellia. Alternatives A, B modified, and D are relatively similar in vegetation treatment amounts and would have a slightly larger potential for impact. However, all alternatives incorporate the conservation strategy for water howellia and have plan components that would protect habitat and contribute to the conservation of the species, as described earlier in this section.

Under the natural disturbance regimes of the Forest, large, stand-replacing wildfires have occurred in the past and are likely to continue to occur across portions of the landscape in the future. Although plant species in the northern Rockies have evolved in this fire-dominated ecosystem, there might be cases where severe and extensive stand-replacing wildfire events could alter hydrological conditions relative to water levels in water howellia ponds.

The use of vegetation management (e.g., prescribed fire, planting, etc.) is a key component of the whitebark pine restoration strategy when used as a tool to promote the conservation of the species and its persistence on the landscape. The types of treatments that may be implemented have been described earlier. Such restoration treatments would have long-term beneficial effects on the persistence of the species and its contribution to the resilience of high-elevation plant communities on the Flathead National Forest.

Effects from non-native invasive plants and control treatments

Introduced, invasive plant species can displace native plants through competition. Impacts may also result from treatments that include herbicide spraying and mechanical ground disturbance to control noxious weeds once they gain a foothold. Competition from non-native invasive species and noxious weeds can result in the loss of habitat, loss of pollinators, and lowered viability of rare plant species. Roads, trails, livestock, and canopy reduction can provide ideal pathways for the introduction of exotic and non-native species. Indirectly, herbicide spraying can affect populations of native

pollinators by contaminating nesting materials and pollen resources, further decreasing the viability and reproductive success of rare species. Regarding the risk of weed invasions and/or the expansion of populations, the alternatives would vary in some ways. In general, the more emphasis the alternative has on active, ground-disturbing management, the greater the likelihood of weed spread. Therefore, alternative D has a greater potential for impact, followed by alternative B modified, with the least potential under alternative C. All alternatives incorporate similar direction that guides the treatment of invasive species, based on the forestwide analysis and decision for noxious weeds that was incorporated into the existing and forest plan direction. Under this direction, treatments would be designed to avoid or minimize impacts to plant species at risk in order to support their persistence over the long term. Special areas and riparian areas (particularly those associated with water howellia ponds) would be recognized as high-priority areas for the management and treatment of invasive species (FW-DC-NNIP-01 and FW-OBJ-NNIP-01). An integrated management approach to weed control would be applied.

Effects from future wilderness designation of recommended wilderness areas

Wilderness areas pose certain challenges and limitations to active whitebark pine restoration efforts articulated in the Range-Wide Restoration Strategy (R. E. Keane et al., 2012) and briefly discussed earlier under the section “Whitebark pine in designated wilderness.” Some key restoration activities that are increasingly recognized as essential to the long-term restoration efforts are the planting and/or seeding of whitebark pine, particularly of stock that has demonstrated resistance to white pine blister rust. These activities are not currently allowed within wilderness areas.

Recommended wilderness areas are proposed under alternatives A, B modified, and C, with varying acres of potential whitebark pine habitat within these areas under each alternative (see table 41). As the plan states, these areas are to be preserved for inclusion in the National Wilderness Preservation System, with the ecological and social characteristics that provide the basis for wilderness maintained and protected. Exactly when Congress might pass the bill that incorporates these areas into the National Wilderness Preservation System is, of course, unknown. However, the assumption that it will occur at some point is important to acknowledge in terms of the evaluation of effects to whitebark pine restoration efforts in this EIS.

Uncertainty exists as to the degree of flexibility in whitebark pine restoration efforts that would be allowed to occur in the future in the recommended wilderness areas, once Congress incorporates into the National Wilderness Preservation System. As designated wilderness, these areas could be subject fully to the direction and limitations currently practiced in designated wilderness on the Flathead, as described earlier in this section. This could reduce the effectiveness of whitebark pine restoration efforts on the Forest and thus the ability of the Forest to contribute to the restoration of the species and of the high-elevation communities where it exists. However, as also mentioned earlier, the future approach for addressing whitebark pine restoration efforts in designated wilderness areas is not certain; there may be increased emphasis and flexibility, especially if climate changes result in the vast majority of suitable whitebark pine sites occurring in wilderness areas.

In any case, the degree of effect of recommended wilderness areas and their future designation as wilderness varies among the alternatives depending upon the amount of whitebark pine habitat and the existing areas where ongoing whitebark pine restoration activities are occurring within the recommended wilderness areas by alternative. The quality, distribution, and accessibility of the habitat also varies among the alternatives. As shown in table 41, the action alternatives differ substantially in the amount of acres of whitebark pine habitat allocated to recommended wilderness and thus in the potential effects on restoration efforts in the future when these areas become designated wilderness. Effects by alternative are discussed below.

Alternative A

Alternative A has the least amount of recommended wilderness areas (except for alternative D, which has none), and most of the areas lie adjacent to the existing Bob Marshall Wilderness. About one quarter of the whitebark pine habitat outside designated wilderness would be within recommended wilderness under this alternative. About 152 acres of a whitebark pine plantation lies within the Swan Front recommended wilderness area. Because of the relatively low amount of whitebark pine habitat within the recommended wilderness and its location, alternative A would have a relatively low impact on future whitebark pine restoration opportunities. The main detrimental impact would be on the ability to maintain the existing plantation through vegetation treatments such as thinning. The use of hand tools rather than chainsaws might be required.

Alternative B modified

Alternative B modified would include the second largest amount of acres within recommended wilderness. This alternative would include about half the remaining acres of potential whitebark pine habitat outside designated wilderness in recommended wilderness allocations, including some important and relatively accessible known habitat. Also included within alternative B modified recommended wilderness areas are the whitebark pine plantation described under alternative A and three identified cone, scion, and pollen collection trees.

In addition to the recommended wilderness areas in alternative A, alternative B modified includes more acres in the Jewel Basin area, larger areas adjacent to the Bob Marshall Wilderness, and a large block of over 80,000 acres in the upper portion of the North Fork geographic area (the Tuchuck-Whale recommended wilderness). Some of the recommended wilderness areas in alternative B modified contain relatively accessible whitebark pine potential habitat (such as the Swan Front and portions of Tuchuck-Whale). In addition, the Tuchuck-Whale recommended wilderness area contains some of the most extensive and vigorous whitebark pine populations known to occur on the Forest outside of designated wilderness. The extent of this population and the role it may play in future restoration efforts is not fully known, but it may well prove to be a priority site for seed collection, thinning, and other restoration treatments.

In contrast to the very large expanses of the Bob Marshall Wilderness and the recommended wilderness areas that lie adjacent to it, the opportunity to use unplanned fire ignitions (wildfire) to achieve desired vegetation conditions would be more limited in the Tuchuck-Whale area. This recommended wilderness area borders Canada, which increases the complexity of fire management. Fires in the vegetation types in this area under the natural fire regime are typically high-severity, wind-driven fire events that, under the prevailing winds, could spread into the private lands in the valley bottom and also into Canada. Use of planned ignitions (prescribed fire) would thus be especially important in the strategy to maintain and restore whitebark pine, as well as other vegetation conditions, within this recommended wilderness area in particular.

Because of the location of recommended wilderness areas, the acreage of whitebark pine sites they contain, the relative accessibility of the areas, and the inclusion of the whitebark pine plantation and collection trees, alternative B modified would have a greater impact on potential whitebark pine restoration efforts in the long term compared to alternative A, although less than alternative C.

Alternative C

Alternative C includes the largest amount of acres in recommended wilderness, encompassing nearly all of the potential whitebark pine habitat on the Forest that occurs outside designated wilderness. It also includes about 40 percent of the two existing whitebark pine plantations and identified cone, scion, and pollen collection trees. As in alternative B modified, recommended wilderness in this alternative includes some of the potentially more desirable areas for whitebark pine restoration

activities, such as thinning, planting, and prescribed fire. It also includes numerous other areas, both within the North Fork and in other geographic areas, where the use of unplanned ignitions (wildfire) as a method to both restore whitebark pine and create desired vegetation conditions is likely to be more limited due to the location and juxtaposition of the areas to communities and other adjacent values at risk. The limited ability to use higher-severity prescribed fire as a tool would potentially reduce the restoration opportunities for whitebark pine as well as reduce management flexibility to achieve other desired ecosystem conditions. For all these reasons, alternative C would have the greatest negative impact on potential whitebark pine restoration efforts in the long term.

Alternative D

Under alternative D, no acres are proposed as recommended wilderness, and thus this alternative would have the greatest long-term opportunities and the least potential for future restrictions of whitebark pine restoration activities due to wilderness designations.

Cumulative effects

Public lands play a critical role in the conservation of threatened, endangered, proposed and candidate plant species. During the next several decades, human populations are likely to expand, which will likely result in greater human presence and pressure on public lands, for example for recreational uses. These trends suggest not only that public land will play an increasingly important role in the conservation of these species in the future, but also that management to ensure recovery and/or prevention of federal listing of species will be an increasingly difficult challenge.

The results of surveys and monitoring indicate that water howellia populations are persisting in both disturbed and undisturbed settings, on both national forest and other lands, and are likely to persist in the foreseeable future (refer to discussion under “Trends” in the earlier “Affected environment” section). The populations are affected primarily by annual fluctuations in precipitation and temperature, so climate change may eventually affect the hydrology of water howellia ponds. The nature of these effects will depend on the magnitude and direction of any longer-term changes in precipitation and temperature. However, specific changes in ecosystem components due to expected climate change are difficult to predict, as described in earlier sections on climate (Robert E. Keane et al., in press).

