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SWAMP EDDY

Environmental Assessment

Plains/Thompson Falls Ranger District, Lolo National Forest
Sanders County, Montana

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CHAPTER 1: PURPOSE AND NEED FOR ACTION

1.1 Introduction

The Lolo National Forest is proposing to improve the health and resiliency of forest vegetation, support the economic vitality of local rural communities, maintain a suitable transportation system, and improve resource conditions and public safety at a dispersed recreation site in the Swamp and Combest Creek drainages, which are tributary to the Clark Fork River.

This Environmental Assessment (EA) discloses the direct, indirect, and cumulative effects of the proposal to determine whether it may significantly affect the quality of the human environment and thereby require preparation of an environmental impact statement.

Preparation of this EA fulfills agency policy and direction to comply with the National Environmental Policy Act (NEPA), the Lolo National Forest Plan, 40 CFR 1508.9, 36 CFR 220.7, and other relevant federal and State laws and regulations. The reports cited in this EA and additional project documentation are contained within the project file located at the Plains/Thompson Falls Ranger District office in Plains, Montana. These documents are available upon request.

1.2 Background and Setting

The 28,000-acre project area is located about 5 miles southwest of Plains, Montana (see map in Appendix A). The area is primarily allocated to timber management and big game winter range forage production (Management Areas 16, 18, 23, 25) in the Lolo Forest Plan[1].

Since March 2016 when the proposed action was initially presented to the public, approximately 55 percent of the project area burned in the 2017 Sheep Gap Fire. Salvage of fire-killed trees on approximately 10 percent of the National Forest System (NFS) land within the burned area is ongoing to recover the economic value of forest products to contribute to employment and income in local communities. Due to the overall high severity of the fire, the need to conduct vegetation treatments to achieve forest health and resiliency objectives no longer exists currently within the fire perimeter. However, these vegetation needs remain for the unburned lands located within the project area (see section 1.3 below). As described below, providing continued support for the economic structure of local communities is still an important objective of the Swamp Eddy project.

Although some road needs were addressed during post-fire rehabilitation activities and as part of the salvage effort, additional actions are desired to achieve management objectives to maintain a suitable transportation system within the entire project area (both inside and outside the fire perimeter).

1.3 Purpose and Need for Action

The purposes of the Swamp Eddy project are to:

[1] The Forest Plan guides all natural resource management activities and establishes management standards for the Lolo National Forest. It described resource management practices, levels of resource production and management, and the availability and suitability of lands for resource management.

- Restore vegetation conditions that are resilient to natural disturbances such as fires, insects, disease, drought, and other environmental shifts so ecological processes will sustain composition, structure, species, and genetic diversity in the future.
    - Re-establish a mosaic of tree age, species, and size classes across the landscape in varying patch sizes
    - Promote ponderosa pine, western larch, and western white pine
    - Reduce forest fuels
- Provide wood products that contribute to local and regional economies and the sustainable supply of timber from National Forest System lands.
- Maintain a suitable transportation system to support long-term land management and public uses and reduce adverse environmental effects.
- Reduce resource damage and provide for public health and safety at the mouth of Swamp dispersed recreation site.

Restore Resilient[2] Vegetative Conditions

The Lolo Forest Plan provides for the maintenance of a diverse mosaic of vegetation development well-distributed across the Forest to ensure ecological integrity (Forest Plan, page II-2). Most of the land within the Swamp Eddy area is allocated to Forest Plan management areas that emphasize maintaining forest health. Healthy, resilient landscapes have a greater capacity to survive natural disturbances and large-scale threats to sustainability.

Natural events and past land uses have led to the current environmental conditions of the area, resulting in the need to conduct management activities. Fire is the primary natural disturbance process that historically affected vegetation patterns in western Montana. However, naturally ignited fire has been suppressed since the early 20th century due to Agency policy and values at risk. Prior to the advent of active fire suppression, fires generally occurred within the Swamp Eddy area about every ten to twenty years, burning from 5 to 1500 acres at varying severities depending on fuel conditions, topography, and weather. The result was a mosaic of tree densities, and size and age classes across the landscape. Before the 2017 Sheep Gap Fire, fire had been nearly absent within the project area for about 100 years.

Fire exclusion and vegetative development have resulted in denser stand conditions than historic reference conditions (Hessburg et al. 1999). Current conditions in the unburned portion of the project area are more likely to support stand-replacing fires as experienced in the 2017 Sheep Gap Fire. Increased stand density causes tree stress due to competition for water, light, and nutrients. Stressed trees are more susceptible to insects, diseases, and drought. Restoring resilience in these forest types means restoring and maintaining stand structures, species composition, and stand densities that are more likely to support low- and mixed-severity wildfire and reduce inter-tree competition in the future (Peterson et al. 2005; Noss et al. 2006; Drever et al. 2006; Hessburg et al. 2005).

[2] Forest Service Manual 2020 defines resilience as the ability of an ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Certified silviculturists and Forest Service Regional insect and disease experts reviewed the unburned portion of the project area and identified four primary pathogens of concern including root disease, Douglas-fir beetle, western pine beetle, and mountain pine beetle. Although naturally occurring, these agents have greater impact today due to the altered forest composition which has led to more uniformity in tree species, density, size, and age compared to historic conditions.

Over 70 percent of the project area has a moderate or high root disease hazard rating. Field reviews validated the presence of root disease with overstory tree mortality ranging from observable to over 50 percent in affected stands (Lockman et al. 2016). Douglas-fir and true firs are the most susceptible species to the primary root disease found on site. The forest in Swamp Eddy is dominated by Douglas-fir cover types with mixes of ponderosa pine, larch, and lodgepole pine in various proportions with the Douglas-fir.

Douglas-fir beetles, which tend to kill large, old Douglas-fir trees, are attracted to trees weakened by fire, drought, defoliation, or root disease. Dense stands have higher susceptibility (Kegley 2004). Approximately 40 percent of the project area has a moderate to high hazard, meaning there is potential for 10 to 30 percent loss of basal area[3]. The hazard is likely even higher due to the 2017 Sheep Gap Fire because fire-damaged trees are more attractive to bark beetles. The combination of a landscape dominated by sites with root disease and Douglas-fir cover type results in on-going and foreseeable mortality from the interaction between Douglas-fir beetles and root disease, and from each pathogen individually.

Ponderosa pine and lodgepole pine stands within the project area have moderate to high hazard for western and mountain pine beetles due to tree size and density. Past and ongoing mortality from these beetles is evident. Western pine beetles typically kill large, old ponderosa pine trees, but in recent decades have become more aggressive in dense stands of younger ponderosa pine. Mountain pine beetles generally attack mature lodgepole pine and young ponderosa pine trees. Beetle outbreaks are dependent on several factors including favorable climatic and stand conditions and proximity to an existing beetle population. Extensive tree mortality from mountain pine beetle outbreaks can substantially alter vegetation successional pathways. Late successional, shade tolerant, fire intolerant, and insect- and disease-susceptible species such as subalpine fir or Douglas-fir often replace the pine that have been killed by mountain pine beetles in the absence of fire (Gibson et al. 2009). This conversion to less resilient species composition is apparent in mid- and upper-elevation areas within the Swamp Eddy project area.

Restoring resistance to bark beetles means restoring and maintaining more open (less dense) stand structures to both reduce tree stress and beetle habitat suitability, increase age class diversity to reduce the continuity of suitable beetle habitat, and increase species diversity to increase spatial heterogeneity across landscapes (Fettig et al. 2013).

In the Swamp Eddy project, a host of scientifically-based treatments, including timber harvest, prescribed burning, and non-commercial mechanical treatments are proposed to achieve the project's vegetation objectives.

Support Communities

One of the goals outlined in the Lolo Forest Plan is to provide a sustained yield of timber and other outputs at a level that will help support the economic structure of local communities and provide for

[3] Basal area is a measure of tree density per acre based on the total area in square feet of the cross-section of tree trunks measured 4.5 feet above the ground on an acre of land.

regional and national needs (Forest Plan, page II-1). Approximately 30 percent of the NFS land within the project area is allocated in the Lolo Forest Plan to be managed with an emphasis toward timber production. Another 40 percent of the NFS land within the Swamp Eddy area is identified in the Forest Plan as suitable[4] for timber harvest with objectives that include providing for healthy stands of timber.

The Swamp Eddy project lies within Sanders County, of which 52 percent of the land base is NFS land. Thus, the local community has significant social and economic ties to NFS lands. According to the U.S. Department of Labor, Sanders County currently has one of the highest unemployment rates in the state (nearly twice the state average, ranking 5th out of 56 counties in terms of highest unemployment). Management decisions made by the Forest Service can have an impact on the economies of smaller, resource-based communities. Economic effects can include changes in local employment and income, and changes in local services and community infrastructure. Forest products resulting from management activities on NFS lands contribute to the local economy and to the sustainability of the forest products industry.

Currently, Montana's forest products industry is one of the largest components of manufacturing in the state and employs roughly 7,700 workers earning about $335 million in compensation annually, with most of the industry centered in western Montana where the Swamp Eddy project is located. (Morgan et al. 2015). Most Montana mills are operating at less than full capacity and require an adequate supply of timber to remain viable and meet market demand (Morgan et al. 2015, 2017)

The Swamp Eddy project includes commercial timber harvest treatments that would yield various wood products to local and regional forest industries. Two lumber mills are located within about 30 miles of the project area by paved road. In addition, treatments would result in resilient forests which would continue to grow and maintain future opportunities for sustainable products removal.

Maintain a Suitable Transportation System

The Lolo Forest Plan directs that roads be kept to the minimum number and size needed to meet user and resource needs (Forest Plan, pages II-2 and II-17).

Within the Swamp Eddy project area, there are approximately 115 miles of system roads under Forest Service jurisdiction that are recorded and tracked in the Agency's road atlas. In addition, during the assessment of the project area, another 90 miles of non-system[5] roads were identified on NFS lands. As described above, most of the project area is allocated in the Forest Plan as suitable for timber production and thus a well-designed road system is necessary to provide access for management activities.

The Forest Service conducted a project-level Travel Analysis to determine which roads are needed (e.g. access for land management activities, recreation, and access to other ownerships) and to identify

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[4] The Lolo National Forest Plan defines suitable forest lands as "land for which technology is available that will ensure timber production without irreversible resource damage to soils, productivity, or watershed conditions, for which there is reasonable assurance that such lands can be adequately restocked, and for which there is management direction that indicates that timber production is an appropriate use of that area" (Lolo Forest Plan, page VII-40 and 36 CFR 219.12)

[5]Non-system roads are old (relic) roads that are not recorded in the Forest Service road atlas. Most of these roads were constructed prior to 1970 to provide access for timber harvest. Although their prisms still exist on the landscape, most of these roads have since been abandoned and most are heavily vegetated with brush and/or trees and are currently impassable. Due to the capabilities of today's timber harvesting equipment, many of these roads are not needed for land management activities.

resource concerns. The Travel Analysis also identified the need to conduct maintenance on some existing roads and adopt some of the non-system roads to the National Forest road system.

The Swamp Eddy project would balance access needs and desired uses while addressing resource concerns and budgetary constraints to maintain a suitable transportation system into the future.

Reduce Resource Damage and Provide for Public Health and Safety

One of the Forest Plan goals is to provide for a broad spectrum of dispersed recreation (Forest Plan, page II-1). The mouth of Swamp dispersed recreation site is located on the Clark Fork River and is popular with local residents for swimming, boating (mostly non-motorized), general day-use, and overnight camping. This is one of the few public access points to the river in the Plains area. The amount of summer use has resulted in concerns about sanitation, safety, and resource impacts. For example, the road into and within the site is in poor condition and unauthorized off-road motor vehicle use is causing riverbank erosion.

The Swamp Eddy project would reconstruct the access road, confine motorized use to designated roads and established camping areas, develop non-motorized trails to concentrate use in appropriate areas, and install a vault toilet. The proposal is designed to accommodate public use and protect natural resources, without substantially altering the site's character or general recreational experience of visitors.

1.4 Original Proposed Action

The original proposed action was developed to address the purposes and needs for action as described above. The proposed action was later modified in response to the effects of the Sheep Gap Fire, as described in Chapter 2 and analyzed in Chapter 3 of this document.

The original proposed action included approximately 3,779 acres of timber harvest and 4,449 acres of non-commercial treatments. To access vegetation treatment areas, approximately 8.6 miles of new road (including temporary and long-term specified) was proposed for construction. The proposed action also contained several road management activities including road decommissioning (78 miles); adding existing non-system roads to the National Forest system (16 miles); road maintenance (91 miles); storage (1 mile); culvert replacements (2); and improving the access to the mouth of Swamp dispersed recreation site to accommodate current use and address resource concerns. A Forest Plan amendment was included to correct management area allocation mapping errors.

Design criteria were included in the proposed action to minimize and/or avoid potential environmental impacts. These design criteria are incorporated into the modified proposed action and reflected in the resource protection measures (see section 2.2.1).

1.4.1 Design Criteria

Project-level design features were identified upfront to protect resources in the area. The design features are based on Forest Plan direction, relevant science, and site-specific evaluations. Design features include best management practices (BMPs), which minimize effects on soil and water resources. For harvest and road management activities, BMPs are designed to assure compliance with the Clean Water Act and State of Montana water quality standards.

- Large trees, as appropriate for the forest type, would be retained to the extent that the trees promote stands that are resilient to insects and disease.

- Vegetation treatments would be designed to be consistent with relevant scientific information to maintain or restore ecological integrity, including maintaining or restoring structure, function, and composition.
- Fire-tolerant trees, primarily larch and ponderosa pine, would be retained, but a mix of trees of all species in a stand would be represented after treatment.
- Machine operations would occur when soils are dry or frozen.
- Off-road equipment would be washed prior to entry into the project area to reduce the risk of weed establishment and spread.
- Wildlife features such as wallows, mineral licks, and seeps would be protected.
- Woody debris and snags would be left within all vegetation management treatment areas at levels outlined in the Lolo National Forest Coarse Woody Material Guide and Forest Plan to provide for soil productivity and wildlife habitat.
- Forestry Best Management Practices would be utilized to minimize effects to soil and water.
- No harvest treatments would occur within riparian areas to protect streams and other aquatic features.