In the northern Rockies ecosystem, the vast majority of whitebark pine forests occur on public lands, which includes the Forest Service and National Park Service in the United States and provincial and federal agencies in Canada (R. E. Keane et al., 2012). Public land management will play a very important role in the restoration of this species. Coordination between public land managers is key to effective and efficient restoration efforts. Climate change is likely to cause shifts in the range of whitebark pine, with changes in wildfire a catalyst for those shifts (Robert E. Keane et al., in press).

3.5.2 Plant species of conservation concern

Introduction

A species of conservation concern is a species, other than a Federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area (national forest, for example) and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species’ capability to persist over the long term in the plan area (36 CFR § 219.9). This section covers plant species that have been designated as species of conservation concern by the regional forester under the action alternatives B modified, C, and D. Public comment during scoping for the proposed action expressed interest in knowing the status of and effects to plant species previously listed as sensitive by the regional forester (under the

1982 planning rule) but not determined to be a species of conservation concern (under the 2012 planning rule) for the Flathead National Forest. Effects to plant species in this category are also addressed in this section of the final EIS. Federally recognized threatened, endangered, proposed, and candidate plant species are covered in section 3.5.1.

Regulatory framework

The National Forest Management Act (NFMA) of 1976: According to this act, "It is the policy of the Congress that all forested lands in the NFS shall be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth, and conditions of stand designed to secure the maximum benefits of multiple use sustained yields. Plans developed shall provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet the overall multiple-use objectives, and within the multiple-use objective."

2012 planning rule (36 CFR § 219.9(b)(1)): This rule states that the responsible official will evaluate whether the plan components provide the ecological conditions necessary to contribute to the recovery of Federally listed species, conserve proposed and candidate species, and maintain a viable population of species of conservation concern in the plan area. Evaluation would consider components that provide for ecosystem integrity and diversity (coarse-filter approach) and species-specific components (fine-filter approach).

Methodology and analysis process

The USFS regional forester is responsible for identifying the species of conservation concern for each planning unit (such as a national forest). Criteria for identifying and evaluating species of conservation concern are outlined in the 2012 planning rule and directives (Forest Service Handbook 1909.12.52). Refer to the document outlining the process for identifying plant species of conservation concern on the USDA Forest Service Northern Region's Web site: http://bit.ly/NorthernRegion-SCC .

To determine the effects to plant species under each alternative, the Forest organized the plant species into habitat groups based on the similarity of their habitat requirements and use of similar resources. Potential management or environmental stressors to the species were identified. Determinations were made as to whether the needs of plant species of conservation concern would be met by plan components, considering known locations of the species and their habitats as well as key drivers and stressors.

Information sources and incomplete/unavailable information

Primary information sources used were the Forest Service's Natural Resource Manager and the Montana Natural Heritage Program's Element Occurrence databases, including NatureServe and the Montana Natural Heritage Program's online Montana Field Guide.

Although published information is available on federally listed species (i.e., threatened and endangered species) on species population trends, viability, threats, and conservation strategies, the majority of plant species in the Natural Resource Manager and Montana Natural Heritage Program databases do not. Most information on these plants is derived from expert opinion and/or panel consensus, specifically at biannual meetings held by the Montana Native Plant Society in conjunction with the Montana Natural Heritage Program. There is little published information about most rare plant species concerning their viability, biology, habitat, population dynamics, occurrences, etc. Although there are uncertainties and gaps in the data and knowledge about most rare plant species, the best available information is utilized in this analysis to assess the existing condition and

determine potential effects of the alternatives. Information gaps relevant to at-risk species may be filled in through future inventories, plan monitoring program results, or research, and this information would be integrated into the databases as it becomes available.

Analysis area

The geographic scope of the analysis of effects to native plant species is the lands administered by the Forest. The range of a species may extend beyond the Forest, but the lands administered by the Forest represent the area where changes may occur to these species or their habitats from activities that might be allowed under the alternatives.

Affected environment

Sixty-seven plant species are identified and evaluated in this EIS, representing the diversity of habitats on the Flathead National Forest. These species include those identified as sensitive by the regional forester, Federally listed species (i.e., threatened and endangered), and species of concern in Montana as documented in the Montana Natural Heritage Program and NatureServe databases (see http://mtnhp.org/SpeciesOfConcern/?AorP=p). Threatened and endangered plant species (water howellia, Spalding's catchfly, and whitebark pine) are discussed above in section 3.5.1. The remaining 64 plant species have been grouped for purposes of analysis based on broad similarities in the habitat they occupy and are discussed in this section of the final EIS. Although there may be variation in specific habitat needs for species within a group, the potential stressors and associated conservation strategies for the species in the habitat group would be very similar, allowing for more efficient analysis and identification of relevant information pertaining to the species. A description of the habitat groups is provided below, as well as information on the known stressors to the plant species that occur within these habitat groups. Refer to appendix 6, tables 6-4 through 6-8, for the full list of the plant species that were evaluated, as well as a brief description of their habitat and their status. Refer to Shelly (2017) for more detailed documentation related to the sensitive plant species that were evaluated that are known or suspected to occur on the Flathead National Forest. Information and evaluation related to identification of the species of conservation concern can be found on the USDA Forest Service Northern Region's Web site: http://bit.ly/NorthernRegion-SCC .

Peatland/fen habitat group

This habitat group contains 19 of the plant species evaluated in this EIS. One species (*Howellia aquatilis*) is listed as threatened by the USFWS under the Endangered Species Act; 15 species are currently identified as sensitive; 14 species are identified as a species of conservation concern under the 2012 planning rule.

Peatlands, specifically fens, are groundwater-dependent wetlands with accumulating organic matter (Chadde et al., 1998). Fens form where high water tables and permanent saturation slow rates of decomposition and where soils are formed from accumulating partially decayed organic matter. Fens are fed by precipitation, surface water, and groundwater and may be mineral rich or poor depending on the surrounding bedrock. They are usually dominated by grasses, sedges, and mosses, but they frequently have a high diversity of other plant species. Fen habitats are relatively rare and occupy small, isolated areas on the Flathead and surrounding lands.

Fen-associated plant species are vulnerable to disturbances and stressors, including changing climatic conditions, fire, and hydrologic changes. Stressors and ecological processes that may influence their habitats apply to all species. These include

- management actions or natural processes that alter hydrologic regimes, such as draining of wetlands or ditching, changes in adjacent forest communities, and climate changes that influence surface flows, snowpack amounts, and other hydrologic factors;
- management activities that disturb soils adjacent to wetlands and may affect water quality, such as road construction, reconstruction, and maintenance activities that result in runoff; livestock use; herbicide application; and sedimentation from timber harvest activities;
- invasive plant species; and
- invasive plant treatments.

Aquatic habitat group

This habitat group contains five of the plant species evaluated in this EIS. Four are currently identified as sensitive; no species are identified as a species of conservation concern under the 2012 planning rule. These species generally occur in shallow water associated with lakes, ponds, and rivers in the valley and montane zones. Stressors to these species would be similar to those associated with the species in the peatlands/fen and wetland/riparian habitat groups, particularly related to changes in hydrology or water quality that might occur either from natural or human-caused sources.

Wetland/riparian habitat group

This habitat group contains three of the plant species evaluated in this EIS. All three are currently identified as sensitive; two are identified as a species of conservation concern under the 2012 planning rule.

This group is composed of species that predominantly inhabit marshes or the very moist forested areas associated with riparian areas. Marshes are wetlands with standing water, and they have emergent vegetation that is rooted in mineral soil. Stressors and ecological processes that may influence these habitats include

- management activities that disturb soils and vegetation within riparian areas or adjacent to wetlands, such as road construction, reconstruction, and maintenance; livestock use;
- fire disturbances and fire exclusion, which change vegetation conditions in riparian areas and vegetation adjacent to wetlands;
- invasive plant species;
- invasive plant treatments;
- recreational use, trails, visitor trampling, camping in riparian areas;
- flooding events;
- natural succession of wetlands; and
- climate change, which may alter stream flows, timing of snowmelt, and other hydrological factors.

Alpine habitat group

This habitat group contains 13 of the plant species evaluated in this EIS. One (*Pinus albicaulis*) is listed as a candidate species by the USFWS under the Endangered Species Act; two species are currently identified as sensitive; and no species are identified as species of conservation concern under the 2012 planning rule.

Species in the alpine habitat group generally occur on exposed ridges and slopes in alpine and subalpine zones. Species associated with this habitat generally have few stressors due to their remote habitats, although recreational uses and management activities (such as trail construction) may be stressors in some locations. Changes in fire patterns and severities, and associated effects on vegetation succession, may be a stressor in some environments. Also refer to section 3.5.1 under the discussion related to whitebark pine for additional information on forest conditions and changes in high subalpine habitats due to the loss of much of the whitebark pine component.

Mesic montane, rock/talus/scree, disturbance habitat group

This habitat group contains 27 of the plant species evaluated in this EIS. Sixteen of these are currently identified as sensitive, and 10 are identified as species of conservation concern under the 2012 planning rule.

This habitat group is composed of species that generally inhabit upland sites at various elevations, including forested areas and openings in both moist or dry settings; in or near riparian areas; rock outcrops and cliffs; on bark and wood (in the case of lichens); or in settings disturbed either by natural events (such as fire) or by human-caused actions (such as grazed areas or roadsides). Stressors and ecological processes that influence upland habitats apply to all species in this habitat group to varying degrees. These include

- vegetation treatments that disturb vegetation or soils (logging, prescribed fire, etc.);
- fire disturbances, particularly changes in natural fire regimes such as more frequent or severe fire, or fire exclusion or fire suppression that alters natural succession and vegetation conditions;
- natural succession and resulting changes in forest canopy cover;
- cattle grazing and trampling;
- construction of roads and other developments;
- recreational activities, such as trails, camping, and wheeled vehicle use that could disturb or trample plants; and
- invasive plant species and treatment of infestations.

Climate change may also affect plant species in this group. Increased temperature and prolonged summer drought conditions may increase the risk of desiccation. Increased fire severity or frequency may also affect habitat for some of these species, either favorably or detrimentally depending upon their habitat requirements. Species that may be favorably affected are stalked moonwort (*Botrychium pedunculosum*) and pale corydalis (*Corydalis sempervirens*), and species that may be detrimentally affected are jelly lichen (*Collema curtisporum*) and clustered lady’s slipper (*Cypripedium fasciculatum*).

Environmental consequences

Alternative A—No action

The 40 plant species currently identified as sensitive by the Regional Forester (see appendix 6, tables 6-4 through 6-8) would continue to be protected under the current 1986 forest plan, which includes standards designed to protect rare plant species (1986 forest plan, section II, Forestwide Standards; section F-9, Rare Plants; and section F-10, Sensitive Species). Standards direct that adverse impacts to rare plants or their habitats should be avoided. If impacts cannot be avoided, the significance of the potential adverse impacts would be analyzed. Project decisions are directed to not result in loss of

species viability or to create significant trends towards Federal listing. The no-action alternative would require inventories and preparation of biological evaluations for project decisions to determine potential effects to rare plant species.

Alternatives B modified, C, and D

Under these alternatives, 26 plant species would be identified by the Regional Forester as species of conservation concern. Table 42 lists the plant species of conservation concern by habitat group, and it also provides information on their habitat and primary stressors

Table 42. Species of conservation concern designated by the regional forester for the Flathead National Forest for the final EIS, with information on habitat and stressors

	Name	Habitat	Primary Stressors
	FEN HABITAT GROUP		
1	*Amerorchis rotundifolia* Roundleaf orchid	Spruce forest ecotones around fens and seeps or along streams, often in soil derived from limestone.	Changes to hydrology of the groundwater-dependent habitat; changes to canopy cover; riparian zone disturbances.
2	*Carex chordorrhiza* Creeping sedge	Wet, organic soils of fens in the montane zone.	Changes to hydrology of the groundwater-dependent habitat.
3	*Carex lacustris* Lake-bank sedge	Marshes and fens.	Changes to hydrology of the groundwater-dependent habitat.
4	*Cypripedium passerinum* Sparrow's-egg lady's-slipper	Mossy, moist, or seepy places in coniferous forests and forest ecotones adjacent to fens, often on calcareous substrates.	Changes to hydrology of the groundwater-dependent habitat; changes to canopy cover; riparian zone disturbances.
5	*Drosera linearis* Slenderleaf sundew	Wet, organic soils of fens in the montane zone.	Changes to hydrology of the groundwater-dependent habitat.
6	*Eleocharis rostellata* Beaked spikerush	Wet, often alkaline soils, associated with warm springs or fens in the valley and foothills zones.	Changes to hydrology of the groundwater-dependent habitat.
7	*Eriophorum gracile* Slender cottongrass	Wet, organic soil of fens from low to moderate elevations.	Changes to the hydrology of the groundwater-dependent habitat.
8	*Liparis loeselii* Loesel's twayblade	Wet, organic soils of calcareous fens in the valley and montane zones.	Changes to hydrology of the groundwater-dependent habitat; unknown causes of decline appear to be a factor as well.
9	*Lycopodiella inundata* Northern bog club moss	Wet, organic soils of nutrient-poor fens in the valley and lower montane zones.	Changes to hydrology of the groundwater-dependent habitat.
10	*Meesia triquetra* Meesia moss	Fen and peat dome at the bases of slopes, fed by perennial springs. Also found adjacent to shallow pools and ponds and in wet lawn.	Changes to hydrology of the groundwater-dependent habitat.
11	*Scorpidium scorpioides* Scorpidium moss	Found on wet soil in calcareous seeps and fens.	Changes to hydrology of the groundwater-dependent habitat.
12	*Sphagnum magellanicum* Magellan's peatmoss	Rich fens, peatlands.	Changes to hydrology of the groundwater-dependent habitat.

	Name	Habitat	Primary Stressors
13	*Trichophorum alpinum* Hudson's Bay bulrush	Wet, cold organic soil of fens and slopes in the montane and subalpine zones; sphagnum lawns and other very wet places.	Changes to hydrology of the groundwater-dependent habitat
14	*Trichophorum cespitosum* Tufted club-rush	Wet meadows and sphagnum-dominated fens in the montane to alpine zones.	Changes to hydrology of the groundwater-dependent habitat.
	WETLAND/RIPARIAN HABITAT GROUP		
15	*Epipactis gigantea* Giant helleborine	Streambanks, lake margins, fens with springs and seeps, often near thermal waters.	Changes to hydrology of the groundwater-dependent fen and wetland habitat; changes to canopy cover adjacent to occupied habitat; riparian zone disturbances; non-native species.
16	*Petasites frigidus* var. *frigidus* Arctic sweet coltsfoot	Swamps, fen margins, and riparian seeps within open forest and meadows in the valley and foothill zones.	Changes to hydrology of the groundwater-dependent fen and wetland habitat; riparian zone disturbances such as road construction and maintenance and timber harvest.
	MESIC MONTANE, ROCK/TALUS/SCREE, DISTURBANCE HABITAT GROUP		
17	*Botrychium paradoxum* Peculiar moonwort	Mesic meadows associated with spruce and lodgepole pine forests in the montane and subalpine zones; also found in springy western red cedar forests.	Grazing, trampling, and wheeled motorized vehicle use on designated routes and areas.
18	*Botrychium pedunculosum* Stalked moonwort	Various mesic sites from valley bottoms to the montane zone; the most common habitats are western red cedar bottomlands.	Cattle grazing, road building and maintenance, timber harvesting, and recreational activities such as camping, horse riding, and wheeled motorized vehicle use on designated routes and areas. Successional change due to fire exclusion on some sites.
19	*Collema curtisporum* Jelly lichen	Moist riparian forests, often in narrow sheltered valleys; substrate is the trunk (bark) of *Populus trichocarpa* (black cottonwood); occasionally on conifer twigs.	Riparian zone disturbances, timber harvest; changes to native fire regimes; stand-replacement fires.
20	*Corydalis sempervirens* Pale corydalis	Montane; rocky, disturbed or eroding soil of steep slopes in open forest, often appearing after fire.	Successional change due to fire exclusion; non-native plant species; timber harvest or other disturbances.
21	*Cypripedium fasciculatum* Clustered lady's slipper	Warm, dry mid seral montane forest in the Douglas-fir and grand fir/ninebark habitat types; also in mixed conifer stands in the warm-moist type (western red cedar)	Disturbances such as timber harvest, road construction; native fire regime changes; stand-replacement fires; successional changes due to fire exclusion; canopy removal may also be a stressor.

	Name	Habitat	Primary Stressors
22	*Dryopteris cristata* Crested shieldfern	Moist to wet, often organic soils at the forest margins of fens and swamps in the montane zone.	Changes to hydrology of the wetland habitat; riparian zone disturbances such as road construction.
23	*Grimmia brittoniae* Britton's dry rock moss	Vertical faces of shaded, calcareous cliffs at moderate elevations; warm, dry but climatically moist valley bottoms or forests dominated by Douglas-fir.	Human activities such as road construction that disturb habitat.
24	*Grindelia howellii* Howell's gumweed	Vernally moist, lightly disturbed soil adjacent to ponds and marshes, as well as similar human-created habitats, such as roadsides and grazed pastures.	Invasive weeds in many occurrences because the habitat occupied by this species is also favorable for many weedy species; application of herbicides along roadsides, grazing, and road construction and maintenance; changes in native fire regime.
25	*Idahoa scapigera* Scalepod	Vernally moist, open soils on rock ledges in the lower montane zone.	Invasive weeds, primarily spotted knapweed and cheatgrass, as well as hydrological changes.
26	*Mimulus breviflorus* Short-flowered monkeyflower	Shallow, vernally moist soil among rock outcrops in coniferous forests or grasslands in the montane zone.	Soil disturbance; changes to hydrology; timber harvest activities and road construction.

Plan components related to plant species of conservation concern are the same in all the action alternatives. The action alternatives are built upon the principle that by maintaining key ecosystem characteristics (such as vegetation composition, structural features, and patterns) and ecosystem functions (such as natural disturbance processes, soil and nutrient retention), the biodiversity of the forest would be maintained, providing for the habitat needs of diverse native animal and plant species. This coarse-filter approach focuses on managing for conditions consistent with the natural range of variation at the landscape scale, with the expectation that the needs and functional capacity of most organisms would be fulfilled. The coarse-filter components in the terrestrial and aquatic sections of the plan are designed to achieve these conditions across the landscape and would provide for the habitat needs of most plant species, including species of conservation concern as well as species formerly identified as sensitive plants under the current 1986 forest plan. Fine-filter plan components are provided that would contribute to the protection of plant species of conservation concern in key areas, specifically related to ground disturbance associated with management activities. Some of this direction is located in the "Plant species diversity" section of the plan; some direction addresses the sites and habitats associated with plant species of conservation concern and is located in other sections of the plan (such as the Riparian Management Zone and the Soils and Geology sections). Table 6-1 in appendix 6 provides a list of the primary coarse- and fine-filter plan components that contribute to providing for the habitat needs and protection of plant species of conservation concern. Discussion of these plan components follows.

The standards for the designation and conservation of riparian management zones adjacent to streams and wetlands (FW-STD-RMZ-01) and the associated plan direction for riparian management zones would contribute to the protection of plant species of conservation concern associated with fen and wetland habitat. The width of the riparian management zone for ponds, lakes, reservoirs, and wetlands greater than 0.5 acre, and for all howellia ponds, fens, and peatlands, is a minimum 300 feet, which is greater than the current riparian habitat conservation area widths specified in the existing 1986 forest plan for ponds and wetlands greater than 1 acre. Refer to the "Riparian Management Zone" section of the plan and to section 3.2 in the final EIS for more detailed information on management direction in riparian management zones. The plan components related to riparian management zones would conserve plant species of conservation concern in these habitats by buffering them from impacts that could alter the hydrologic conditions necessary for their persistence.