1.5 Public Involvement

Collaboration

In August 2014, a letter was sent to over 200 individuals and organizations inviting them to participate in a collaborative effort to help in the development of site-specific projects on NFS lands in Sanders County. Several people including local residents, County Commissioners, Sanders County Resource Advisory Committee (RAC) members, representatives of timber industry, Montana Department of Natural Resources and Conservation, and other organizations responded. Discussions regarding the Swamp Eddy project began in April 2015 at a meeting held in the Sanders County Courthouse. On October 14, 2015, the Forest Service sponsored a public fieldtrip to the project area. The Forest Service used the valuable input from the collaborative participants to develop the proposed action for the project.

In addition to the project's natural resource objectives, collaborative participants wanted to highlight the social and economic benefits this project would provide to the public, including enhanced recreation opportunities, employment, and income within Sanders County.

In October 2018, the Sanders County Collaborative requested that the Swamp Eddy project be continued after the Sheep Gap Fire (letter dated 10/26/2018). Members felt that the reasons the area was originally identified for treatment are still valid outside the fire perimeter. They believe the Swamp Eddy project will contribute to one of their group's stated goals, which is to help improve the economic stability of Sanders County (ibid.).

On December 12, 2018, the Forest Service met with the Sanders County Collaborative to share what the modified project proposal would likely include. The members expressed their support.

Scoping

On March 28, 2016, a scoping letter soliciting comments on the proposed action was mailed to 175 landowners, organizations, other agencies, and individuals who had previously requested notification about the types of activities included in the project. The scoping letter and associated map were posted on the Lolo National Forest website. A legal notice requesting comments was published in the *Missoulian* newspaper on March 31, 2016.

A project announcement and public meeting notice was published in the *Clark Fork Valley Press* and *Sanders County Ledger* on April 6th and 7th, respectively. The Forest Service held a public meeting on April 12th to share information about the project and encourage public comment. Twelve people attended the meeting.

At the completion of the scoping period, eleven letters had been received.

Agencies and Persons Consulted

The Forest Service consulted the following organizations, Federal, State, tribal, and local agencies and tribes while preparing this environmental assessment:

Federal, State, and Local Agencies:

U.S. Fish and Wildlife Service
Montana Department of Environmental Quality
Montana State Historic Preservation Office
Montana Department of Fish, Wildlife, and Parks
Sanders County Commissioners

Tribes:

Confederated Salish and Kootenai Tribes

1.5.1 Issue Resolution

Public comments were reviewed to identify concerns and issues relative to the Proposed Action. Most comments were supportive of the overall project, but there were a few concerns expressed about the project's potential effects to water quality and public motorized access. These concerns were addressed: 1) in project design; 2) by creating resource protection measures; and 3) through analysis to determine environmental effects. The issues raised during scoping and how they were addressed are briefly summarized below.

- Road closures could affect public motorized access.

  Project design considered public access. Travel analysis was completed to address long-term transportation needs for land management and public access. As displayed in Chapter 3, section 3.6, public access would not measurably change. Although 79 miles of road would be decommissioned, most are non-system roads on which public motorized travel is not permitted and/or are undrivable due to vegetation growth on the roadway.

  Approximately 1 mile of non-system road would be added to the National Forest system and designated as open yearlong to public motorized use. However, public use is already occurring on these roads, most of which are located at the mouth of Swamp dispersed recreation site and one segment accesses state land in lower Swamp Creek. About 1 mile of National Forest system road (NFSR) designated as open yearlong to public motorized use *would be decommissioned. This road (NFSR 17350) is currently undrivable due to vegetation. Thus, public motorized access would remain essentially the same as it is now.*

- Mixed severity prescribed burning could damage/destroy merchantable timber.

  Approximately 750 acres of mixed severity prescribed burning is proposed within the Cherry Peak Inventoried Roadless Area (IRA) and within Forest Plan Management Area 11 (large roadless blocks). The Lolo Forest Plan designates MA 11 as unsuitable for timber production and timber harvest is generally not permitted. Tree cutting within this MA is limited to that required to eliminate safety hazards or permit trail construction (Forest Plan, page III-32). However, prescribed burning is permitted to maintain or restore the composition and structures of plant communities or for hazard reduction purposes (Forest Plan, page III-33).

- Timber harvest and road construction could adversely affect environmental resources, including water quality, aquatic habitat, and wildlife habitat.

  Chapter 3 discloses the effects of timber harvest and road management activities on forest resources. The analysis concludes that the project would not have significant adverse effect on the environment. Resource protection measures (Chapter 2, section 2.1.1), best management practices, and project design would minimize adverse effects to soils, water, fisheries and wildlife, and reduce the risk of weed establishment and spread.

  The Modified Proposed Action does not include any permanent road construction but does contain approximately 2.6 miles of temporary road construction. Temporary roads would be situated in upper slope locations and not cross streams. Following use for this project, temporary roads would be decommissioned by recontouring the ground back to the original slope as much as possible.

- Regeneration harvest could adversely affect wildlife cover/security, particularly considering past harvest on State and private industrial timber lands.

  Chapter 3 discloses the direct, indirect, and cumulative effects of regeneration harvest. The analysis concludes that the project would not have significant adverse effect on the environment.

- Project activities could exacerbate weed establishment and spread.

  As described in Chapter 2 (sections 2.1.1 and 2.1.2) and Chapter 3 (section 3.2.2), the Swamp Eddy project includes resource protection measures and monitoring requirements to minimize the potential for weed establishment and spread. Haul roads and landings would be treated with herbicide prior to use. After project completion, monitoring for the presence of new weed infestations would be conducted. Additional weed treatments would be applied as needed.

  One commenter was particularly concerned about the potential effects of prescribed burning in unit LS21 adjacent to their land. This area had a similar low severity prescribed burn treatment in 2004 with planned follow-up herbicide treatments. However, post-burn monitoring determined herbicide treatments were not necessary. Unit LS21 would likely have a similar prescription; a low-severity burn with follow-up herbicide treatment as necessary. Resource protection measure #9 applies to prescribed burning. Prior to burn operations, the District weed coordinator would survey the area to determine weed presence and make site-specific recommendations for burn activities. Prescribed burning in dry habitats like LS21, *are required to occur in the spring or during spring-like conditions in the fall when soil moisture is higher to minimize duff consumption mineral soil exposure.*

CHAPTER 2: ALTERNATIVES

Section 102(2)(E) of the National Environmental Policy Act (NEPA) requires the Forest Service to study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources. The project was designed to minimize effects on the environment and address and resolve the issues described above. There are no unresolved issues that drove the need to develop additional alternatives.

2.1 Alternatives

No Action

The no action alternative closely correlates with the existing condition and is a management option that could be selected by the Responsible Official.

No action would continue the standard resource protection and recurrent maintenance activities such as access management and routine scheduled road maintenance that are currently ongoing in the project area. Ecosystem processes such as vegetation succession would continue their current trends.

Stands with low to moderate levels of root disease and dominated by root disease susceptible species would continue to suffer mortality and would lose basal area over time. If there is a component of root disease-tolerant species, such as western larch or ponderosa pine, then the species composition may slowly shift towards those species if natural disturbances provide sites with suitable environmental conditions for their establishment and growth. But without disturbance, such as fire, the stands would continue to regenerate to root disease susceptible species and would continue to experience losses from root disease. (Lockman and Egan 2016). Approximately 70 percent of the project area has moderate to high hazard and risk of loss to root diseases.

Dense stands dominated by mid-sized Douglas-fir would continue to grow and increase in their susceptibility to Douglas-fir beetles through the management horizon of this project. In general, Douglas-fir beetle outbreaks require susceptible host, conducive weather conditions, and amplified beetle populations (typically resulting from a catalyst such as windthrow, fire-injury, migration from surrounding area, etc.). For these factors, it is known that forest conditions are currently susceptible, and this susceptibility would increase through time. It is reasonable to assume that within the subsequent near-future (20-30 years) substantial and protracted drought will occur, likely multiple times. What is unknown, and impossible to predict, is whether Douglas-fir beetle populations will increase to cause outbreak-level mortality specifically within this project area. (Lockman and Egan 2016)

Similarly, dense stands dominated by lodgepole pine or ponderosa pine would continue to grow and increase in their susceptibility to western and mountain pine beetles. In general, mountain and western pine beetle outbreaks require a susceptible host, conducive weather conditions, amplified beetle population within the stand or migration from the surrounding area. The Swamp Eddy project area has forest conditions that are currently susceptible, and susceptibility will increase through time. While western and mountain pine beetles outbreaks have already occurred in the area, it is unknown and impossible to predict whether pine beetle populations will increase again to cause outbreak-level mortality specifically within the project area.

Fuel hazard would be maintained at current increasing levels in stands that are not treated. The west half of the project area had fuels reduced by the 2017 Sheep Gap Fire. Where the fire burned at low severity, ground and surface fuels were reduced and the lower canopy base height was raised. Where the fire burned at mixed and high severity, crown fuels were also reduced through active and passive crown fires that killed or scorched crowns, resulting in reduced fuel continuity. The east half of the project area has similar dense crowns and fuel accumulation as the pre-Sheep Gap Fire area, so it can be expected to burn similarly under similar weather conditions. Crown and surface fuels would continue to accumulate as trees grow and die from insects, disease, and inter-tree competition.

Drought susceptibility and susceptibility to environmental shift would be maintained at current and increasing levels. In the west half of the project area, the 2017 Sheep Gap Fire reduced stand densities, featured fire-tolerant species, and diversified age classes. The long-term effects are not yet known, and the hazard posed by drought and climate change depends largely on establishment and development of regeneration in severely burned areas and under trees that had lower severity burns. The east half of the project area would maintain dense crowns with continued mortality from inter-tree competition for water, light, and nutrients and the resulting effects of insects and disease.

Modified Proposed Action

As previously described, the original proposed action was modified in response to the 2017 Sheep Gap Fire. The modified proposed action would conduct commercial and non-commercial vegetation treatments to address disease and insect concerns and reduce fuels on approximately 3,472 acres outside the 2017 Sheep Gap Fire perimeter (see Table 2-1). The project contains road management activities, including maintenance, decommissioning, and temporary road construction (see Table 2-3). Refer to Appendix A for the maps and Appendix B for unit- and road-specific information. Also included are recreation management activities at the mouth of Swamp dispersed recreation site.

Vegetation Management Activities

Table 2-1: Summary of Vegetation Treatments (refer to Map 1)

Treatment Type	Acres
Commercial Treatments	
Intermediate Timber Harvest	283
Small Tree Commercial Thin	210
Regeneration Timber Harvest	1,162
Subtotal	1,655
Non-commercial Treatments	
Non-commercial Thin (acres)	278
Mixed Severity Prescribed Burn (acres)	741
Low Severity Prescribed Burn (acres)	687
Subtotal	1,706

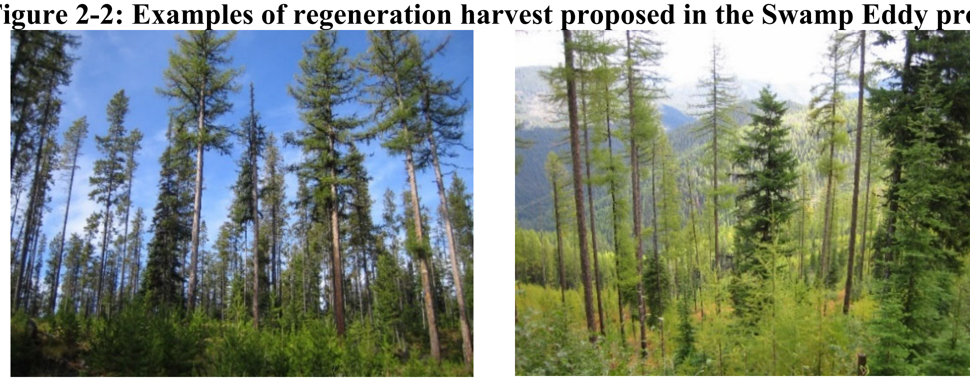
Intermediate Timber Harvest treatments (e.g. commercial thinning) are designed to enhance growth, quality, vigor, and composition of the existing stand. Generally smaller trees are removed from the lower and main canopy, retaining the larger trees of desired fire-tolerant species with gaps between the crowns. Within some stands, prescribed fire would be applied following harvest activities.

Figure 2-1: Examples of intermediate harvest proposed in the Swamp Eddy project

Small Tree Commercial Thinning would occur within ponderosa pine plantations that originated from timber harvest and subsequent planting in the 1960s. Today, these stands are densely stocked with trees that range in size from 5 to 10 inches in diameter and are at high risk to insect-induced mortality. Commercial thinning would remove smaller trees from the lower and main canopy.

Regeneration Timber Harvest treatments are designed to replace the existing stand with a stand that has a species composition and stocking density that meets desired future conditions specified in management objectives. Regeneration harvests are proposed where stand conditions (insects, disease, blowdown, etc.) do not meet and are not projected to meet desired conditions and where intermediate harvest cannot alter stand development to a desired condition. Prescribed fire would be applied following harvest to reduce fuel and prepare the site for natural regeneration or planting. Natural regeneration is expected at various densities and species, and most of these units would be planted to ensure regeneration of larch, ponderosa pine, and blister rust-resistant white pine.

Figure 2-2: Examples of regeneration harvest proposed in the Swamp Eddy project



Non-commercial thinning would occur in young (20-40 years old) stands to remove smaller trees from the lower and main canopy, retaining the larger trees of desired fire-tolerant species with gaps between crowns. This would provide growing space to reduce competitive stress, resulting in trees that grow bigger faster, develop characteristics that increase fire-tolerance both at individual tree and at stand levels, and better resist some of the most damaging insects and diseases. The resulting stand densities would typically be between 110 and 170 trees per acre, but that would vary by species distribution and tree sizes. The trees cut during this process would be left on site and allowed to decompose back into the soil.

Low Severity Prescribed Burn treatments would primarily be low intensity surface fire. This type of burning is proposed on the drier ponderosa pine/Douglas-fir forest types where wildfire historically burned at frequent intervals, with low to mixed severities. This burning would be used to improve big game winter range areas and forest stand resilience.