Management direction for water howellia includes a standard for retention of a 300-foot minimum management buffer from the margins of occupied and unoccupied ponds and guidelines limiting ground-disturbing activities within this buffer (FW-DC-PLANT-02; FW-GDL-PLANT-01 and 02). These measures will also provide protection for other plant species of conservation concern associated with this habitat.

Plan components that ensure the conservation of plant species of conservation concern include desired conditions that support maintaining the ecological processes and habitat conditions that would contribute to the conservation of these species. This direction includes desired conditions associated with wetland and riparian areas where many of the plant species of conservation concern species occur (FW-DC-PLANT DIV-01; FW-DC-WTR-03, 10, 11, 12, and 13; FW-DC-RMZ-01) as well as the upland terrestrial areas that support other plant species of conservation concern (FW-DC-TE&V-04). Guidelines specific to plant species diversity and plant species of conservation concern would provide mitigation and protection measures to maintain species and habitats during the planning and implementation of activities that might impact populations (FS-GDL-PLANT DIV-01 and 02). Other standards and guidelines would restrict ground-disturbing activities, such as timber harvest and road construction, within riparian management zones associated with wetlands, which would simultaneously provide protection to plant species of conservation concern associated with these habitats (FW-STD-RMZ-05 and 06; FW-GDL-RMZ-06, 14, and 15). Plan components associated with soils (FW-STD-SOIL-01; FW-GDL-SOIL 01, 02, and 03) also

provide direction that would limit ground disturbance associated with management activities, which would benefit and contribute to the protection of plant species of conservation concern in all types of habitats, including riparian and upland terrestrial areas. Other actions that have the potential to impact riparian and aquatic ecosystems, such as fire suppression activities, use of chemicals, management or construction of facilities, and mining activities would also be restricted within riparian management zones, which would contribute to the protection of plant species of conservation concern (FW-STD-RMZ-03 and 04; FW-GDL-RMZ-02 through 05; FW-GDL-REC-06; FW-GDL-LSU-02 and 03; FW-GDL-E&M-07).

Fens support unique and very diverse plant communities, including many plant species of conservation concern, and the action alternatives acknowledge the special botanical features associated with fens by designating eleven botanical special areas (management area 3b) that focus on the more distinctive fen complexes on the Forest. In addition to the forestwide plan components described above, these special areas have plan components that emphasize retaining the natural conditions of these areas (MA3b-Special Area-DC-01), and protecting them from invasive plant species and human disturbances that might adversely affect their special character (MA3b-Special Area-DC-02).

Non-native invasive plant species are a threat to many of the plant species of conservation concern. Areas where populations of plant species of conservation concern are known to occur are given priority status with respect to addressing concerns with and/or treating invasive species (FW-DC-NNIP-01, FW-OBJ-NNIP-01). Livestock grazing is also a threat to some species, and the plan contains components related to grazing practices that might negatively impact plant diversity and ecological conditions, particularly within riparian areas (FW-DC-GR-03; FW-STD-GR-07 and 08; FW-GDL-GR-01 and 03). This direction would contribute to the protection of the habitats of plant species of conservation concern that might be affected by grazing.

Taken together, the coarse- and fine-filter plan components described above that are related to ecological conditions and conservation of native plant communities, and that limit disturbance from management actions, would buffer populations of plant species of conservation concern from hydrologic or other changes resulting from management activities or would prevent direct impacts to them. As a result, these plan components should maintain a viable population of each plant species of conservation concern within the Flathead National Forest.

Sensitive plant species currently on the regional forester’s sensitive species list

Of the 40 plant species currently identified as sensitive by the regional forester that are known to occur on the Flathead National Forest, over half (24) have been identified as species of conservation concern by the regional forester for the final EIS. Effects to these species are discussed above.

Of the remaining 16 plant species identified as sensitive, 10 occupy a habitat group that is also associated with the identified plant species of conservation concern: three within the peatland/fen group, one within the wetland/riparian group, and six within the mesic montane/rock/talus/disturbance group. Thus, the habitat and stressors, as well as the effects of the action alternatives, would be similar to those disclosed for the species of conservation concern species within the group. The protections provided by plan components to plant species of conservation concern and their habitats described above (such as limiting soil disturbance and treating invasive species) would also help protect sensitive plant species and communities that occupy these types of habitats.

Six species identified as sensitive occur within habitat groups that have no identified species of conservation concern: four within the aquatic habitat group and two within the alpine habitat group. The sensitive species associated with open water (aquatic habitat) would be protected by plan components that

address the conditions of aquatic ecosystems on the Forest. These include desired conditions, and supporting standards and guidelines, to provide for resilient, diverse, and sustainable aquatic plant and animal communities and to maintain water quality, the physical integrity and flow of streams, and aquatic ecosystems free of invasive species (see the “Aquatic Ecosystems” section of the forest plan). These measures should adequately protect plant species previously identified as sensitive associated with this habitat and should result in a low risk of impact. The sensitive species associated with high-elevation alpine sites would be protected by plan components associated with the restoration of the subalpine-associated whitebark pine plant communities and the ecological processes within these communities. This would benefit other plant species associated with subalpine habitats (refer to the whitebark pine discussion in section 3.5.1). In general, plants in alpine environments grow in remote areas with limited potential for human disturbance; threats would mainly be associated with factors such as changes in natural fire regimes and resulting changes to natural vegetation conditions.

Consequences to species of conservation concern from forest plan components associated with other resource programs or management activities

Effects from recreation

Recreation impacts can include ground disturbance, trampling, removal of individual plants, and introduction of weeds by hikers, stock, and wheeled motorized vehicle use on designated routes and areas. The development of campgrounds and other facilities used by recreationists also contribute to plant habitat impacts because these developments make more areas accessible and concentrate use. Dispersed camping has similar impacts. Parking areas, particularly undesignated areas, pose similar impacts to plants. In addition, there can be long-term impacts of bisecting a rare plant population with a trail or other linear feature and affecting its reproduction and/or plant dispersal. Roads and trails for recreational use can contribute to the spread of noxious weeds. These potential impacts are most likely to affect plant species of concern associated with upland terrestrial habitats rather than those in fens or marshes. All alternatives are similar in the kinds and amounts of nonmotorized recreational uses and thus the potential effects would be similar. Because of the widely dispersed nature of these recreational uses, impacts on plant species of conservation concern would be expected to be low. As for motorized recreational use, alternative C would have the least potential impact because it would decrease the opportunity for wheeled motorized vehicle use on designated routes and areas the most (see section 3.12). Alternative A would have a similar impact to alternative C because it would lead to the most roads reclaimed or decommissioned as well as a reduction in the current amount of motorized trails. Alternatives B modified and D would have the most potential impact on species of conservation concern; this would be essentially status quo, with little if any change in current motorized use across the Forest. The action alternatives differ from alternative A because they contain specific plan components designed to protect plant species of concern and provide protection measures for site-specific proposed projects.

Effects from vegetation management and road access

Vegetation management treatments can have impacts to plants and plant habitat through canopy removal and soil disturbance. In addition, vegetation treatment may require road building or maintenance. Roads used for vegetation management increase access and provide an avenue for invasive plant species. Forest plan standards and guidelines limit the implementation of ground-disturbing activities (such as road construction and mechanical harvesting) within riparian management zones to protect aquatic and riparian resources, including plant species (FW-STD-RMZ-05 and 06; FW-GDL-RMZ-11, 12, 14, and 15).

Sudden changes in forest conditions may cause damage to individual plants immediately, such as through light stress and ground disturbance. An abundance of early-successional forest reduces the available habitats for those plants that require mid- to late-successional stages. However, those disturbance-

dependent species that prefer openings, early-successional stages, or some ground disturbance could benefit from moderate levels of activities after a few years. Many plants within this ecosystem have evolved so that they are adapted to the conditions created by fires of all severities. The use of fire as emphasized under the action alternatives would create suitable habitat over time for some rare plant species, such as the pale corydalis (*Corydalis sempervirens*) and the clustered lady's-slipper (*Cypripedium fasciculatum*). However, if species are rare due to very limited habitat or human-caused stressors, loss of habitat or populations due to fire may be of concern. Alternative C would have the least amount of vegetation treatments and associated roads and thus the least potential for impacts to plant species of concern. Alternatives A, B modified, and D have similar amounts of vegetation treatments, but alternative A would reclaim or decommission the most amount of road among the alternatives which, over the long term, would reduce stressors to species of conservation concern associated with roads. Alternative A would be second to alternative C in potential for impact. Alternatives B modified and D are relatively similar in vegetation treatment amounts and would have the most potential for impact to species of conservation concern associated with vegetation treatments and access roads. Under all the alternatives, plan components are designed to protect plant species of concern from impacts associated with these activities, and anticipated effects are expected to be low or nonexistent.

Effects from non-native invasive plants

Non-native invasive plant species can displace native plant communities through resource competition. Negative impacts from management activities could include impacts from herbicide spraying and mechanical ground disturbance to control noxious weeds once they gain a foothold. Competition from invasive weeds could result in the loss of habitat, loss of pollinators, decreased native plant diversity, and decreased rare plant species viability. Roads, trails, livestock, and canopy reduction could provide ideal pathways for the introduction of non-native species. Regarding the risk of weed invasions and/or expansion of non-native populations, the alternatives would vary in some ways. In general, the more emphasis the alternative has on ground-disturbing vegetation management activities and motorized use and access (a primary vector for weed spread), the greater the risk of weed spread and establishment. Alternative A likely has the least potential for invasive plant species establishment and spread, followed by alternatives D, C, and B modified. Section 3.6 describes the effects of the alternatives in more detail regarding the risk of weed spread and establishment.

All alternatives incorporate similar direction that would guide the treatment of invasive plants based on the forestwide analysis and decision for noxious weeds that was incorporated into the existing 1986 forest plan and the forest plan direction (refer to the Non-Native Invasive Plant/Noxious Weeds section of the forest plan). An integrated management approach to weed control would be applied. The action alternatives have specific objectives for acres of invasive plants to treat, which would provide even more focus on control efforts. Priority areas for treatment are identified in the plan, and these include areas associated with known plant species of conservation concern (FW-DC-NNIP-01; FW-OBJ-NNIP-01).

Cumulative effects common to all alternatives

Public lands play a critical role in the conservation of plant diversity and species of conservation concern. During the next several decades, human populations are likely to expand, which will likely result in greater human presence and pressure on public lands, such as for recreational uses. These trends suggest not only that public land will play an increasingly important role in the conservation of these species in the future but also that management to ensure the maintenance of viable populations of species of conservation concern and to prevent the Federal listing of species and will be an increasingly difficult challenge.

3.5.3 Plant determinations associated with alternative B modified

Alternative B modified includes plan components that would provide the ecological conditions necessary to maintain, improve, and restore ecological conditions within the Flathead National Forest that maintain viable populations of at-risk plant species. This conclusion is based upon the analysis of existing vegetation conditions and natural range of variation across the landscape, which forms the basis of the desired conditions in the plan as well as the effects and projected trends resulting from implementation of the plan. This coarse-filter approach would provide for the habitat needs of plant species of conservation concern, in addition to the guidelines specific to plant species of conservation concern that require avoiding locating temporary fire facilities (e.g., base camps) or using heavy, ground-based equipment in areas with known plant species of conservation concern populations.

The coarse-filter approach, along with species-specific standards and guidelines, would provide for the habitat needs of federally listed plant species. Water howellia (*Howellia aquatilis*) is a federally designated threatened species on the Forest. The species is restricted to small ponds or oxbows long since isolated from the flowing surface waters of the river. Currently, there are 220 known populations of water howellia, all located in the Swan Valley, with 191 of these occurring wholly or partially on Flathead National Forest lands. These 220 populations represent 73 percent of the known 304 global occurrences. Plan components would provide for ecological conditions in the plan area to support the persistence of water howellia in its range (§ 219.9). The USFWS's five-year review of water howellia, completed in 2013, concluded that the threats identified at the time of listing have been mitigated through regulatory mechanisms such as the conservation strategy and the incorporation of project design features that remove or minimize disturbance to populations, such as the 300-foot minimum management buffer around both occupied and unoccupied ponds (USFWS, 2013b). Reed canary grass threatening ponds has been successfully treated in some states and does not seem to be invading other habitat as previously feared. The conservation strategy for water howellia would be retained. The 300-foot minimum management buffer around all water howellia sites (occupied and suitable but unoccupied) would be retained, with restrictions applied to management activities. For more information, see Kuennen et al. (2017).

Whitebark pine (*Pinus albicaulis*) is designated as a candidate for Federal listing as a threatened or endangered species. Whitebark pine occurs widely across the Forest at upper-mid- to high-elevation sites. Plan components specific to whitebark pine restoration efforts on the Forest would contribute to rangewide restoration efforts for whitebark pine, guided by the principles of the restoration strategy (R. E. Keane et al., 2012). Alternative B modified provides plan components that would support whitebark pine restoration, including desired conditions to sustain whitebark pine habitats and increase the presence and abundance of the species. A guideline is included to protect individual trees (such as disease-resistant cone-producing trees) that are important to whitebark pine restoration goals. Because of the ecological importance of whitebark pine and its precipitous decline due to an introduced disease, the preferred alternative also includes an exception to the Northern Rockies Lynx Management Direction standard VEG S6, which provides for noncommercial felling of trees larger than sapling size within 200 feet of whitebark pine trees (in stands that contain trees identified for cone, scion, and pollen collection) to make whitebark pine more likely to survive wildfires, more resistant to mountain pine beetle attack, and more likely to persist in future environments.

There are no known populations of Spalding's catchfly on the Forest. Ecosystem plan components emphasize the protection of high-priority areas, including the native dry grasslands where this species might occur. Treatments that focus on these areas would provide protection to these rare plant communities that serve as potential habitat for Spalding's catchfly (see appendix 6, table 1). For more information, see Kuennen et al. (2017).

3.6 Non-Native Invasive Plants

3.6.1 Introduction

A plant species is considered to be an invasive plant if it meets two criteria: (1) it is non-native to the ecosystem under consideration and (2) its introduction causes, or is likely to cause, economic or environmental harm or harm to human health (Executive Order 13112, 1999). Non-native invasive plants include exotic plants and noxious weeds. Exotic plants are species that have been introduced inadvertently or intentionally to an area, usually from a different continent; however, not all exotic species are invasive species.

The term noxious weed is a legal designation and is defined by Montana Code Annotated (7-22-2101, 2014) as “any exotic plant species established or that may be introduced in the state that may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities.”

Although invasive plants are often adapted to habitats where they are not native, they lack the natural controls (insects, disease) that may have evolved within their native ranges. As a result, they tend to spread aggressively and reduce overall native community diversity, and generally disrupt the natural processes of the environment. They displace native plants or reduce forage for some animal species, degrade natural communities, change hydrology, change microclimatic features, increase soil erosion, alter wildfire intensity and frequency, and cost millions of dollars in treatments and fire suppression to land management agencies and governments (USDA, 2001c).

Regulatory framework

Federal law

Federal Insecticide Fungicide and Rodenticide Act of 1947, as amended (Pub. L. 92-516): This act requires all pesticides to be registered with the Environmental Protection Agency. It also states that it is unlawful to use any registered pesticide in a manner inconsistent with its labeling.

Carlson-Foley Act of 1968 (Pub. L. 90-583): This act authorizes and directs the heads of Federal departments and agencies to permit control of noxious plants by State and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-Federal land. In other words, this act permits county and State officials to manage noxious weeds with herbicides on Federal lands and to be reimbursed for that management, given that other applicable laws such as the National Environmental Policy Act are also met.

Federal Noxious Weed Act of 1974: This act states that each Federal agency shall establish and adequately fund an undesirable plant management program; complete and implement cooperative agreements with State agencies regarding the management of undesirable plant species on Federal lands under the agency’s jurisdiction; and establish an integrated management system to control or contain undesirable plant species targeted under cooperative agreements.

Federal Land Policy and Management Act of 1976 (Pub. L. 94-579): This act provides authority to Federal agencies to control weeds on rangelands as part of a rangeland improvement program.

Executive orders

Executive Order 13112 (Feb. 3, 1999): This order directs Federal agencies to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective

and environmentally sound manner; to monitor invasive species populations accurately and reliably; to provide for restoration of native species and habitat conditions in ecosystems that have been invaded; to conduct research on invasive species and develop technologies to prevent introduction; to provide for environmentally sound control of invasive species; and to promote public education on invasive species and the means to address them. All of these actions are subject to the availability of appropriations.

State and local law

Montana County Noxious Weed Management Act of 1985: This act states that it is unlawful for any person to permit any noxious weed to propagate or go to seed on the person's land, except that any person who adheres to the noxious weed management program of their weed management district or who has entered into and is in compliance with a noxious weed management agreement is considered to be in compliance with this section.

Other regulation, policy, and guidance

Forest Service Manual 2900: This guidance ensures that forest management activities are designed to minimize or eliminate the possibility of establishment or spread of invasive species on NFS lands or to adjacent areas.

Forest Service Manual 2070 Vegetation Ecology: This guidance provides direction for the use of native and non-native seed use on NFS Lands. It specifically emphasizes the use of native seed mixes in all revegetation, rehabilitation, and restoration projects on NFS lands.

Forest Service National Strategic Framework for Invasive Species Management of 2013 (http://www.fs.fed.us/invasivespecies/framework.shtml): This framework provides broad and consistent strategic direction on the prevention, detection, and control of invasive species. It incorporates the invasive species systems approach to respond to threats over the next 5 to 10 years.

Indicators, methodology, and analysis process

The following indicators are used for the analysis of invasive species:

- vegetation treatments
- motorized use and access
- recreational activities
- livestock grazing
- fire activity

Effects to invasive species are indicated by evaluating the difference in frequency, intensity, or type of management activity or natural processes by alternative, insofar as they may potentially disturb the ground and result in greater risk of weed spread or invasion. The process for identifying risk and impacts resulting from invasive species is completed by Forest Service botanists and vegetation specialists.

Information sources, and incomplete or unavailable information

The Forest Service uses the Montana Noxious Weed List (MNWP, 2015), collaboration with county weed coordinators, and the results of project-specific invasive plant risk assessments to identify invasive species needing management across the national forests. As project areas are surveyed, new infestations are inventoried. Existing data on invasive species is stored in the Natural Resource Manager's Threatened, Endangered, and Sensitive Plants and Invasive Species database (NRM-TESP-IS).This database is continually updated with inventoried infestations. Refer to the Forest's assessment (USDA,

2014a) for summaries of multiple years of data from Natural Resource Manager queries, risk assessments, and field observations. The current condition and trend of invasive plants on the Flathead National Forest is also summarized in the assessment.

Many areas of the Forest have not yet been inventoried for invasive species infestations. Wilderness and research natural areas, for example, are not well inventoried. There is also a lack of information on areas that are weed free, especially in vegetation types at highest risk. The Natural Resources Manager database is continually updated with field observations that are reported by project personnel.