Mixed Severity Prescribed Burn treatments would be a combination of low to moderate severity surface fire with areas that would likely burn at high severity where surface fuels are heavy. This type of prescribed burning is primarily proposed in mixed conifer forest types where there is existing tree mortality.

Forest Openings Greater Than 40 Acres

Forest Service Manual (FSM) 2470, Section 2471.1, Region 1 Supplement 2400-2001-2 generally limits the size of harvest openings to 40 acres or less. To exceed this size, Regional Forester approval is required except where natural catastrophic events (such as fire, windstorms, or insects and disease attacks) have occurred. Several regeneration harvest treatment areas could create forest openings that exceed 40 acres in size due to existing conditions (i.e. insects and disease). These larger openings could range in size from 41 to about 224 acres, mimicking natural disturbance patterns. Varying densities of trees would be retained within these areas, from scattered individuals to groups consisting of the largest, healthiest trees (see Figure 2-2). Compared to intermediate harvest areas and untreated forests, regenerated areas would appear as openings until new trees grow to fill the site.

The following table describes existing and desired conditions for each unit or set of units and why the size is important. Most of the units would likely be smaller than indicated due to logging system limitations, stream buffers, and other resource considerations, but they would still likely exceed 40 acres.

Table 2-2: Summary of Treatments Resulting in Forest Openings Greater than 40 Acres

Unit(s)	Acres	Condition
C12	42	Existing Condition: Stand consists of scattered overstory Douglas-fir (DF) and western larch (WL) from previous harvest that established and released shade-tolerant understory. Mid and understory is dominated by grand fir (GF) with subalpine fir (AF), mountain hemlock (MH), Engelmann spruce (ES), western redcedar (WRC). Root disease is throughout the unit causing mortality in the firs. Stand resilience to fire, disease, drought, climate change has been lost. Dense flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand is becoming primarily root disease susceptible species with ongoing mortality and increasing fuel load. Stocking level and high water demanding species are susceptible to mortality from extended drought and warm temperatures expected with climate change. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and reestablish blister rust-resistant western white pine (WP), which would improve resilience to all anticipated disturbance agents. Opening size treats all of the accessible stand.
C21	41	Existing Condition: Stands consist of GF dominated overstory with shade-tolerant understory. Root disease and indian paint fungus throughout the units are causing decay and mortality in the firs. WL stumps and snags indicate shift of forest type. Stand resilience to fire, disease, drought, climate change has been lost. Flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand has ongoing mortality and increasing fuel load. Stocking level and high water demanding species are susceptible to mortality from extended drought and warm temperatures
S43, S54, S57, S96X, S97X	87	

Unit(s)	Acres	Condition
		expected with climate change. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and reestablish blister rust-resistant WP, which would improve resilience to all anticipated disturbance agents. Opening size is required to treat the entire stand without leaving untreated patches susceptible to accelerated root disease-caused mortality and blowdown.
C16, C16X, C17, C17X, C18, C38X	192	Existing Condition: Stands consist of lodgepole pine (LP) dominated stands with mixes of GF and DF. High bark beetle-caused mortality in LP has created high surface woody fuel buildup and left intermediate and suppressed LP crown classes. Desired Condition: Regeneration harvest would provide WL and rust-resistant WP for long-term fire resilience, provide seed sources for recovery after major disturbances, replace a forest floor of wood and litter with grasses and shrubs for herbivores. Size is desirable to treat the entire natural lodgepole pine stand.
C14, C15, C39X, C41X, C42X, C44X	224	Existing Condition: Stands consist of GF, LP, DF dominated overstory with shade-tolerant understory. Root disease and indian paint fungus throughout the units are causing decay and mortality in the firs. WL stumps and snags indicate shift of forest type. Stand resilience to fire, disease, drought, climate change has been lost. Flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand has ongoing mortality and increasing fuel load. Stocking level and high water demanding species are susceptible to mortality from extended drought and warm temperatures expected with climate change. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and blister rust-resistant WP, which would improve resilience to all anticipated disturbance agents. Opening size is required to treat the entire stand without leaving untreated patches susceptible to accelerated root disease-caused mortality and blowdown.
C06, S90X, S92X	95	
C01, S42, S69, S70, S91X	114	
S71, S74, S74X	49	Existing Condition: Stand consists of GF, WL, DF dominated overstory with shade-tolerant understory. Root disease and indian paint fungus throughout the units are causing decay and mortality in the firs. Larch with stumps and snags indicate shift of forest type. Stand resilience to fire, disease, drought, climate change has been lost. Flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand has ongoing mortality and increasing fuel load. Stocking level and high water demanding species are susceptible to mortality from extended drought and warm temperatures expected with climate change. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and blister rust-resistant WP, which would improve resilience to all anticipated disturbance agents. Opening size is required to treat the entire stand without leaving untreated patches susceptible to accelerated root disease-caused mortality and blowdown.
S04, S04X	51	Existing Condition: LP-dominated stands with mixes of WL and DF. High bark beetle-caused mortality in LP has created high surface woody fuel buildup and left intermediate and suppressed LP crown classes. Desired Condition: Regeneration would provide WL and rust-resistant WP for long-term fire resilience, provide seed sources for recovery after major disturbances, and replace a forest floor of wood and litter with grasses and shrubs for herbivores. Size is desirable to treat the entire natural lodgepole pine stand.

Unit(s)	Acres	Condition
S45, S45X, S72	59	Existing Condition: Stands consist of a DF dominated overstory with WL, LP with shade-tolerant understory and areas with high LP mortality. Root disease pockets throughout the units are causing mortality in the firs. Larch are infected with dwarf mistletoe. Stand resilience to fire, disease, drought, climate change is decreasing. Flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand has ongoing mortality and increasing fuel load. Stocking level and species are susceptible to mortality from extended drought and warm temperatures expected with climate change in part due to increasing bark beetle susceptibility. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and blister rust-resistant WP, which would improve resilience to all anticipated disturbance agents. Opening size is required to treat the entire stand without leaving untreated patches susceptible to accelerated root disease-caused mortality and blowdown.
S07, S08, S89	64	Existing Condition: Stands consist of a DF and WL dominated overstory with LP and GF with shade-tolerant understory. There are areas with high LP mortality. Root disease pockets throughout the unit are causing mortality in the firs. Larch is infested with dwarf mistletoe. There are areas of previous salvage harvest with an under- and mid-story of GF. Stand resilience to fire, disease, drought, climate change is decreasing. Flammable lower canopy crowns serve as ladder fuel to carry flames to the overstory. Stand has ongoing mortality and increased fuel load. Stocking level and species are susceptible to mortality from extended drought and warm temperatures expected with climate change in part due to increasing bark beetle susceptibility and stress from dwarf mistletoe. Desired Condition: Regeneration harvest would retain fire-tolerant, root disease-resistant, moderately drought tolerant WL and PP, which would improve resilience to all anticipated disturbance agents. Opening size is required to treat the entire stand without leaving untreated patches susceptible to accelerated root disease-caused mortality and blowdown.

Road Management Activities

- Herbicide treatment of weeds would occur as needed on roads not currently drivable that would be opened for access to timber harvest units and/or those to be physically stored or decommissioned. Weed treatments on drivable roads within the project area are already authorized under the 2007 Lolo National Forest Integrated Weed Management Record of Decision (see Section 3.1 in Chapter 3).

Table 2-3: Summary of Road Management Activities (refer to Map 2)

Road Management Activity	Miles
Maintenance	47
Temporary Road Construction (multiple segments ranging from 0.1 to 0.8 miles in length)	2.6
Decommission[1]	**Total: 79**
System Roads (no physical treatment)	6
Non-system Roads	73
Physical closure	4
Administrative closure (no physical treatment)	69
Add Existing Non-system roads to the National Forest System	**Total: 16**
Add existing non-system roads and keep open yearlong for public motorized use	1

Road Management Activity	Miles
Add existing non-system roads and close yearlong to public motorized use	2
Add existing non-system roads and store	13
Convert Existing Non-system Road to Non-motorized Trail	0.4

[1]See Table 2-4 below for closure method. Proposed road decommissioning would not reduce existing legal, currently drivable public motorized access.

Maintenance activities would include surface blading, minor earth work (e.g. cut and fill shaping), road surface shaping, ditch cleaning and reshaping, roadside clearing and/or brushing, seeding disturbed areas, drain dip and cross drain cleaning and construction, culvert cleaning, armoring, and/or replacement, slash filter windrow and sediment trap construction near live water crossings. Because these roads are intended for long-term access, and many would remain open to public travel, work would be performed to minimize environmental impacts and to provide a safe and stable road.

Temporary roads would be constructed to a minimal standard to provide access for timber harvesting equipment and log trucks. These roads would be decommissioned following use for this project. Decommissioning of the roads would generally include replacing overburden (excavated soils) back onto the road prism to return the ground to its natural contour as much as possible, placing woody debris on the disturbed area, and seeding the disturbed soil.

Decommissioning treatments would occur on roads not needed for future use. Activities could vary from full recontouring of roads found to be causing resource impacts to no treatment of roads that are fully revegetated, contain no stream crossings, and have no associated resource impacts (see Table 2-4 for proposed decommissioning treatments). Road decommissioning in this project would not affect currently drivable, legal public motorized access.

Add non-system roads to the National Forest road system: Approximately 16 miles of existing non-system roads were identified as needed over the long-term and would be adopted to the National Forest road system:

- Approximately 1 mile of these roads would be added to the system as open yearlong for public motorized use. These roads are currently drivable and primarily associated with the mouth of Swamp dispersed recreation site and one segment provides access to State land in lower Swamp Creek.
- Approximately 2 miles are located behind yearlong closed gates and would be available for administrative use only.
- The remaining 13 miles would be placed in storage and available for administrative use when needed at some time in the future.

Convert Existing non-system road to non-motorized trail: A short segment of a non-system road would be converted to a trail and used to connect the Sacajawea Peak trail #385 to NFSR 7581.

Table 2-4: Road Decommissioning and Storage Levels for Existing Roads

Road Treatments	Miles
Road Decommissioning	**79**
3D	2
5	2
3DN (Administrative)	75
Road Storage (roads to be added to the system)	**13**

Road Treatments	Miles
3S	2
3SN	11

Decommission Level 3D: Closure activities would include road surface ripping (de-compaction) along the entire length of the roadway, placement of woody debris on the road surface, removal of structures (culverts, bridges) and reshaping of stream crossings to natural contours, installation of water bars at frequent intervals, seeding of the road prism, and recontouring the entrance of the road. On flatter terrain, boulders could be used to close the road entrance.

Decommission Level 5: Closure activities would include full recontouring; replacing overburden (excavated soils) back onto the road prism to return the ground to its natural contour, removal of structures (culverts, bridges) and reshaping of stream crossings to natural contours, placing woody debris upon the disturbed area, and seeding and fertilizing the disturbed soil.

Decommission Level 3DN (Administrative closure): These roads are already revegetated with brush and trees, and no physical activities would be conducted on the ground. The intention of this treatment is to administratively decommission roads without re-disturbing road surfaces that are already stable from natural processes.

Storage Level 3S: Closure activities would be the same as those described for Decommission Level 3D. However, the roads to be stored are needed for long-term access and would be reopened in the future when needed.

Storage Level 3SN (Administrative storage): Roads to be added to the system that are needed for long-term access, but not in the near future. No physical treatments would occur as these roads are already in a stored condition.

Recreation Management Activities (refer to Site Plan in Appendix A)

Project activities at the mouth of Swamp dispersed recreation site to reduce resource damage and provide for public safety and sanitation include:

- reconstruction and realignment of the access road
- development/designation of a parking area outside the riparian zone
- placement of boulders and/or other natural materials to confine motorized use to the designated road and established camping areas.
- development of non-motorized trails to concentrate use in appropriate areas
- installation of a vault toilet

Forest Plan Amendment

The project would amend the Lolo Forest Plan by changing the management area designation on two parcels of land that were incorrectly mapped near Combest Peak during the development of the 1986 Lolo Forest Plan (see map in Appendix A):

- Approximately 481 acres would be changed from Management Area 27 (land where timber management is not economically or environmentally feasible due to physical features of the parcels) to Management Area 25 (land with a medium degree of visual sensitivity and is available for varying degrees of timber management), which is the current allocation of adjacent lands.

- Approximately 46 acres would be changed from Management Area 27 (land where timber management is not economically or environmentally feasible due to physical features of the parcels) to Management Area 16 (timber management), which the current allocation of adjacent lands.

Forest Plan amendments initiated after May 9, 2015 are governed under the 2012 Planning Rule (36 CFR 219 Subpart A). This amendment would be consistent with the substantive requirements outlined in the 2012 Planning Rule. This minor modification of management area allocation would not affect the Forest Plan's overall framework, which provides for sustainability, diversity, and multiple uses.

This amendment would result in an increase of 527 acres to the timber suitable base, which equates to approximately 0.02 percent of the acres contained within the Lolo National Forest. These areas were field-reviewed by Forest Service resource specialists and determined to be suitable for timber management. At the Forest-scale, this change would be insignificant. The Forest Plan acknowledges that the management area boundaries are not firm lines but represent a transition from one set of opportunities and constraints to another with management area direction established for each. Management area boundaries are flexible to assure that the values identified are protected and to incorporate additional information gained from further on-the-ground reconnaissance and project-level planning (Forest Plan, page III-1). Site-specific data collected for the Swamp Eddy project environmental analysis served as a check on the corrections of land allocations in the Plan (Forest Plan, page V-2).

This amendment is needed for approximately 40 acres of timber harvest displayed in Table 2-1.

2.1.1 Resource Protection Measures

Resource protection measures are incorporated into the modified proposed action to mitigate the potential for unintended harm to the environment. The environmental effects displayed in Chapter 3 reflect the implementation and known effectiveness of these measures (Tables 2-5 and 2-6).

Specific resource protection measures (Table 2-5) have been identified for the project. In addition, the Lolo National Forest has developed standard operating procedures (SOPs), which include best management practices that have been determined to be effective in minimizing potential environmental effects (see Table 2-6). SOPs area applied to all projects.

Table 2-5: Project-specific Resource Protection Measures

Resource Protection Measure	Description of Project-Specific Resource Protection Measure	Units/Location
Soils		
1	All existing soil wood (wood in an advanced state of decay) would be retained unless it is deemed a hazard to equipment operations. Non-merchantable materials would be left standing within project units.	All harvest units
2	Residual slash materials would be left on the forest floor for 1 year prior to prescribed burning to allow for improved nutrient cycling and coarse woody debris recruitment.	Unit E21
3	Activity units would be reforested after harvest and post-harvest activities are complete following the silvicultural prescription. Reforestation is required as a resource protection measure to increase soil nutrient inputs, add organic matter, and decrease soil erosion potential in Units C08, C15, and S08. Additional reforestation units are proposed beyond those required for soil mitigations. These units would also benefit the soils resource; however, they are not needed as a soil resource protection measure.	Units C08 and C15: within skid trail prisms. S08: throughout the unit with emphasis on rehabilitated temporary road prism.
4	To offset detrimental soil disturbance where activity units do not meet soil regulatory framework. Following harvest, slash of mixed sizes (at least 50%, less than 6 inches diameter) would be placed over skid trails in the prescribed units. Slash would cover approximately 65-70% of the skid trail to a depth of approximately 2-3 inches where available (approximately 10-15 tons/acre).	Unit C05, C08, C15, S57, S96X
Wildlife		
5	To protect nesting eagles, prescribed burning in Unit LS21 would occur between August 15 and February 1. Burning may occur outside this time period if surveys indicate the known nest located within the unit is inactive.	Unit LS21
Vegetation		
6	Ponderosa pine stumps over 12 inches in diameter will be treated with a registered borate product within 24 hours for powdered product or within 72 hours for liquid product to prevent infection by *annosum* root disease spores.	All harvest units

Resource Protection Measure	Description of Project-Specific Resource Protection Measure	Units/Location
Weeds		
7	Unless otherwise agreed, haul roads and potential landings would be treated with herbicide prior to harvest activities. When possible, weeds would be treated at least one growing season prior to activities.	Haul routes and landings
8	Roads would be treated with herbicide prior to ground-disturbing road activities including but not limited to road maintenance and decommissioning unless existing road conditions (i.e. vegetation on road, road barriers, etc.) prohibit reasonable access for spraying equipment as determined by the District Road Engineer or District Weed Coordinator. If existing road conditions prohibit access, then treatment would be deferred until the road activities clear the obstruction. The determination of which roads to be treated would be made by the District Weed Coordinator based on weed inventories and treatment schedules.	Roads
9	Prescribed burning in drier habitats groups (groups 1, 2 and the drier habitat types of group 3) would take place in the spring or during spring-like conditions in the fall. • If pre-ignition native vegetation is less than 50% of ground cover, the District Weed Coordinator would perform a field visit and make a site-specific determination for burn activities. Burning may be deferred until the native plant community recovers and is able to compete with noxious weeds. • The amount of bare mineral soil exposed by burning would be minimized to less than 15% of the total unit area. • Burn boundaries would be modified, where possible, to avoid burning through large areas (3-5 acres) with high mineral soil exposure (greater than 15%) and low native plant ground cover (less than 50%).	Prescribed burn units
Aquatics		
10	Unit E21, a 150-foot stream buffer would be applied to West Fork Swamp Creek along the unit's southern boundary. Timber harvest or ground-based equipment would be prohibited within the buffer. No buffer is needed on the unit's western boundary as there is no stream or swale present.	Unit E21
Heritage		
11	Forest Service archaeologist and Confederated Salish and Kootenai Tribal Preservation staff would be involved in site design and implementation of ground disturbing activities at the mouth of Swamp dispersed recreation site. Monitoring would be conducted by the Forest Service as described below in section 2.1.2. The Confederated Salish and Kootenai Tribal staff would be invited to participate in monitoring.	Unit LS21 and mouth of Swamp dispersed recreation site
12	The tread on Trail #404 would be maintained. Equipment crossings of the trail would be minimized and designated. At the close of harvest operations in these units, the affected trail segments would be re-established.	Units C23, C31, S57, S96X
13	A 100-foot no-equipment buffer would be applied around the rock cairn located on the ridgetop in Unit C08. To the extent practicable, skidding equipment would re-use existing skid trails.	Unit C08
Botany		
14	A 75-foot buffer would be applied around the clustered lady's slipper population in Unit C40X. No timber harvest activities would occur within the buffer.	Unit C40X
15	To protect whitebark pine trees along the ridge and in the upper elevations of the unit, prescribed burning would occur	Unit MS1

Resource Protection Measure	Description of Project-Specific Resource Protection Measure	Units/Location
	when snow cover is present in these areas.	
16	Post-harvest prescribed burning would be of low severity to protect clustered lady's slipper plants within the unit. Follow-up planting, if any, should include ponderosa pine.	S70

Table 2-6: Standard Operating Procedures

Standard Operating Procedures	Units/Location
Soils	
Summer Operating Conditions: • Ground-based harvest would only occur on dry soils. Soil moisture would be evaluated at the bottom of the root tight layer (2-6 inches below soil surface). Refer to Table B1 in Soil File 4 (Lolo NF Ground-Based Harvest Guidelines) for dry soil, field assessment information. • All ground-based harvest would be limited to slopes of 35% or less unless otherwise approved by soil scientist. Winter Operating Conditions: • Winter operating conditions would require frozen ground or depth of snow sufficient to support equipment and protect soil surface. Because depth of snow necessary to protect forest floor varies with snow density, sufficient snow depth would be approved by the Timber Sale Administrator.	All tractor units: Summer Operating Conditions Optional for all tractor units: Winter Operating Conditions
• Existing skid trails and landings would be reused to the extent possible to limit new soil disturbance. • Skid trails would be spaced 75 to 100 feet apart to minimize soil disturbance of the harvest footprint. • By purchaser agreement, in lieu of waterbars, slash of mixed sizes (at least 50% less than 6 inches diameter) would be placed over skid roads to prevent erosion in units. Slash would cover approximately 65-70% of the road or trail to a depth of approximately 2-3 inches (approximately 10-15 tons/acre).	All tractor units
If seasonally moist areas are present at time of harvest, a 50-foot no-equipment buffer would be applied around wet area.	All units

All Landings
• Existing landings would be re-used to the extent possible
• Sites would be seeded using appropriate Lolo NF native grass mix
 	
Ground-based Harvest Units
• Landing rehabilitation (erosion control) would occur on dry soils and would be completed as follows:
    o Landing site preparation (scarification) to a depth of 4-6 inches would occur.
    o Slash material would be placed throughout site, 3-6 inches thick.
• In highly accessible areas along open roads, barriers would be placed to block vehicle entry into landings.
	Log Landings

<table>
<tr><th>Standard Operating Procedures</th><th>Units/Location</th></tr>
<tr><td>Level of temporary road and excaline trail decommissioning would depend on existing condition of the site prior to road or trail construction and would be decommissioned following site-appropriate combinations of the following:
• Top soil and slash would be stored along the temporary road to the greatest extent possible and pulled back over the road surface during decommissioning.
• The temporary road surface would have site preparation to a depth of at least 6 inches. Site preparation may include recontouring, de-compaction, and/or scarification.
• Site would be seeded using appropriate Lolo NF native grass mix, with seeding occurring prior to slash placement.
• By purchaser agreement, in lieu of waterbars, slash of mixed sizes (at least 50% less than 6 inches diameter) would be placed over temporary roads and excaline trails to prevent erosion in units. Slash would cover approximately 65−70% of the road or trail to a depth of approximately 2−3 inches where available (approximately 10-15 tons/acre).</td><td>Temporary roads and excaline trails</td></tr>
<tr><td>Region 1 soil quality standards require that prescribed fire activities limit areas of severe soil burning that are larger than 10 x 10 ft^2 to less than 15% of the project area. In this definition, severe soil burning results in complete consumption of duff and litter material resulting in bare top soil that is at risk for soil erosion.

To meet this requirement, the depth and timing of strip head-fire would be adjusted to limit burn severity if necessary to protect the soil resource.</td><td>All prescribed burn units.</td></tr>
<tr><td colspan="2">Wildlife</td></tr>
<tr><td>Snags and snag replacements would be retained in timber harvest units consistent with the Lolo National Forest Dead and Down Habitat Components Guidelines (June 1997) and Appendix N of the Lolo Forest Plan. Unless specified for removal in the silvicultural prescription, snags would remain within treatment areas. Snags that need to be cut for safety or operational reasons would remain in the unit.</td><td>All timber harvest units</td></tr>
<tr><td colspan="2">Weeds</td></tr>
<tr><td>Soil disturbance would be minimized.</td><td rowspan="9">Project Area</td></tr>
<tr><td>Off-road equipment would be cleaned (power or high-pressure cleaning) of mud, dirt, and plant parts before moving into the area.</td></tr>
<tr><td>If gravel or other material is hauled for road surfacing, it would be from a site (pit) that has been previously treated for weeds and is currently weed free.</td></tr>
<tr><td>Disturbed sites would be seeded with native seed mixtures or appropriate Lolo seed mixtures.</td></tr>
<tr><td>Skid trails, skyline corridors, and landings would be approved by the Timber Sale Administrator prior to use. Where possible, they would be located where there are no obvious weed infestations.</td></tr>
<tr><td>Temporary roads would be treated with herbicide prior to final road obliteration unless waived by the District Weed Coordinator.</td></tr>
<tr><td>Roads to be physically decommissioned or stored would be sprayed with at least one herbicide treatment before closure.</td></tr>
<tr><td>Straw and/or other material used for road stabilization and erosion control would be certified weed-free or weed seed-free.</td></tr>
<tr><td>Any use of herbicides for weed control would follow mitigation measures outlined in the Lolo National Forest’s 2007 Integrated Weed EIS and Record of Decision to protect water resources. These measures include:
▪ All application of herbicides would be performed by, or supervised by, a state licensed applicator following all current legal application procedures administered by the Montana Department of Agriculture.
▪ All herbicides would be handled following Environmental Protection Agency (EPA) label guidelines and other state and federal</td></tr>
</table>

Standard Operating Procedures	Units/Location
laws for storage, application, and disposal methods. ▪ Mixing would take place at least 150 feet from open water unless spill containment devices are readily available, and an anti-back siphoning device is used when drafting water. ▪ Applicators would review stream and wetland areas to ensure that herbicides would not be applied to open water. ▪ Herbicides would be used to water's edge only when absolutely needed and provided the product label allows such use. ▪ Herbicide applications near live water or in areas with shallow water tables would follow label directions. ▪ Herbicide applicators would not initiate spraying when heavy rains are forecast that could cause offsite herbicide transport into sensitive resources such as streams. ▪ Herbicide applicators would be familiar with and carry an Herbicide Emergency Spill Plan to reduce the risk and potential severity of an accidental spill. Herbicide applicators would also carry spill containment equipment. ▪ Herbicides would not be applied if snow or ice covers the target vegetation. ▪ Low boom pressure (less than 40 pounds per square inch) would be used to reduce drift. ▪ Drift reduction products would be used as needed near sensitive resources. ▪ Ground-based herbicide application would occur only when wind speed is 10 mph or less. ▪ If commercial applicators are used for the application of restricted use pesticides, Forest Service contract administrators would check to make sure their Montana commercial restricted use pesticide license is current.	
Aquatics	
Timber harvest and ground-based equipment would be prohibited within stream buffers. Stream buffer widths would be the standard buffer widths outlined in the Lolo National Forest Plan, as amended by the 1995 Inland Native Fish Strategy: 300 feet of fish-bearing streams, 150 feet of non-fish-bearing streams, and 100 feet of wetlands. See project-specific resource protection measure for Unit E21 in Table 2-5 above.	Harvest units
Road surfaces and drainage would be improved to protect water quality and fisheries. All roads segments used for haul would have BMP measures installed before timber haul use. BMPs include adequate road surface and ditch drainage, functioning ditches, adequate spacing of drain dips or ditch relief culverts, leadouts or drainage structures before stream crossings, road shaping to shed water off the surface and not into streams and graveling of areas where drainage treatments may not be fully effective due to stream proximity. BMPs would be maintained for their effectiveness through the life of the project.	Haul roads
As needed, slash filter windrows would be applied to stream crossings on haul routes and select areas where the road is within 300 feet of streams before blading, haul, and other project activities are to occur. As needed, slash filter windrows would be placed on relief culvert outlets that are within 300 feet of a waterway.	
Short-term BMP actions would be implemented on an as needed basis and include silt fences, straw bales, or other temporary effective measures to reduce turbid water from reaching streams.	
Erosion control measures (e.g. straw bales, wattles, silt fences, hydro mulching, slash, etc.) would be implemented where necessary and remain in place during and after ground disturbing activities. Erosion control devices are required on reconstructed roads within 300 feet of streams or drainage crossings and temporary roads. Disturbed areas would also receive appropriate seeding and mulching, and/or slash treatment.	
Implementation of road BMP treatments would occur between April 1 and October 15 during dry weather periods, unless otherwise agreed to with a watershed specialist (hydrologist or fisheries biologist).	

Standard Operating Procedures	Units/Location
If winter haul occurs: • Snow plowing would maintain a minimum 2 inches of snow on the roadway to protect the road surface. All debris except snow and ice that is removed from the road surface and ditches shall be deposited away from stream channels at agreed locations. • Snow berms would not be left on the running surface of the road. Berms left on the shoulder of the road would be removed and/or drainage holes would be opened and maintained in them. Drainage holes would be spaced as needed to obtain satisfactory surface drainage without discharge on erodible fills. • Ditches and culverts would be kept functional during and following road use. Snow removal would be done in such a way as to protect surface water drainage structures and the road surface.	
Erosion control measures would remain functional until disturbed sites (roads, culverts, landings, etc.) are stabilized; typically for a minimum period of one growing season until vegetative cover stabilizes and reduces runoff potential. This would require regular inspection, in particular following rainfall events and prior to fall and spring runoff and may require maintenance.	Project area
Temporary road construction would occur between April 1 and October 15 during dry weather periods unless otherwise agreed to with a watershed specialist (hydrologist or fisheries biologist) and engineering.	Temporary roads
Instream work/disturbances would need a Montana Fish, Wildlife & Parks issued 124 Stream Protection Act permit. Instream work is limited to July 15–August 30, unless otherwise stated in the 124 permit.	Roads
Forestry Best Management Practices would be utilized to minimize effects to soil and water.	All activity areas
Heritage	
If previously unrecorded heritage resources are encountered during project implementation, activities would be halted, and a Forest Archaeologist would be notified immediately. If necessary, additional mitigation measures would be developed in consultation with the Montana State Historic Preservation Office.	Project area

2.1.2 Monitoring

During and after project completion, implementation and effectiveness monitoring would be conducted to: (1) determine whether the original objectives of the activities are met; (2) determine the need for additional action; and (3) educate and assist in the design of future projects.