Analysis area

The geographic scope of the analysis for non-native invasive plants is the NFS lands of the Flathead National Forest. This area represents the NFS lands where changes may occur to vegetation as a result of management activities or natural events. For cumulative effects, the analysis area also includes the non-NFS lands within and immediately adjacent to the administrative boundary of the Flathead National Forest.

3.6.2 Affected environment

As reported in the assessment (USDA, 2014a), as of 2014 nearly 10,000 separately recorded invasive plant infestations have been recorded on the Forest, comprised of approximately 30 invasive species. These records include revisits to known infestations. The majority of these sites are in road corridors, gravel pits, and log landings. In the Swan Valley, many dense infestations were found on the recently acquired Montana Legacy Project lands (formerly owned by Plum Creek Timber Company), which added to the forestwide weed inventory considerably.

On a landscape scale, the Flathead National Forest has been less affected than many other public lands because most invasive species are best adapted to grasslands, shrublands, and warmer and drier forest types, and such habitats are limited in extent on the Forest. However, the Forest has many roads, landings, clearings, gravel pits, trails, campgrounds, private inholdings, and other areas that are disturbed and highly susceptible to infestation. Weed infestations in such areas are potential seed sources for spread into more remote areas that may be vulnerable to invasion, such as grassland habitats in the Bob Marshall Wilderness and other undeveloped areas.

The most abundant invasive species on the Forest are oxeye daisy, spotted knapweed, the hawkweed complex, and Canada thistle. The species of highest priority for treatment are Dyer’s woad, tansy ragwort, leafy spurge, both toadflax species, and those species that are on the State noxious list that have not yet found their way onto the Forest. Eradication of some of these species is possible to achieve on the Forest. Although there are widespread species such as spotted knapweed and St. John’s wort that occupy almost all roads, gravel pits, and recreation areas and many trails, these species are not considered high priority due to their abundance on the Forest, in the state, and in the West at large. They are still treated in some areas, but with the goal of control, not eradication, in contrast to the aforementioned species. Treatment of such widespread weed species around trailheads, and along roads that provide access to them, is a means of preventing their spread into wilderness and other undeveloped lands that are currently weed free. Refer to the assessment (USDA, 2014a) for additional details on the current condition of non-native invasive plant species on the Forest and future trends.

Non-native invasive plant management

Forest Service policy (specifically Executive Order 13112; Forest Service Manual 2900) and the national invasive species strategic framework (USDA, 2013b) identify prevention of the introduction and establishment of non-native plant species as an agency objective. This policy directs the Forest Service to

- determine the factors that favor establishment and spread of invasive plants;
- analyze invasive species risks in resource management projects; and
- design management practices that reduce these risks.

The desired condition inferred from Executive Order 13112, Forest Service Manual 2900, and the national strategy is the prevention of new infestations (within areas of activities and along travel routes associated with those activities) and management of the infestations currently established on the Forest through control measures.

For all National forests, management goals for non-native invasive species are as follows:

- potential invaders—*prevent* establishment and, if found, promptly *eradicate*
- new invaders—for small infestations, *eradicate*, and for larger infestations, *reduce*
- widespread invaders—*contain* areas that are already infested and *reduce* plant populations

Methods used to prevent invasive species from being introduced and spreading into new areas include closing infested areas to travel, washing vehicles and equipment upon entering an area, requiring the use of weed-free hay for pack animals, and using weed-free seed and straw mulch for revegetation. Manual, mechanical, biological, and chemical methods of treatment are generally limited to localized areas and those species on the Montana State list. Containment combines prevention and treatment, with the objective of limiting spread of an existing infestation and reducing the acres of existing infestations by treating around the perimeter of the infestation. Invasive weed management in cooperation with private and agency partners, county weed districts, and others is important in all of these treatment activities.

Seeding temporary roads as a conservation measure to reduce invasive species infestations has been occurring on national forests for many years. Desirable non-native mixes of grasses and forbs have primarily been used in the past. Native grasses and forbs have been used more in recent years. Observations of some of the temporary roads constructed in the last 30 to 40 years on the Forest indicate some success in the prevention of infestation in the road corridors (based on monitoring reports located in Forest invasive plant program records).

Infestations in some sites have been reduced by these measures. However, in spite of these control efforts, existing infestations continue to invade disturbed areas and intact plant communities. It is still common to see noxious weeds along many roadsides, railroad and utility rights-of-way, and other disturbed areas such as gravel pits. Changes to the landscape with warmer temperatures, associated drier conditions, and more severe or frequent droughts may lead to more frequent fires and may increase the ability of invasive plants to outcompete native plants in the future.

Below is a description of the management activities or natural processes potentially influencing weed establishment or spread and used as indicators to measure differences in effects among alternatives.

3.6.3 Environmental consequences

Effects by alternative for management direction

Alternative A—No action

The 1986 forest plan, as amended, is the existing management being used by the Flathead National Forest to address non-native invasive plants. This direction represents the no-action alternative. However, because the no-action alternative is the baseline to which the action alternatives are compared, it is important to understand what actions would continue under the no-action alternative.

The existing Flathead National Forest forest plan includes a forestwide objective for noxious weeds:

- Inventory, map, and complete an activity schedule for five significant noxious weed plant communities during the first planning period (Spotted Knapweed, Dalmatian Toadflax, Leafy Spurge, Goatweed, and Whitetop) (USDA, 1986, p. II-8).

and a forestwide standard:

- 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 native fish (USDA, 1986, p. II-34).

Development of additional management direction for noxious weeds has occurred under the existing forest plan. In 1993, amendment 17 to the forest plan added standards to implement an integrated pest management approach for weeds in the Bob Marshall Wilderness Complex and to conduct an environmental analysis for the use of chemical treatments in this area. This direction is incorporated into the existing 1986 forest plan.

In 2001, the Flathead National Forest Noxious and Invasive Weed Control Decision Notice and Finding of No Significant Impact (USDA, 2001b) resulted in a more robust integrated pest management program and provided for the use of herbicides with the following active ingredients: clopyralid, dicamba, picloram, 2,4-D amine, and glyphosate.

Since this decision, the chemical industry has continued to produce herbicide formulations that improve upon environmental and human safety and/or the efficacy and efficiency of weed control. The Flathead National Forest continually evaluates new herbicides to determine whether they fall within the parameters of the 2001 decision. For example, metsulfuron sulfur is labeled for the same uses as herbicides in the 2001 decision, is considered low risk to human and environmental safety, moves less through the soil than clopyralid or picloram, and has less residual than picloram (and therefore lower risk of buildup in the soil). Because it is a powder, it has less risk of liquid concentrate spill. Metsulfuron sulfur is more effective on houndstongue than any other herbicide in the 2001 decision. Evaluation and use of other new herbicides has also occurred, such as chlorsulfuron for dyer’s woad and aminopyralid on a variety of locations throughout the Forest.

Under the no-action alternative, there is no targeted amount of acres to treat for noxious weeds. The 2001 weed control decision notice adopted an adaptive strategy to determine where, when, and how to treat sites, considering such factors as weed species and treatment prioritization, the ecological importance of the site, and funding. In spite of its lack of specificity in the actual 1986 forest plan direction, the no-action alternative as it is amended encompasses current practices and is considered appropriate for addressing invasive species while being flexible in response to budget constraints.

Alternatives B modified, C, and D

A primary difference of the action alternatives compared to the no-action alternative is their targeted management direction, including treatment objectives and more clarity regarding treatment strategies, priorities, and methods. Regardless, direction for non-native invasive species is not anticipated to be substantially different with regard to impacts to or from vegetation management than the no-action alternative. Management direction under all the action alternatives for non-native invasive plants includes desired conditions that emphasize the maintenance of native plant communities that are not compromised by the presence of non-native invasive plant species, with emphasis on maintaining these conditions through the monitoring and treatment of certain areas and plant communities, including native persistent grasslands, riparian areas (particularly water howellia ponds), research natural areas, areas where species of conservation concern occur, and special areas (management area 3b). A guideline for the treatment of

disturbed soils resulting from ground-disturbing management activities helps reduce the probability of the establishment of new invasive plant populations to areas at risk. Targeted objectives for non-invasive plant control are an administrative change that promotes measurable objectives and accountability of the program towards reaching desired conditions. The objective was chosen to be responsive towards desirable conditions while also being flexible in response to uncertain yearly budgets, which is the program's primary operating constraint.

Although preference for the use of low-leaching chemical treatments is currently exercised under the no-action alternative, the action alternatives formalize this practice. Consideration of technological advances in weed treatments is emphasized if they are shown to be equivalent to, or more effective than, existing treatments. Preference is stated regarding the use of low-leaching chemical treatments and application methods to minimize ground and subsurface drift effects. Additionally, evaluating and incorporating new chemical treatments, if equivalent or more effective than existing treatments, into the integrated pest management program is also current program practice. Thus, the action alternatives update the 1986 forest plan by formalizing current invasive species management practices. As such, alternatives B modified, C, and D forestwide direction is not anticipated to have adverse effects over the no-action alternative.

The action alternatives incorporate standards and guidelines of the draft Grizzly Bear Conservation Strategy (USFWS, 2013a). Forest plan guideline FW-GDL-TE&V-01 incorporates management direction from the draft Grizzly Bear Conservation Strategy related to reducing risk of disturbance to bears by vegetation management activities, such as restricting activities in spring habitat during the spring time period. However, this direction acknowledges that some activities, including weed spraying, may need to be completed during the spring time period in order to be effective and meet other resource objectives (especially if needed to prevent resource damage). This provides the flexibility that may be needed to meet desired conditions associated with invasive plants across the Forest.

Often, invasive plant species are best treated in spring during emergence, in early summer prior to seed-set, and in fall for new germinants and for susceptible perennial species. Weed treatments rarely if ever can be effectively conducted during the winter denning season, which would be the time when the potential for grizzly bear disturbance would be lowest. Although this draft Grizzly Bear Conservation Strategy direction may result in some reduction of flexibility in weed treatment implementation, the expectation is that treatments would be able to be timed appropriately to ensure effective weed control under the guideline.