Monitoring of project activities conducted under contract would occur during and immediately following contract implementation. All preparation and subsequent project-associated operations would be monitored by Forest Service representatives to ensure compliance with specifications.

Weeds

In conjunction with other post-harvest monitoring or inventory activities, harvest and prescribed burn units would be monitored for the presence of new weed infestations. In addition, roads treated with herbicide would be monitored for herbicide efficacy, the presence of new weeds, and/or the spread of existing weeds. Follow-up actions would depend on the monitoring findings.

The mouth of Swamp dispersed recreation site would also be monitored for weeds in conjunction with other recreation responsibilities. New infestations would be treated.

Soils

The Lolo National Forest Soil Monitoring Program objective is to evaluate project design standards and mitigations to ensure they were implemented so that a project complies with the Lolo Forest Plan and Region 1 soil quality standards. Swamp Eddy units S04, S08, S14, S44, S97X, and C17X would be added to the Forest soil monitoring program for post-harvest soil quality assessment. Post-harvest monitoring would be initiated 2-3 years following an activity.

Heritage

Following implementation heritage sites located within areas affected by project activities would be inspected to assess their condition.

2.2 Alternatives Considered but Eliminated from Detailed Study

Several alternatives were considered but dismissed from detailed consideration for the reasons summarized below.

Original Proposed Action

The original proposed action was dropped from detailed study because it was modified in response to the 2017 Sheep Gap Fire. As previously described, the fire burned approximately 55 percent of the Swamp Eddy project area including proposed vegetation treatment areas. As a result, nearly 4,800 acres (58 percent) of originally proposed vegetation treatments were dropped along with 6 miles of associated road construction.

No timber harvest or road construction

One person asked the Forest Service to consider an alternative that did not include any timber harvest or road construction due to potential effects of these activities on the environment. The Forest Service considered using only non-commercial silvicultural treatments to accomplish vegetation objectives but determined that they would not be effective in lowering fire hazard, insect infestation, or disease without removal of some of the larger-sized trees. An alternative that does not conduct timber harvest and associated road construction is essentially represented by No Action.

The analysis summarized in Chapter 3 concludes that proposed timber harvest and temporary road construction would not have significant adverse effects on forest resources. The Lolo Forest Plan allows for timber harvest to achieve management objectives within the project area. To respond to the identified needs within the project area, the modified proposed action uses the range of silvicultural "tools" available, including timber harvest, prescribed burning, and non-commercial mechanical treatments.

Use pheromones to manage insects

One person asked the Forest Service to analyze an alternative that uses pheromones rather than mechanical silvicultural treatments to address stand susceptibility to mountain pine beetles. Bark beetles regulate the attack process on a tree to avoid overcrowding the tree through a very complex chemical communication system that includes the use of pheromones. Verbenone has been identified as a chemical with anti-aggregation or repellent properties that arrests additional mountain pine beetle attacks on a tree. This anti-aggregation compound is insect-produced and is most likely released when the tree is fully utilized by the insects already present. The use of synthetically-produced verbenone has been experimentally tested for reducing the number of mountain pine beetle attacked trees in various studies. Results have been mixed. Often it is effective early in an outbreak when beetle populations are still low, but over the course of an extended outbreak or under high beetle populations it is less.

Verbenone is not recommended for widespread, general forest use unless forest management, such as thinning or other stand improvement activities, is planned in the near future. Pheromone applications are considered prophylactic treatments used to protect high value individual trees or areas (Six 2014), typically until more long-term silvicultural treatments to reduce susceptibility can be applied. On the Lolo National Forest, pheromones have been used successfully at campgrounds and administrative sites as one part of integrated pest management. Pheromone treatments are costly. For example, verbenone is typically used to reduce mountain pine beetle susceptibility at 30 pouches per acre. At $4 to $8 per pouch, the materials alone exceed $120 per acre and it needs to be applied annually.

An alternative that uses pheromones to control mountain pine beetles across the Swamp Eddy project area was dropped from further consideration because application at a landscape scale would be cost-prohibitive and ineffective.

CHAPTER 3: ENVIRONMENTAL EFFECTS

This chapter provides a summary of the environmental effects of modified Proposed Action. It provides the necessary information to determine whether the project would have significant effects that would warrant preparation of an environmental impact statement. Further analysis and conclusions about the project effects are available in the reports for each resource and other supporting documentation cited in those reports, contained in the project file.

3.1 Past, Present, and Reasonably Foreseeable Future Actions

Consistent with 36 CFR 220.4(f) and Council on Environmental Quality (CEQ) guidance, the past, present, and reasonably foreseeable future actions were considered for analysis of cumulative effects where appropriate for each resource. Past actions considered in the cumulative effects analysis include those that contributed to establishing the baseline conditions of the project area today.

Past Actions

Sheep Gap Fire

The Sheep Gap Fire was ignited by lightning on August 29, 2017 and burned approximately 25,000 acres including NFS land (about 19,700 acres) and other ownerships (800 acres of State land, 3,900 acres of Weyerhaeuser land, and 600 acres of other private land). About 15,400 acres (55 percent) of the Swamp Eddy project area was affected.

The fire burned with varying severity, leaving a mosaic of burn patterns on the landscape that range from unburned islands to areas where tree crowns are completely consumed. Of the 19,700 acres of NFS land affected, approximately 70 percent were burned at very high, high, or moderate severity. In the very high severity burned areas (about 8,100 acres), most of the organic matter on the forest floor was consumed and most of the trees were killed.

None of the vegetation treatments included in the Swamp Eddy project would occur within the Sheep Gap Fire perimeter.

Sheep Gap Fire Suppression Actions and Post-fire Rehabilitation

Fire suppression actions conducted in 2017 in response to the Sheep Gap Fire included constructing bulldozer and hand lines, use of existing roads as fire line, and aerial application of fire retardant. Approximately 11.5 miles of dozer line and 0.6 miles of hand line were constructed across the multiple land ownerships affected by the fire. In addition, approximately 6.1 miles of road were used as fire line. In early fall 2017, constructed fire lines (dozer and hand) and areas of high use, including camps, staging areas, water pumping sites, and drop points, were rehabilitated by scarifying and seeding to minimize soil erosion and reduce weed establishment. Water bars were installed as needed to provide appropriate drainage and minimize erosion potential. Roads used as fire lines were inspected and reconditioned as necessary following use.

Burned Area Emergency Response (BAER)

After containment of the Sheep Gap Fire an evaluation of values at risk, considering imminent threats to human life and property, was completed. This evaluation determined that BAER actions were needed to address immediate threats to public safety, values at risk, and resource damage. Actions completed in 2018 included:

- Weed spraying (authorized under 2007 Lolo National Forest Integrated Weed Management Record Decision) and monitoring along roadsides (210 acres).
- Road surface storm-proofing and drainage maintenance (26 miles).
- Culvert replacement (upsizing) on stream crossings (6 locations).

Timber Harvest

Previous management actions on NFS lands within the project area include timber harvest and related activities. According to Forest Service records, timber harvest has occurred on approximately 10,670 acres (38 percent) of National Forest System land within the project area since the 1950s. The past harvest has ranged from individual tree removals to clearcuts. Regeneration-type harvests account for about 48 percent of the federal land harvested within the project. (Note: the last regeneration harvest that occurred within the project area was in the 1990s). The remaining 52 percent of the harvest area received an intermediate treatment. Prior to the Sheep Gap Fire, all the regeneration harvested areas were certified as stocked.

Although the Forest Service has no detailed records of past harvest prior to 1950, timber cutting that supported the development of community and infrastructure likely occurred on the lower slopes.

Table 3.1-1: Summary of Harvest on NFS Land *within Entire Project Area* by Decade

Type of Harvest	**1950s** (acres)	**1960s** (acres)	**1970s** (acres)	**1980s** (acres)	**1990s** (acres)	**2000s** (acres)	**2010s** (acres)	**TOTAL** (acres)
Regeneration	10	2,938	1,383	804	167	0	2,000*	7,302
Intermediate	0	2,786	1,190	600	596	576	0	5,748
TOTAL	10	5,724	2,573	1404	763	576	0	13,050

*Salvage of fire-killed trees in the Sheep Gap Fire occurring in 2018 & 2019 (see Ongoing and Reasonably Foreseeable Future Actions, below).
Note: total acres of past harvest shown in the table is inflated due to multiple entries on the same piece of ground.

Due to the high burn severity of the Sheep Gap Fire, the vegetation was reset in many areas regardless of whether previous harvest activities occurred or not. As previously stated, none of the timber harvest included in the Swamp Eddy project would occur within the Sheep Gap Fire perimeter.

Below is a summary of past harvest that has occurred on NFS land within the Swamp Eddy project area, but outside the Sheep Gap Fire perimeter. This summary is a subset of the acres displayed in Table 3.1-1.

Table 3.1-2: Summary of Past Harvest on NFS Land *Outside the Sheep Gap Fire Perimeter* by Decade

Type of Harvest	**1950s** (acres)	**1960s** (acres)	**1970s** (acres)	**1980s** (acres)	**1990s** (acres)	**2000s** (acres)	**2010s** (acres)	**TOTAL** (acres)
Regeneration	0	2,331	1,016	106	144	0	0	3,597
Intermediate	0	1,142	320	504	1147	0	427	3,540
TOTAL	0	3,473	1,336	610	1,291	0	427	7,137

Note: total acres of past harvest shown in the table is inflated by approximately 900 acres due to multiple entries on the same piece of ground.

Timber Harvest on Other Ownerships

The Swamp Eddy project area forms somewhat of a rind around Weyerhaeuser Timber Company and Montana Department of Natural Resources and Conservation (DNRC) lands, located in the lower end of the drainages. Most of these lands have been harvested within the last two decades. Within the Sheep Gap Fire perimeter in 2018, fire salvage activities occurred on approximately 172 acres of Montana DNRC land and 285 acres of Weyerhaeuser land.

Livestock Grazing

A grazing allotment has been in place within the Swamp Creek drainage since about 1947. Currently, the allotment includes approximately 17,754 acres of NFS land, none of which overlaps areas of proposed vegetation treatment. Prior to the Sheep Gap Fire, 45 cow/calf pairs were allowed to use the allotment from June 1 to September 1. The Swamp Creek Allotment Management Plan includes resource protection measures to minimize effects to riparian areas, soils, and weeds.

In 2018 after the Sheep Gap Fire, livestock grazing was halted except on 2,000 acres that were unburned or burned at low severity. On these 2,000 acres, grazing was limited to 30 days. Grazing in future years will depend on recovery of the burned area.

Road Development

There are approximately 115 miles of National Forest system roads in the project area. About 46 percent (53 miles) of these are open year-round to public travel and 16 percent (18 miles) open seasonally. There are approximately 90 miles of non-system roads under Forest Service jurisdiction. Most of these non-system roads are heavily grown-in with vegetation.

Road Management Activities

In 2018, a segment of Road 7581 was relocated to avoid an area of stability concerns. Relocation activities included construction of approximately 0.6 miles of new road and decommissioning the problematic segment.

Weed Treatment

After the Sheep Gap Fire as part of the BAER actions in 2018, herbicide was applied to approximately 319 acres of roadsides within the fire perimeter.

Ongoing and Reasonably Foreseeable Future Actions

Ongoing and reasonably foreseeable future actions within the project area include:

Fire Salvage (harvest of fire-killed trees)

Approximately 2000 acres of fire salvage is currently under contract in two timber sales on NFS land within the Swamp Eddy project area boundary. This is about 10 percent of the NFS land that burned in the 2017 Sheep Gap Fire and 80 percent of what was initially authorized for harvest under the Sheep Gap Fire Salvage Decision Notice (July 2018). Project design criteria minimized the potential for adverse effects and the Sheep Gap Fire Salvage analysis disclosed that salvage activities would not have significant effects on the environment.

Salvage activities will be completed by October 2020, about a year before the Swamp Eddy project would be initiated.

Post-Fire Tree Planting

As authorized in the Sheep Gap Fire Decision Notice, approximately 7,200 acres of post-fire tree planting will occur inside and outside salvage units over the next several years. Depending on site conditions, western white pine, western larch, and ponderosa pine will be planted.

Road Maintenance

Maintenance was recently conducted on roads used for haul as part of the two fire salvage timber sales. Prior to sale termination, the contractors are required to conduct post-haul maintenance.

3.2 Vegetation

3.2.1 Resilient Vegetative Conditions

As described above in Chapter 1, certified silviculturists and Regional insect and disease experts identified four primary pathogens of concern in the project area including root disease, Douglas-fir beetle, western pine beetle, and mountain pine beetle. The science basis for conducting vegetation treatments to address these pathogens, forest fuels, and forest resilience is contained in Appendix C.

Root disease is present and causing tree mortality in units C01, C06, C08, C10, C10X, C12, C14, C15, C16, C16X, C17, C17X, C18, C21, C26, C27, C38X, C39X, C40X, C41X, C42X, C44X, LS12, LS15, S04, S04X, S07, S08, S42, S43, S44, S45, S45X, S54, S57, S67, S69, S70, S71, S72, S74, S74X, S89, S90X, S91X, S92X, S96X, and S97X. In addition to the Douglas-fir dominated units identified with root disease, units C02, C03, C04, C05, C07, C07X, C11, C20, S05, S06, S14, S17, S18, S46, and S46X have past, ongoing, and likely future mortality from Douglas-fir beetles. Susceptible lodgepole pine unit MS1 and ponderosa pine units C13, C19, C25, C31, C32, C34, C45X, E21, LS14, LS16, LS17, LS18, LS19, LS20, MS1, S19, and S56 have moderate to high hazard for western and mountain pine beetles due to tree size and density characteristics (see map in Appendix A). Mortality has been observed in most of these units.

No harvest would occur within old growth stands as defined by the Forest Service Northern Region in Green et al. (1992, errata corrected 2011)[6]. Individual and small patches of large, old trees that occur throughout the project area would be retained within harvest units. Approximately 7 acres of small tree commercial thinning would occur within Forest Plan Management Area 21, which is allocated in the Lolo Forest Plan to old growth management. These 7 acres of treatment would occur within a young second growth stand that was previously harvested in the 1960s.

Direct, Indirect, and Cumulative Effects

Root Disease

Managing losses from root disease is a function of reducing susceptible host species (primarily Douglas-fir and true firs) and increasing root disease tolerant species (primarily larch, ponderosa pine, lodgepole pine, and western white pine) (See Appendix C for more information). The project would reduce root disease hazard on approximately 1,364 acres (5 percent of the project area) (see Table 3.2-1). Treatments include regeneration harvest followed by planting of disease-tolerant species on approximately 1,236 acres and low severity prescribed burning on 128 acres with moderate to high levels of existing root-disease caused mortality. Stands with root disease and dominated by root disease susceptible species greatly benefit from regeneration harvest if the stand is regenerated with disease tolerant species (Lockman and Egan 2016). Perpetuating and maintaining root disease-tolerant species decreases fungus biomass on site, and thus lowers root disease severity over time (ibid).

[6] In Green et al. 1992 (errata corrected 2011), old growth definitions are stratified by habitat type groups that reflect similarity of disturbance response, potential productivity, stocking density, down wood accumulation, fire frequency, and tree species.

Past harvest likely had mixed effects on root disease. The extent of moderate and high root disease hazard in the project area indicates that the *intermediate* harvests conducted in the 1950s through 1980s (nearly 18 percent of the project area) likely exacerbated root disease by some combination of removing root disease tolerant tree species and increasing fungal inoculum through increased root biomass available after removing Douglas-fir trees. Some of those intermediate harvests retained mature root disease tolerant and fire tolerant trees that will contribute in the long term to stands of low risk due to the lack of susceptible host trees.

The *regeneration* harvests since the 1950s (nearly 29 percent of the project area, including on-going fire salvage) likely resulted in a flush of fungal inoculum. Current root disease hazard is related to the proportion of susceptible species in the regeneration. Likewise, the root disease hazard on the 19,700 acres burned in the Sheep Gap Fire will be influenced by the susceptibility of the species that reforest the sites. Approximately 7,200 acres of the NFS land burned in the Sheep Gap Fire will be planted with native species that are root disease-resistant (i.e. ponderosa pine, western larch, and western white pine). Planted areas will be less susceptible to future tree mortality from root disease.

Bark Beetles

Managing bark beetle hazard is a function of altering stand conditions (primarily density and age class) and increasing the proportion of non-host species (see Appendix C for more information). The project would reduce bark beetle hazard on approximately 1,769 acres (see Table 3.2-1).

Intermediate harvest would reduce stand density and susceptibility to Douglas-fir beetle-attack where root disease occurrence is low. Silvicultural techniques that reduce density levels below 100 feet^2 per acre of basal area and prioritize the removal of larger-diameter Douglas-fir trees can effectively reduce susceptibility to Douglas-fir beetle-attack (Lockman and Egan 2016). Regeneration harvests, whether they occur across or within smaller patches of stands, would reduce Douglas-fir beetle susceptibility to low levels until regenerated Douglas-fir trees reach or exceed 10 inches dbh (ibid.).

Long-term reduction of western and mountain pine beetle hazard through silvicultural treatments includes:

- Thinning to reduce beetle-caused mortality by changing microclimate and wind patterns within the stand, allowing beetle-produced pheromones to dissipate, and providing more growing space, nutrients, and water for remaining trees if the thinning is performed prior to initiation of the bark beetle outbreak.

- Regeneration harvest of patches to create a mosaic of age and size classes to reduce the amount of pine that is susceptible to bark beetles at any one time (Gibson et al. 2009).

Past harvest in the project area reduced the bark beetle hazard by reducing tree densities. However, the hazard is increasing within the areas that were intermediately harvested in the 1950s through the 1980s. Although it varies by site, intermediate harvests more than 20 to 30 years old likely have moderate to high susceptibility due to ingrowth of understory trees that have changed the microclimate around overstory tree boles. The mountain pine beetle outbreak of the 1990s responded similarly. Initially the surviving trees had low susceptibility, but as understory trees developed the stands are increasing in susceptibility. Bark beetle-caused mortality was observed in both past intermediate harvested stands and stand naturally thinned by bark beetles.

The regeneration harvests since the 1950s had no or low bark beetle hazard for decades. However, the area currently has bark-beetle caused mortality in regeneration harvest units from the 1950s through the 1970s as the ponderosa pine and some lodgepole pine grow to susceptible size and density.

Cumulatively, past and proposed regeneration harvests since the 1980s outside the Sheep Gap Fire, intermediate harvests since the 1990s outside the Sheep Gap Fire, high fire severity areas within the Sheep Gap Fire, and proposed underburning have and would reduce bark beetle hazard on about 12,887 acres (46 percent of the project area) (see Table 3.2-2).

Table 3.2-1: Summary of Project Treatments Resulting in Reduced Insect and Disease Hazard

Issue	Proposed Activity	Alternative 2 (acres)
Root Disease	Regeneration harvest	1,236
	Low severity prescribed burn	128
	Total – reduced root disease hazard	**1,364** (5% of project area)
Douglas-fir Beetle	Root disease treatments (see above)	1,364
	Intermediate harvest	233
	Small tree commercial thinning	143
	subtotal – reduced Douglas-fir beetle hazard	**1,740**
Western and Mountain Pine Beetle	Intermediate harvest	101
	Small tree commercial thinning	143
	Non-commercial thin	164
	subtotal – reduced Western & Mountain Pine beetle hazard	**408**
	Total Footprint of reduced beetle hazard (with overlap removed)	**1,769** (6% of project area)

Fuel Hazard

Swamp Eddy vegetation treatments are designed to meet the hazardous fuel reduction recommendations from the scientific literature as described in Appendix C. This scientific information and fuel modeling[7] indicate that Swamp Eddy vegetation treatments would result in the area having low to moderate severity fire behavior characteristics under normal summer conditions over the next several decades years as opposed to those that support moderate to high severity fire behavior characteristics if no action is taken. For example, project treatments would reduce the rate of fire spread, fireline intensity, flame length, and scorch height in treated areas (see the Fire and Fuels report in the Project File). They would reduce the amount of heavy surface fuel accumulations providing conditions that are less resistant to control efforts. They would also reduce the amount of ladder fuels and break up the horizontal continuity of the tree crowns, allowing more heat energy to be dissipated into the air instead of to adjacent aerial fuels. This would reduce the likelihood for sustained crown fires and associated long-range spotting.

Timber harvest would result in a 1 to 2-year increase of surface fuels until follow-up slash treatments (e.g. burning or piling) were completed. Non-commercial thinning would temporarily increase surface fuels. The light, flashy fuels (needles, fine twigs) would be reduced to acceptable levels within three to five years as they dry, fall into contact with the ground, and are compacted by snow loads.

Past regeneration harvests outside the Sheep Gap Fire perimeter broke up fuel continuity by creating patches of uniformly younger, smaller trees, and slash treatments on a portion of those acres have reduced surface fuels. Past intermediate harvests outside the fire perimeter likely had variable effects

[7] For the Swamp Eddy project, the “Standard fire behavior fuel models: a comprehensive set for use with Rothermel’s surface fire spread model” developed by Scott and Burgan (2005) were be used to categorize surface fuels. These were used in conjunction with the BehavePlus (Andrews et al. 2008) fire modeling system.

depending on understory ladder fuel development and slash disposal treatments, although active crown fire is not likely due to the lower canopy densities.

The Sheep Gap Fire left the burned area in a low fuel hazard condition for an estimated 20 to 30 years, until the accumulation of down, fire-killed trees, and regenerating trees and shrubs create fuel conditions supporting high intensity ground fires that are difficult to control. The areas that were salvaged will retain a lower fuel hazard for a much longer period because these areas have low surface fuel accumulations and the young trees tend to have higher moisture content.

The proposed vegetation treatments combined with the 2017 Sheep Gap Fire would reduce hazardous fuels on about 18,900 acres (67 percent) of the Swamp Eddy project area (see Table 3.2-2). Hazardous fuel reduction would be variable, with different site-specific reductions of ground, surface, and crown fuels depending on burn severity and treatment activity sequence. The fuel hazard reduction effectiveness would decrease over time due to annual vegetative growth and litter accumulations. The effectiveness of prescribed burning would diminish after 10 to 20 years (Graham et al. 2004). The effectiveness of timber harvest and non-commercial thinning would likely last longer in areas where vegetative development is slower compared to highly productive areas.

Drought and Environmental Shift Resilience

Observed climate changes over the past several decades in the western United States include increased seasonal, annual, minimum, and maximum temperatures, altered precipitation patterns, and earlier timing of peak runoff. Predicted changes include additional increases in average temperature over the next 50 years, reduced snowpack, and reductions in runoff and natural water storage (Loehman and Anderson 2009). In western North America, increased water deficits accelerate the stress complexes that normally involve some combination of multi-year drought, insects, and fire (McKenzie et al. 2007).

Restoration of patterns of burning and fuels and forest structure that reasonably emulate pre-fire exclusion historical conditions is consistent with reducing the susceptibility of these ecosystems to catastrophic loss (Fule 2008). Adaptation strategies for conserving native forest vegetation focus on increasing resilience to chronic low soil moisture and increasing environmental disturbances such as wildfire, insects, and nonnative species (Halofsky et al. 2018). Adaptation tactics include stand treatments to reduce stand density and prescribed fire to reduce fuel continuity.

As supported in the scientific literature summarized in Appendix C, all proposed vegetation treatments would improve resilience to drought and environmental shift. Timber harvest and non-commercial thinning would immediately reduce stand density and increase the proportion of large drought-tolerant species. Prescribed burning would reduce the number of the small trees that increasingly create water stress as they grow. It would also decrease crown density to alleviate competition for water, light, and nutrients by scorching individual and patches of trees. The benefits of prescribed burning would be like harvest and non-commercial thinning but on a smaller, less predictable scale ranging from individual tree effects to patches up to several acres.

The proposed vegetation treatments combined with the 2017 Sheep Gap Fire would immediately increase the resilience of forest vegetation to drought and environmental shift on about 18,900 acres (67 percent) of the Swamp Eddy project area (see Table 3.2-2). The resilience would be variable, with different site-specific conditions depending on burn severity and treatment activity sequence. Over time, these improved conditions would diminish as annual growth of existing vegetation and ingrowth of tree seedlings increase inter-tree competition for resources. The effectiveness of harvest and non-commercial thinning for density reduction to improve drought resilience would likely persist for 20 to 40 years or more.

Table 3.2-2: Estimated Achievement of Vegetation Purpose and Need

Resource Indicator	Treatment Acres (% of project area	Known Contribution from Sheep Gap Fire (% of project area)	Cumulative Total Resource Improvement (% of project area)
Root Disease Hazard Reduction	1,364 (5%)	0%[1]	5%
Bark Beetle Hazard Reduction	1,769 (6%)	38%[2]	46%
Fuel Hazard Reduction	3,472 (12%)	55%[3]	67%
Drought and Environmental Shift Resilience	3,472 (12%)	55%[4]	67%
Total Area Improved *2017 thru Implementation of this project*	3,472 (12%)	55%	67%

[1] Root disease hazard reduction is largely dependent on regeneration of root disease-resistant species. Regeneration surveys have not yet occurred within the fire area to determine effect. Authorized post-fire tree planting of root disease resistant species would reduce hazard on up to 7,200 acres of the Sheep Gap Fire.
[2] Bark beetle hazard reduction occurred on the 70% of very high, high, and moderate severity burns in the 15,400 acres of Sheep Gap Fire within the Swamp Eddy project area through killing potentially susceptible trees. The remainder of lower severity burning likely exacerbated bark beetle hazard by scorching and stressing susceptible trees.
[3] The Sheep Gap Fire reduced fuels on 15,400 acres within the Swamp Eddy project area.
[4] The introduction of fire and its effects on reducing stocking density, featuring fire-tolerant trees and large trees, and creating age class diversity are consistent with recommended actions for resilience to drought and environmental shift (see Appendix C).

Forest Plan Consistency

The Swamp Eddy project is consistent with the Lolo Forest Plan. Reducing insect and disease hazard addresses one of the primary goals Forest Plan goals for the area, which is to provide for healthy stands. Timber harvest would occur where the Plan allows this activity or where a site-specific Forest Plan amendment would allow harvest. Forest-wide standards related to vegetation management were followed in project design (see Vegetation report in the Project File for more information).

3.2.2 Weeds

Issue Raised in Public Comment

Project activities could exacerbate weed establishment and spread.

Activities which create canopy openings, reduce cover of competing vegetation, or create favorable soil conditions such as newly exposed soil surfaces and increased nutrient availability are known to make sites susceptible to new or increased existing weed populations (Erickson 2007). The Lolo Forest Plan, as amended in 1991, requires that all management activities incorporate appropriate weed prevention measures (Forest-wide standard 59). As displayed in Chapter 2 (section 2.1.1), weed prevention measures are included in the Swamp Eddy project. Post-implementation weed monitoring is also prescribed (section 2.1.2).

Surveys conducted within the project area indicate that weed populations are generally small and located along roadsides. The most common weed species are spotted knapweed, St. Johnswort, and houndstongue. Since 2007, approximately 1,400 acres of roadside herbicide treatment has occurred within the project area. About 319 acres were treated in 2018 after the Sheep Gap Fire as part of the Burned Area Emergency Response effort.