Effects by alternative for indicators

Vegetation management

Ground-disturbing activities, equipment transport and use associated with management activities such as timber harvesting, fire treatments and fire suppression, and other authorized uses are a common vector influencing the expansion of noxious weeds and exotic plants. The establishment and expansion of invasive plant infestations is dependent on seed sources in the area or seed transported in from another area plus local soil and climate conditions. Most of these risks are minimized with localized site restoration and rehabilitation as well as the use of weed control measures during implementation (e.g., contract clauses to wash equipment).

The great majority of timber harvest activities and associated road access would be expected to occur on lands on the Forest identified as suitable for timber production. It could be assumed that a larger amount of area suitable for timber production would result in more areas where timber harvest could occur to achieve desired vegetation conditions and thus would result in potentially more ground-disturbing

activities associated with timber harvesting and roads. In actuality, acres harvested is not necessarily directly tied to the amount of suitable lands; it is also related to the treatment type that may be applied in order to achieve the management emphasis associated with the alternative. For example, alternative C has the least amount of land suitable for timber production, but the anticipated annual average harvest acres over the next decade (as modeled) is highest for this alternative (see table 43). This is because less intensive treatment types (e.g., commercial thinning) that remove less timber volume per acre are used by the model to achieve desired vegetation conditions while still providing for desired conditions associated with timber production. Under all alternatives, budget is also a major factor that constrains harvest levels. Table 43 displays the estimated annual average harvest acres as modeled for the next decade as well as the total acres suitable for timber production. Refer to section 3.21 and to appendix 2 for additional details on the analysis of lands suitable for timber production and harvest amounts.

Table 43. Total acres suitable for timber production[1] and average annual acres of timber harvest treatment over the next decade, by alternative (source: Spectrum model)

	Alternative A (acres)	Alternative B modified (acres)	Alternative C (acres)	Alternative D (acres)
Total acres suited for timber production	534,600	465,200	308,200	482,600
Average annual acres treated by timber harvest over the next decade	1,699	3,138	2,577	1,833

1. As defined by the 2012 planning rule and described in section 3.21 of this final EIS.

The acres of timber harvest are an estimate; actual treatment acres and types would be highly subject to project-and site-specific conditions, as would the potential ground disturbance that might occur from timber harvest activities. The differences between alternatives as to the risk of invasive weed establishment and spread discussed below thus have an element of uncertainty and are likely to be very subtle.

Alternative A

Alternative A has the greatest amount of area suitable for timber production between the alternatives but the least modeled acres of potential timber harvest. Ground disturbance from timber harvest, and associated vulnerability to invasive weed establishment and spread, may be lowest under this alternative. Management direction to address non-native invasive plant species is in place within the 1986 forest plan, largely via the Flathead National Forest Noxious and Invasive Weed Control Decision Notice, and would continue to be followed.

Alternatives B modified, C, and D

Alternative D has the greatest amount of area suitable for timber production of the action alternatives but the least amount of modeled acres of potential timber harvest. Of the action alternatives, alternative D may have the lowest risk of invasive weed establishment and spread associated with ground disturbance in timber harvest areas, followed by alternatives C and B modified. Management direction associated with control of ground disturbance and weed management would be expected to reduce the risk of invasive weed establishment and spread under all alternatives.

Motorized use and access

A main vector for seed spread is vehicle use (e.g., road construction and maintenance equipment, logging vehicles, and passenger cars and trucks) (Taylor, Brummer, Taper, Wing, & Rew, 2012). Many existing infestations can be found along or have originated from roadsides because vehicle traffic provides ideal

means for noxious weed spread. Roads and vehicle traffic pose difficult challenges to the management of invasive species.

The transportation of weed seed by contractor or special-use vehicles or equipment on NFS roads is managed, to a degree. Contract stipulations are used to require specific actions, e.g., vehicle and equipment washing, to lessen the possibility of weed transport and reduce the risk of new infestations. The use of roads and motorized trails by the general public presents a greater risk because of the lack of control measures and the lack of knowledge about invasive species spread.

The alternatives vary in the amount of motorized access opportunities for recreational use, both on roads and trails. These differences are tied primarily to differences in forest plan direction for grizzly bear habitat management and in management area designations. Summer motorized uses pose the greatest risk of invasive weed transport. The amount of the Forest in recreation opportunity spectrum classes that allow for summer motorized recreational uses also provides an indication of the potential area where the risk of weed establishment and spread might be higher. Table 44 displays the amount of Forest by alternative with summer motorized recreation opportunity spectrum classes. Refer to section 3.10 for more detailed discussion.

Table 44. Estimated percent of the Forest in desired summer motorized and roaded natural recreation opportunity spectrum classes by alternative

Category	Alternative A	Alternative B modified	Alternative C	Alternative D
Percent of area in summer semiprimitive motorized recreation opportunity spectrum class	3%	2%	1%	8%
Percent of area in roaded natural recreation opportunity spectrum class	25%	29%	24%	34%

Because of the small differences and site-specific localized nature of weed infestation and spread, changes in weed spread or establishment estimated at the programmatic level would be subtle and might not be noticeable on the ground or attributable solely to actions associated with different road density or summer motorized access. A site-specific environmental evaluation would be required prior to on-the-ground activities to determine specific impacts, and integrated weed management and revegetation of disturbed sites would continue to be used to treat infestations. Public education on invasive species prevention would be continued.

Alternative A

Alternative A would provide the least opportunity for wheeled motor vehicle use (allowed on designated roads): it would be allowed on 1,262 miles of the Forest. In addition, an estimated 518 miles of road would need to be reclaimed or decommissioned and about 57 miles of trails would no longer allow motorized wheeled use in order to fully meet amendment 19 in each grizzly bear management subunit, unless site-specifically amended. About 79 miles of roads that are open either yearlong or seasonally would be closed to public use. Refer to section 3.12.3 for details on road management changes. The existing lands allocated to summer semiprimitive motorized or roaded natural recreation opportunity spectrum classes is a total of 28 percent of the Forest, which, when compared with the desired recreation opportunity spectrum in the action alternatives, is the second lowest of all the alternatives.

Alternative A would result in the greatest long-term overall decrease in motorized roads and trails as well as the second lowest amount of area with summer motorized recreational opportunity. The potential for invasive species establishment and spread due to ground disturbance and impacts from motorized uses is likely lowest under alternative A. Inadvertent seed spread could decrease in areas that are either closed to

motorized access or are more difficult to access. However, during road closure and decommissioning activities that require short-term ground disturbance (e.g., relocating gates), there could be short-term invasive plant establishment until invasive weed treatments are applied to the disturbed area. Additionally, road closures and/or decommissioning make administrative access more difficult for treating invasive species in some areas of the Forest.

Alternatives B modified, C, and D

Alternatives B modified, C, and D provide opportunity for wheeled motor vehicle use on 1,427 miles of designated NFS roads on the Forest. Alternatives B modified and D provide the same amount of wheeled motorized trail opportunity, which is higher than under alternatives A or C. Under alternative C, existing wheeled motorized use would not be suitable in recommended wilderness areas, which would reduce the motorized trail opportunity for wheeled motorized vehicles by 75 miles on the Forest. In addition, about 48 miles of closed roads (maintenance level 1) that are currently within recommended wilderness areas might need to be to be removed from the system after site-specific analysis. Refer to section 3.12.3 for details on road management changes.

Alternatives B modified and D have little change to the existing amounts of motorized roads and trails and thus would result in no change from existing invasive plant conditions associated with these uses. However, alternative C would result in an overall long-term decrease in motorized roads and trails, with associated reductions in ground disturbance and the potential for invasive species establishment and spread. Under alternative C, inadvertent seed spread could decrease in those areas that are either closed to motorized access or are more difficult to access. During road closure and decommissioning activities that require short-term ground disturbance (e.g., relocating gates), there could be short-term invasive plant establishment until invasive weed treatments are applied to the disturbed area. Additionally, road closures and/or decommissioning would make administrative access to treat invasive species more difficult in some areas of the Forest.

The desired amount of lands allocated to summer semiprimitive motorized or roaded natural recreation opportunity spectrum classes is highest (42 percent) under alternative D, followed by 31 percent under alternative B modified and 25 percent under alternative C (see table 44). These recreation opportunity spectrum classifications define areas with opportunities and suitability for motorized vehicle uses. Increased area classified as a motorized summer recreation opportunity spectrum could imply a potential increase in motorized use within the area in the future. However, many forest plan components restrict motorized use across the Forest, particularly those associated with grizzly bear habitat management. A site-specific environmental evaluation would be required prior to authorizing any new motorized uses, and notable increases in motorized use across the Forest is not expected to occur under any alternative. In any case, integrated invasive plant management would continue to occur under all alternatives to manage and control weed infestations.

Recreation

Recreational activities, including nonmotorized, are another vector for potential seed establishment and dispersal. Recreational activities and areas receive concentrated and frequent use and continual ground disturbance. Generally, wilderness areas and large unroaded lands are less likely to contain invasive weeds due to less widespread public access, especially via motorized means. However, these large unroaded areas are vulnerable to weed infestation and spread from recreational uses. Humans, dogs, and pack stock transport seed inadvertently. Trails that receive high uses, including those in wilderness areas, are vulnerable to invasive weed infestation and may serve as vectors for spread into surrounding sites. Bike and horse trails and motorized trails are at higher risk for the introduction, spread, and establishment of weeds compared to hiking trails. Areas of high use and ground disturbance occur within wilderness

areas and are as vulnerable to weed infestation as developed sites outside wilderness. Frequently, infestations are found around trailheads, trails, campgrounds, and other developed recreation sites. These seed sources pose a risk of further spread into wilderness and undeveloped lands. Areas located immediately adjacent to and surrounding developments tend to experience the most disturbance, but the peripheries of these areas are less disturbed and less likely to be favorable for invasive species' establishment and persistence.