Direct and Indirect Effects

Weed spread could be facilitated by vehicle travel in and out of the project area and by ground disturbing activities including log skidding, prescribed burning, road maintenance, and temporary road construction. Harvest methods that cause less ground disturbance such as skyline yarding (94 percent of the Swamp Eddy harvest acres) would have a lower risk of weed spread than tractor skidding. Prescribed burning may kill native vegetation, temporarily exposing soil. The majority of the area affected by the project has a moderate risk for weed susceptibility, meaning that weeds may dominate interspaces of native vegetation, but sites generally have a limiting factor which prevents full development of the weeds (see Weed report in the Project File for more details).

All road-related activities (e.g. construction, reconstruction, maintenance, and physical decommissioning treatments) pose a high susceptibility for weed establishment and spread. This means weeds may frequently dominate native vegetation following disturbance or through invasion into a disturbed community.

To minimize the risk of weed introduction and spread, several measures would be applied to project activities (see Chapter 2, section 2.1.1) including:

- Washing off-road equipment to remove mud, dirt, and plant parts before moving into project area.
- Applying herbicide to weeds on roads prior to conducting ground-disturbing activities on or near them.
- Minimizing soil disturbance and revegetating bare soil as appropriate.
- Monitoring for weeds after completion of project activities and treating weeds as necessary.

Cumulative Effects

Past soil disturbing activities over the last sixty years, whether they were natural or man-caused, have helped spread noxious weeds into and within the Swamp Eddy project area. The 2017 Sheep Gap Fire burned approximately 15,400 acres (55 percent) of the Swamp Eddy project area. The resulting exposed soil and reduced canopy was susceptible for colonization by both native and non-native pioneer species. In 2018, high weed risk road segments within the fire perimeter were treated with herbicide to control weed populations before seed production occurred and before post-fire salvage operations began. Over the decade prior to the fire, drivable roads within the project area were treated with herbicide. Monitoring across the Lolo National Forest indicates herbicide treatment efficacy has ranged from 75 to 100 percent control of target weed species.

Recent studies from around the western United States indicate that post-fire logging treatments produce no significant statistical differences to understory plant diversity and exotic plant [weed] cover when compared to unlogged areas (Knapp and Ritchie 2016, Peterson and Dodson 2016, McGinnis et al. 2010, Keyser et al. 2009). Therefore, additional soil disturbance from ongoing salvage operations with applied mitigation has not substantially exacerbated weed risk. None of the Swamp Eddy vegetation treatments would occur within the fire perimeter and haul routes have already been treated for weeds. In addition, the salvage sales will be completed before implementation of the Swamp Eddy project begins. Weed treatments and mitigation associated with both projects would minimize the potential for weed establishment and spread in the project area.

Private land located adjacent to the project area could be a source for weed seed. Weed treatments on other lands may or may not occur depending on the landowner. Without treatments, these areas could contribute to increased existing weeds populations and possibly the number of species in the project area.

While it is unknown when the first noxious weeds were established in the project area, a good estimate would be in the late 1960s. The Lolo National Forest adopted preventive measures to avoid weed spread and establishment of new invasive species with the 1991 Noxious Weed Management Amendment to the Lolo Forest Plan. This authorized integrated pest management strategies including the use of certain herbicides. Timber sale contracts were modified to include washing of equipment to remove weed seeds prior to entry onto NFS land, herbicide spraying of haul routes, and use of weed-free grass seed to re-vegetate disturbed ground. In 2007, the Lolo National Forest adopted an adaptive and integrated weed management strategy to include treatment of new weed species, new weed populations, and use of new control methods.

Project-related ground-disturbing activities may contribute to weed spread in the project area. However, recent roadside herbicide treatments and project resource protection measures (e.g. washing mechanized equipment, minimizing ground disturbance, and revegetating disturbed sites) would minimize the potential for establishment and spread of weeds.

Forest Plan Consistency

Project activities would be consistent with the Forest Plan because all management activities would incorporate appropriate weed prevention measures outlined in Appendix W of the Plan (amended to the Forest Plan in 1991).

3.3 Soils

Forest Service Soils Manual (FSM 2550) and Region 1 Soil Quality Standards provide guidelines and methods to comply with the National Forest Management Act (NFMA). The NFMA requires that timber will be harvested from NFS lands only where soil, slope, or other watershed conditions will not be irreversibly damaged (U.S.C. 1604(g)(3)(E)). It also requires that management of NFS lands will not produce substantial and permanent impairment of the productivity of the land (U.S.C. 1604(g)(3)(C)).

Region 1 soil quality standards outlined in Forest Service Manual 2500-14-1 limit detrimental soil disturbance (DSD) to no more than 15 percent of an activity area to maintain soil productivity and show compliance with the NFMA. They are based on the use of six physical and one biological attribute to assess current soil quality and project effects. These attributes include compaction, rutting, displacement, severely-burned soils, surface erosion, soil mass movement, and organic matter.

Direct and Indirect Effects

Harvest activities would result in soil disturbance, but this disturbance would not be permanent or irreversible, based on local forest soil monitoring studies and peer-reviewed research. Best Management Practices and standard operating procedures (described in Chapter 2, section 2.1.1 and the Project File) would be applied to minimize disturbance and limit the effects of management activities on soil resources. Project-related soil disturbance would dissipate with time as illustrated by Lolo National Forest soil monitoring studies (see Project File).

All project activities would maintain long-term soil productivity, hydrologic function, and ecosystem health, consistent with the NFMA. All harvest units would meet Region 1 soil quality standards (see Soil report in Project File for detailed soil effects by treatment unit). This conclusion is based on field surveys and a review of each unit, including harvest methods, post-harvest activities, landings, unit access, and remediation.

Soil Productivity

Soil productivity is defined as the inherent capacity of the soil resource, including the physical, chemical, and biological components, to support resource management objectives. It includes the growth of specific plants, plant communities, or a sequence of plant communities (Page-Dumroese et al. 2010). In the Lolo Forest Plan, soil productivity is defined as "the capacity of a soil to produce a specific crop such as fiber and forage, under defined levels of management." (USDA Forest Service 1986, page VII-39). For this analysis, the effects to soil productivity are measured by two attributes: detrimental soil disturbance (DSD) and organic matter.

Detrimental Soil Disturbance (DSD)

The project includes timber harvest on approximately 1,766 acres, which would result in an estimated 73 acres of total DSD (4 percent of the total acres treated). These disturbances are tied to the anticipated physical footprint of harvest operations. Soil productivity would be maintained because project-related soil disturbance would dissipate with time and DSD would remain below the Regional soil quality standard threshold of 15 percent per activity area.

Tractor Harvest Units
The project includes approximately 113 acres of tractor harvest units (6 percent of the total harvest acres). Soil disturbance is typically associated with landings and wheel tracks within the main skid trails where bare soil is expected.

Detrimental soil disturbance from summer tractor harvest is estimated at 10 percent of an activity area. Past monitoring on the Lolo and Idaho Panhandle National Forests has shown estimated DSD levels from ground-based harvesting to range from 6-14 percent, including post-harvest fuel treatments (such as mechanical fuel piling and prescribed fire) (Rone 2011, Reeves et al. 2011, and Lolo NF Monitoring Reports 2006-2018).

Potential impacts from tractor harvest would be minimized by limiting harvest operations to dry soil conditions when soil strength is at a maximum; restricting equipment to slopes that are 35 percent or less; reusing existing skid trails and landings where possible; maximizing skid trail spacing; and applying erosion control measures on skid trails.

Lolo Forest Plan soil monitoring between 2006 and 2018 found that the above operational controls and soil moisture are key components for achieving soil objectives within harvest units. In addition, this monitoring illustrates that soil disturbance dissipates over time due to revegetation, natural decompaction from freeze thaw cycling, and natural soil recovery processes and forest floor building.

Skyline and Excaline Harvest Units
The project would include approximately 1,653 acres of skyline and excaline harvest units (94 percent of the total harvest acres).

Minimal soil disturbance would occur with hand-felling and hand-processing of logs on the slope. Soil disturbance occurs when moving trees to and within the corridor. Detrimental soil impacts from skyline and excaline harvest are estimated at 2-4 percent of an activity area. Disturbance from skyline harvest ranges from 0-7 percent with an average of 1-3 percent (Rone 2011, Lolo NF Monitoring Report 2018). Disturbance from excaline trails within units is similar to that from temporary roads (see below).

Log Landings
Landings would be associated with most harvest units. Landings would generally be located on flat areas away from streams and outside or on the edge of the cutting units. Where existing landings are re-used, additional disturbance would not occur or would be minimal.

Detrimental effects from landing construction could include soil compaction, litter loss, loss of coarse woody debris, increased potential for erosion, nutrient loss, loss of soil hydrologic and biologic function, and possible weed incursions. Unit-specific DSD from landings is included in the acres of soil disturbance expected from project activities calculated for ground-based units (see Soil report in Project File).

Log landings associated with tractor harvest units would generally be less than ½ acre in size. Erosion control measures would be used if needed to avoid erosion and sediment transport from landing sites during maintenance and construction. All landings would be rehabilitated and/or returned to pre-implementation conditions. Rehabilitation measures including scarification, seeding, and slash placement would encourage expedited soil function recovery and reduced erosion potential.

Temporary Road Construction
The project would construct approximately 2.6 miles of temporary road (2.4 acres within harvest units) to provide access to vegetation treatment units.

Temporary roads are considered 100 percent detrimental disturbance and have reduced soil productivity for greater than 40 years until vegetation, soil organic matter, and the forest floor is restored. Excaline trails result in similar disturbances to temporary road prisms. The project includes approximately 0.8 miles (1.6 acres) of excaline trails.

Temporary roads and excaline trails would be rehabilitated following project completion. Recontouring activities would not immediately ameliorate the long-term impacts to soil productivity but would improve soil conditions compared to those of an existing or abandoned road. The establishment of vegetation and associated additions of organic matter would encourage recovery over time. Recontouring would provide a suitable seed bed for native forest vegetation while increasing soil hydraulic conductivity, organic matter, total carbon, and total nitrogen (Lloyd et al. 2013). These conditions are likely to accelerate the recovery of soil productivity. Hydrologic recovery is expected within the first 10 years with soil infiltration rates lower than undisturbed forest rates for the first 10 years (Luce 1997). For the long-term, infiltration rates improve over time as freeze/thaw cycles and plant roots improve soil porosity. Soil biological function restores as forest floor and native plant communities return to the temporary road base.

Road Decommissioning
The project would decommission approximately 2 miles through slope recontouring and 2 miles through road surface ripping, placement of woody debris, removal of structures, reshaping of stream crossings, installation of water bars, and seeding of the road prism. Although there would be soil disturbance and an elevated risk of soil erosion in the short-term; re-establishing the soil gas and hydrologic exchange and soil biotic processes would expedite soil productivity recovery (Lloyd et al. 2013, Luce 1997).

Prescribed Fire and Non-commercial Thinning
The project includes approximately 687 acres of low severity prescribed burning, 741 acres of mixed severity prescribed burning, and 278 acres of non-commercial thinning. Non-commercial treatments are a low risk to soil resources; the Lolo Soil Monitoring Reports show that there is little long-term

impact associated with non-commercial thinning (by hand) (Lolo Soil Monitoring Reports 2005-2018).

Low and moderate severity prescribed fire treatments benefit soils. The ecosystems within the Swamp Eddy project area are fire-adapted; fire is a necessary and low impact method to remove excess fuels, expedite biogeochemical cycling, and invigorate seed sources in forest floor materials (Ball et al. 2010, Deluca et al. 2006).

Recreation Activities

Activities to provide for resource protection and public health and safety at the mouth of Swamp dispersed recreation site would benefit soils because they would concentrate disturbance within a designated, managed footprint. Rehabilitated areas would have improved soil productivity over time as the vegetation recovers on previously disturbed sites.

Organic Matter

Organic matter and coarse woody debris are good indicators of site resiliency and overall forest health. Organic matter, including the forest floor and large woody material, is essential for maintaining ecosystem function by supporting moderate soil temperatures, improved soil water availability, and biodiversity (Page-Dumroese et al. 2010).

Although timber harvest would remove biomass and site organic matter, the Swamp Eddy project would maintain soil productivity because nutrient replenishment, forest floor, and humus stores would remain on site (Busse et al. 2009). Where organic matter concentrations are low, soil mitigations would leave coarse woody debris on site. Powers (2002) concludes soil productivity should be preserved if the loss of biomass, organic matter, soil porosity and topsoil is limited. Outside of landings and skid trails, large areas (greater than 100 square feet) with detrimental levels of soil disturbance would not occur because project design features, standard operating procedures, best management practice measures would be applied (see Chapter 2).

Soil Stability

Soil stability is tied closely to soil erosion. Harvest activities would not occur on areas with high soil erosion hazard as determined through field surveys. Best management practice measures would be applied to reduce bare surface soil exposure, erosion, and off-site movement of soil material. Soils in the project area are stable in their undisturbed state. Following harvest operations there is potential for a short-term increase in erosion where bare soil is exposed on main skid trails and/or landings. However, erosion control measures would be applied to these areas to minimize erosion potential until the vegetation re-establishes to cover the soil. Erosion events, if they occur, would be small in extent and would not cause long-term changes to soil productivity.

In addition, temporary road segments were field-reviewed and determined to be located within soil types that are suited for road construction. No mass failure concerns were identified.

Cumulative Effects

For activities to be considered cumulative, their effects need to overlap in both time and space with those of the proposed actions. The appropriate geographic area for soil cumulative effects analysis has been defined as the “land affected by management activity” (USDA Forest Service 2014: R1 Supplement 2500-14-1). This is because soil productivity is a site-specific attribute of the land. The productivity of one area of soil is not dependent on the productivity of another area whether that area is adjacent or not. Similarly, if one acre of land receives soil impacts from management activities and a second management activity that may affect soils is planned for that same site, then soil cumulative effects are possible on that site. Thus, cumulative effects to soil productivity are appropriately evaluated on a site-specific basis. A larger geographic area such as a watershed or project area is not considered an appropriate geographic area for soil cumulative effects analysis. Assessment of soil quality within a large area (such as a watershed) a can mask or "dilute" site-specific effects. Thus, cumulative effects to soils are evaluated for site-specific activity areas (i.e. proposed vegetation treatment units), not for the entire watershed or project area.