Motorized and mechanized transport vehicles are another common vector of seed transport and establishment, primarily because there is minimal control over allowing weed-infested passenger and recreation vehicles to travel Forest roads and trails. See discussion under "Motorized use and access" above.

Methods used to help prevent invasive species from being introduced and spreading into recreation areas include public education and requirements for the use of weed-free hay for pack stock, in addition to weed control conducted by the Forest, contractors, and volunteer groups.

Alternative A

Under the no-action alternative, there is less limitation on the number of developed recreation sites that could be constructed than under alternatives B modified, C, and D (see t section 3.10). As a result, there could be more potential for ground disturbance under the no-action alternative and the potential for invasive species establish and spread could be greater. However, this might not be a significant difference or a noticeable increase, particularly when site-specific factors are considered, nor would it be attributable solely to activities related to recreation developments. Treatments would continue, as would prevention efforts. However, in comparing the alternatives qualitatively, the lack of a limitation on the number of recreation developments is a distinctive feature of the no-action alternative for the Flathead National Forest.

Management direction to address non-native invasive plant species is already in place and has been followed where these plants are known to occur or where potential habitat is suspected to exist. The continuation of current invasive plant species management, including the approved methods in the Flathead National Forest Noxious and Invasive Weed Control Decision Notice (USDA, 2001b), would still be available to treat infestations related to the use of recreation sites.

Alternatives B modified, C, and D

The action alternatives limit the number of recreation developments that could be constructed more than the no-action alternative does. Thus, there could be less ground disturbance under the action alternatives, and the potential for invasive species to establish and spread could be less than under the no-action alternative. However, this might not be a significant or noticeable difference, particularly when site-specific factors are considered, nor would it be attributable solely to activities related to recreation developments. Treatments would continue, as would prevention efforts. However, for comparison of alternatives qualitatively, the limit on the number of recreation developments is a distinctive feature of alternatives B modified, C, and D related to invasive species treatments.

Livestock grazing

Livestock may transport seeds from infested areas, resulting in the expansion of invasive species. However, there is not much grazing in the Flathead National Forest (refer to section 3.24). Although there is not much rangeland on the Forest, the areas that support livestock have been impacted by infestations.

Seeds can be spread through livestock feces, fleeces, and hooves, and many can pass through an animal's digestive system and retain the ability to germinate (Belsky & Gelbard, 2000). Native grazers such as

mule deer, bighorn sheep, and elk, and some birds such as mourning doves, can also spread seed in this way. Conversely, domestic livestock grazing (in a process known as prescribed grazing) has also been shown to be an effective method of managing some large invasive plant infestations while assisting the ecological succession process (Jacobs, 2007).

Localized areas where excessive grazing duration and use contributes to reduced groundcover can become potentially susceptible to invasive plant establishment, and areas with low plant cover and frequent disturbance are most at risk of invasion. These areas on the Flathead National Forest are generally roadsides, streambanks, and areas where stock congregate, such as salt blocks.

Alternatives A, B modified, C, and D

There is relatively small area on the forest subject to livestock grazing, and no change in the existing forest conditions or existing forest plan direction relative to grazing would occur under the action alternatives. Livestock grazing poses a relatively small risk of invasive weed establishment and spread on the Forest.

Fire

Fire, although it is a natural and desired ecological process, can have a detrimental impact to the ecosystem post-fire, depending on the occurrence of invasive species infestations pre-fire. Fire can result in an increase in non-native species diversity and cover, whether it is a prescribed burn or a wildfire (Zouhar, Kapler Smith, Sutherland, & Brooks, 2008). While invasive species such as cheatgrass may alter fire regimes in drier forests, shrublands and grasslands, there is no evidence that the presence of invasive plants in moister forested landscapes changes fire regimes (Keeley & McGinnis, 2007). There is little published data on the relationship between fire and invasive plant species in the moist montane forests typical of the Flathead National Forest (USDA, 2010a). Since most invasive plant species are shade intolerant, reduced light availability as the forest grows and the canopy closes may reduce invasive species over time.

Alternatives A, B modified, C, and D

Wildfires would occur in the future under all alternatives, and although uncertainty exists as to extent and location, they would be similar under all alternatives, and influenced largely by weather and climatic factors. Generally, prescribed fire implementation would be similar under all alternatives as well. There is potential for establishment and spread of invasive plant species within burned areas, depending largely upon site specific conditions, such as fire location and forest types that were burned, presence of weed infestations pre-fire, potential vectors, and fire characteristics. Weed infestations within burned areas would be addressed following forest plan management direction, which is similar and in place for all alternatives.

Consequences to non-native invasive plants from forest plan components associated with other resource programs or management activities

Effects from fire and fuels management and vegetation management activities

Undesirable effects from other resource programs would be limited to ground disturbance resulting from management activities that lead to the introduction, spread, establishment, and persistence of invasive species, as discussed above under indirect effects. Site-specific projects are evaluated under NEPA for this impact, and generally projects have requirements to address invasive species during project implementation.

Invasive species introduction, spread, establishment, and persistence has the potential to occur as a result of fire treatments, wildfire, and planned ignitions that escape controls. If this happens, treatment priorities are changed in the invasive species management program, under both the action and the no-action alternatives.

Vegetation management activities such as timber harvest, the use of skidders, and mechanical harvest techniques and equipment have contributed to the introduction, spread, establishment, and persistence of non-native invasive plants on the landscape. Harvest prescriptions cause a range of soil disturbance and canopy removal that provide suitable conditions for weeds to infest forested areas. The movement of equipment and the use of skid trails provide vectors for weed propagules to move from timber unit to timber unit. Contract specifications help prevent that introduction of weed seed to units from outside Forest Service lands by requiring the cleaning of equipment. Other weed-related best management practices include pre- and post-implementation spraying of haul routes and seeding disturbed areas after implementation to prevent establishment of infestations.

Effects from road management program

Road maintenance, reconstruction, and construction can contribute to the establishment and spread of invasive plants. Gravel pits often are infested with weeds. Weed seeds can be spread onto lands far from the gravel pit when gravel is used for road surfacing or other purposes. This effect would be the same under all alternatives. Management direction to address invasive plant species is in place for all alternatives and would continue to be followed. Gravel pits would be a priority area to consider for weed management and treatments.

Cumulative Effects

The effects that past activities have had on non-native invasive plants are discussed in the “Affected environment” section and are reflected in the current condition. Therefore, past activities are not carried forward into the cumulative effects analysis. Consequences to non-native invasive plants from forest plan components associated with other resource programs or management activities is a form of cumulative effects analysis and was discussed in the previous section.

Invasive species spread without regard to administrative boundaries. As a result, the cumulative effects of the Flathead National Forest’s treatment of weeds under any alternative, including the no-action alternative, may negatively or beneficially impact adjacent Federal, State, and private lands, depending upon the specific site treatment or lack thereof. Adjacent or nearby landowners’ specific site conditions and weed treatment efforts also affect weed conditions and treatments on Forest lands. Over 850,000 acres of non-Flathead National Forest lands (mostly private) lie within the boundaries of the geographic areas of the Forest, although most do not occur directly adjacent to Forest lands. Under all of the alternatives, coordination with State and local agencies and communication with the public would continue to combat the spread of undesirable, non-native invasive species.

Climate change

Climate change is likely to result in differing responses among invasive plant species due to differences in their ecological and life history characteristics. As documented in the Northern Rockies Adaptation Partnership vulnerability assessment (2015), climate change could result in either range expansion or contraction of an invasive species. For example, modeling indicates that leafy spurge is likely to contract and spotted knapweed is likely to shift in range. Invasive species are generally adaptable, capable of relatively rapid genetic change, and many have life history strategies (e.g., prolific seed production, extensive deep roots) that can enhance their ability to invade new areas in response to changes in ecosystem conditions. Warmer temperatures and associated drier conditions, more severe or frequent droughts, and more favorable conditions for wildland fire may increase the ability of invasive plants to

establish and outcompete native plants. These changes may provide more opportunities for invasive plants to gain an advantage over native species and spread beyond the Forest's boundaries. This potential effect is common to all alternatives.

Summary of effects to invasive plants

Alternatives B modified, C, and D update the 1986 forest plan by formalizing the current, effective invasive species management practices. These practices are administrative in nature and result in no adverse effects to the invasive species management program. The potential for invasive weed establishment and spread associated with motorized uses and ground-disturbing timber harvest activities differs between alternatives, with alternative C overall having the least potential due to the reduced area suitable for timber production, the lowest proportion of the Forest in summer motorized recreation opportunity spectrum classes, and the reduction of motorized roads and trails over time. Alternatives A, B modified, and D are more similar in their potential for weed infestation, although the substantial reduction in motorized roads and trails under alternative A compared to no reduction under alternatives B modified and D would likely be more favorable to limiting weed infestations.

Consequences to non-native invasive plants from forest plan components associated with other resource programs or management activities are similar under both the no-action and action alternatives. Suggested timing restrictions for treatments are more restrictive under alternatives B modified, C, and D. However, invasive species may be treated outside of the suggested restrictions to be effective on the landscape and to meet desired conditions for vegetation and forest resilience.

See volume 2 for the remainder of chapter 3: Affected Environment and Environmental Consequences.
The topics of chapter 3 continued in volume 2 are

- Physical and biological (sections 3.7 Wildlife, 3.8 Fire and Fuels Management, 3.9 Air Quality);
- Human uses, benefits, and designations of the Forest;
- Production of natural resources; and
- Economic, social and cultural environment.

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Index