As discussed above, the post-project detrimental soil conditions for all vegetation treatment units would be below 15 percent within each activity area and meet Region 1 soil quality standards (see Soil report in Project File). This assessment of post-project soil conditions reflects the cumulative effects to soils because it considers existing soil conditions resulting from any previous management or natural events that affected the soil as well as the direct and indirect effects of this project's activities. There are no reasonably foreseeable future actions that overlap the activity areas; therefore, there would be no additional cumulative effects than what is described above.

There would be no cumulative effects with the Sheep Gap Fire or post-fire salvage because no areas affected by these events would be harvested under the Swamp Eddy project.

Consistency with the Forest Plan and Other Direction

The project is consistent with the Lolo Forest Plan, National Forest Management Act, and Forest Service directives. The project is consistent with the goals, objectives, and standards for soil resources set forth in the Lolo Forest Plan because project design criteria and Best Management Practices have been included to protect soil resources and limit the disturbance footprint; landscapes with sensitive soils would be protected; and land productivity would be maintained (Forest-wide standard 18, Forest Plan, page II-12). Large wood levels have been considered as found in the Lolo National Forest Down Woody Material Guide (2006) and Graham et al. 1994. A soil scientist has been involved in project planning and would be involved with the project through implementation by coordinating with other team members including silviculture and timber specialists to ensure the maintenance and enhancement of soil resources.

Forest Service Manual 2500, R1 Supplement 2500-14-1 establishes guidelines that limit DSD to no more than 15 percent of an activity area. All units would meet Region 1 soil quality standards following project implementation; this assessment is based on a consistency review completed for each unit that included harvest methods, landings, unit access, and remediation (see Soil report in Project File).

The National Forest Management Act (NFMA) requires that all lands be managed to ensure maintenance of long-term soil productivity, hydrologic function, and ecosystem health. All proposed activities are consistent with this direction and would not result in irreversible damage to the soil resource.

3.4 Aquatics

Issue Raised in Public Comment

Timber harvest and road construction could adversely affect environmental resources, including water quality, aquatic habitat, and wildlife habitat.

The Swamp Eddy project area contains two watersheds: Swamp Creek and Miller Creek. The tributaries to Swamp Creek include West Fork Swamp Creek, East Fork Swamp Creek, and Bemish

Creek. In the Miller Creek watershed, Miller Creek and West Fork Combest Creek are tributaries to Combest Creek. Both Swamp Creek and Combest Creek flow into the Clark Fork River.

Approximately 67 percent of the land in the Swamp Creek watershed is National Forest; however, the Miller Creek watershed consists mostly of Weyerhaeuser, State, and other private ownership. In both watersheds, the upper portions are NFS lands, and the middle and lower sections are State and private land.

The lower portions of West Fork Swamp Creek, East Fork Swamp Creek, and Swamp Creek between the mouth and confluence of the forks are seasonally intermittent. The higher elevation reaches of Bemish Creek and East and West Fork Swamp Creeks support perennial (yearlong) flows. Streams in the Miller Creek watershed are similar in which some streams go subsurface or lose much of their flow in the lower reaches. Stream channel intermittency in the project area is a natural phenomenon. The surface geology is porous and tends to have lower base elevations for water tables (Sando and Blasch 2015).

The Montana Department of Environmental Quality identifies the lower 4.8 miles of Swamp Creek on private land outside the project area as water quality impaired (Montana DEQ 2018). Impairment is due to nitrates/nitrites, total nitrogen, and phosphorous attributed primarily to livestock grazing; and sedimentation due to roads, grazing, stream channelization, and timber harvest. The Thompson Project Area Total Maximum Daily Load (TMDL[8]) Plan (Montana DEQ 2014) assigns a sediment budget for Swamp Creek with reductions allocated for forest roads and upland sources including timber harvest. These sources can be mitigated by riparian buffers and forestry BMPs, both of which would be applied in the Swamp Eddy project.

The 2017 Sheep Gap Fire burned about 15,997 acres (56 percent) of the Swamp Creek watershed and a small portion (146 acres, less than 1 percent) of the Miller Creek watershed. About half of the area affected by the fire burned at moderate to high severity. Field surveys in the spring after the fire found water discharge in streams and in locations that would not generally flow water. Flows in established streams were generally bankfull or less and no channel scour was observed. Surveys conducted in fall 2018 and spring 2019 indicated stream channels are stable, with roots and logs holding the banks. Understory vegetation is common and recovering in riparian areas. Streams are not incised and have access to the historic floodplain.

Sampling data indicates that non-native brook trout and rainbow trout are the most abundant fish species within project area streams and typically occur in the middle to lower reaches (Montana FWP and USDA Forest Service unpublished data). Native westslope cutthroat trout[9] occur in most project area streams with higher densities in the mid to upper reaches (ibid.). There are no bull trout[10] in the Swamp or Miller Creek watersheds. However, the Clark Fork River is bull trout occupied and designated bull trout critical habitat[11].

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[8] A TMDL is a pollution budget identifying the maximum amount of a particular pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded.
[9] Westslope cutthroat trout is a designated Forest Service, Region 1 sensitive species, which indicates viability of the species is a concern.
[10] Bull trout is listed as a Threatened under the Endangered Species Act.
[11] Critical habitat is defined in the Endangered Species Act as a specific geographic area(s) that contain features essential for the conservation of a threatened or endangered species and that may require special management and protection.

Direct and Indirect Effects

The project includes resource protection measures (see Chapter 2) to minimize or avoid potential effects to water resources.

The project would not create permanent or long-term unnatural stress on project area streams. It would not affect stream temperature or measurably affect water yield. Fine sediment potentially generated from road maintenance and haul would be of relatively short duration generally occurring during spring runoff or intense rain events over a 3-5 year period and not continuous in nature. The magnitude of project-related short-term sediment delivery would be low compared to existing conditions. The intensity of the sediment effects would also be low based on the relatively small amounts of sediment delivered where they would occur and the limited timing of potential delivery. Thus, the sediment generated from the implementation of project activities would not adversely affect stream stability, substrates, or channel structure (Megahan and King 2004).

Once the project is completed, human-caused sediment in project area streams would be reduced below baseline conditions due to improvements at the mouth of Swamp dispersed recreation area, decommissioning of 2.2 miles of road located within 300 feet of streams, and the improved drainage features applied to haul roads that would continue to be effective post-project.

Temperature

Stream temperature is heavily influenced by solar radiation as a primary influence (Johnson 2004; Caissie 2006). Shade from overhead riparian canopy is the most effective variable to reduce radiant heat sources (Krauskopf et al. 2010).

The project would not affect stream temperature. Riparian and streamside areas would be buffered to protect riparian habitat conservation areas (RHCAs)[12] and no vegetation removal would occur in these areas (see Resource Protection Measures in Chapter 2).

Water Yield

Swamp Eddy vegetation treatments and road activities would not have measurable effects to water yield. Using historical open area conditions, approximately 24 percent of the watershed areas most likely occurred in seedling/sapling or stand replacement condition (Fischer and Bradley 1987). Burton (1997) found that drainages containing more than 30 percent of their area in an open condition (measured by Equivalent Clearcut Acres or ECAs[13]) are considered to have potential for changes in runoff quantities and timing.

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[12] Riparian Habitat Conservation Areas (RHCAs) include traditional riparian corridors, wetlands, intermittent streams and other areas that help maintain the integrity of aquatic ecosystems by influencing the delivery of coarse sediment, organic matter, and woody debris to streams; providing root strength for channel stability; shading the stream; and protecting water quality (Naiman et al. 1992).

[13] Equivalent Clearcut Area or ECA is a common indicator of cumulative watershed effects used to measure the relative loss and recovery of hydrologic function for a forest canopy in areas with snowmelt-dominated runoff (Ager and Clifton 2005). Forest canopy intercepts precipitation and affects snow accumulation and melt, sublimation, evapotranspiration, and temperature moderation (Lewis and Huggard 2010). Any activity that alters the forest canopy has the potential to affect snow accumulation and ablation and subsequent stream runoff timing and magnitude (Grant et al. 2008). When stream flows are higher than those in which the stream evolved for long durations, stream channels may be altered. This creates the potential for bank scour, erosion, and subsequent increases in bedload deposition.

Current ECAs in the Swamp and Miller Creek watersheds are estimated to be 26 and 23 percent, respectively, which is likely within the range of natural variability. Most of the existing ECA is attributed to the 2017 Sheep Gap Fire combined with past timber harvest on state and private lands that occurred within the last decade. Effects of the fire and past harvest dissipate with time as vegetation continues to grow. In-channel surveys conducted within the Swamp Eddy project area do not indicate negative stream channel alterations from management or fire-induced water yield.

The Swamp Eddy project would increase ECA in the Swamp and Miller Creek watersheds by about 3 and 4 percent, respectively. The projected reduced forest canopy conditions resulting from the project combined with the existing condition would be below the thresholds that research indicates would result in detrimental changes in water yield. Thus, peak stream flows would not be affected (see Hydrology report in the project file for more information).

Sediment

Recreation Improvements
Resource protection activities would be conducted at the mouth of Swamp dispersed site. The primary access road would be relocated to reduce the potential for sediment delivery into the Clark Fork River. In addition, boulders or other natural materials would be placed to confine motorized use to the designated road and off the river bank where damage is occurring.

Vegetation Treatments
Vegetation treatments would have no effect to water resources because activities would occur outside of RHCAs (see Resource Protection Measures in Chapter 2) at distances with little to no probability of sediment delivery (Litchert and MacDonald 2009). In addition, the acres treated would be a relatively small percentage of the watersheds. Harvest would occur on approximately 3 and 5 percent, respectively, of the Swamp and Miller Creek watersheds. RHCAs were designed to protect critical riparian values, and existing and future fish habitat (USDA FS 1995). Forestry best management practices would be applied to minimize ground disturbance and soil erosion, which are effective in controlling sediment generation and delivery to streams (Litchert and MacDonald 2009).

Temporary Road Construction
Road encroachment or proximity to water bodies is an indicator of a road's potential to deliver sediment. Roads within 300 feet of a water body are the most likely to deliver sediment (Belt et al. 1992). Monitoring conducted within a research area found that roads within 10 meters (33 feet) of streams delivered 74 percent of the road-related sediment (Cissel et al. 2013).

The 2.6 miles of temporary road construction would have no measurable effect to water resources including fish and fish habitat because of its location. Temporary roads would not cross any streams or be within 300 feet of stream. In addition, construction would occur only in dry weather periods during the summer or fall (see Resource Protection Measures in Chapter 2). Temporary roads would be decommissioned following use for this project.

Road Decommissioning
Approximately 4 miles of road would be physically decommissioned. About 3.5 miles of physical decommissioning would occur in the Swamp Creek watershed and ½ mile in the Miller Creek watershed, which would reduce the project area total miles of road within 100 feet and 300 feet of stream channels by 0.7 and 2.2 miles, respectively.

Although decommissioning activities may temporarily yield additional sediment to area streams during the first year, the quantity would be low due to implementation during dry weather periods and application of best management practices. Once the decommissioning activities were completed, sediment delivery potential would be reduced below existing conditions. Several researchers have found similar results with short-term sediment pulses and long-term chronic sediment decreases from road decommissioning near streams (Hickenbottom 2001; Madej 2001; Switalski et al. 2004).

Road Maintenance and Use

Maintenance would be conducted on approximately 47 miles of roads prior to their use for haul activities (see Table 3.4-1). Activities would include roadside clearing and/or brushing, road surface blading and reshaping, road drainage maintenance and improvement.

Table 3.4-1: Road Maintenance and Use by Watershed

Watershed	**Haul Route** (miles)	**Miles of haul route within 300 feet of streams**
Swamp Creek	27.4	11.8
Miller Creek	19.9	6.5
TOTAL	**47.3**	**18.3**

Road maintenance and haul on roads with stream crossings and those near streams could temporarily increase sedimentation into streams during rain events and/or runoff periods. However, improving and maintaining drainage is an effective way to reduce road-related sediment production (Coe 2006; MacDonald and Coe 2008; USEPA 2005; NCASI 2012). Road drainage structures are used to disconnect road segments from the stream channel network (Coe 2006). Drainage structures installed at appropriate intervals remove storm water from the roadbed before the flow gains enough volume and velocity to erode the surface. Appropriately spaced structures also reduce the downslope transport distance of material off the road surface (Coe 2006, Luce and Black 1999). The proper placement of structures routes the discharge onto the forest floor so that water disperses and infiltrates before reaching a stream (Croke and Hairsine 2006, Woods et al. 2006, Sugden and Woods 2007, Packer 1967).

Following project implementation, best management practice measures installed on haul routes would remain effective. Therefore, the potential of sediment production and delivery from existing roads would be less than the existing condition.

Project-related sediment delivery could cause a short-term increase in turbidity immediately downstream of delivery points, which may temporarily cause fish to move away from affected areas but would not result in mortality (USDI FWS 2010).

If project-generated sediment were to reach the Clark Fork River more than 5 miles downstream, it would be so diluted that any potential effects to water resources in the river would be negligible. The high volume of water in the river would further dilute any potential project-related sediment, rendering it undetectable and inconsequential. Therefore, the project would have no effect to water quality, fish, or aquatic habitat in the Clark Fork River.

Cumulative Effects

In Swamp Creek, the 2017 Sheep Gap Fire resulted in increased sediment delivery from hillslope erosion. However, increased erosion due to wildfire generally occurs during the year following the fire, but as vegetation recolonizes sites, erosion stabilizes (Neary et al. 2005). Field surveys indicate that the vegetation is recovering within burned areas and stream channels show no scour or detriment. The Swamp Eddy project would likely be implemented beginning in fall 2021, four years post-fire. Thus, hillslope erosion would likely have dissipated by that time.

Approximately 2000 acres of post-fire salvage will be completed prior to the implementation of the Swamp Eddy project. Another 500 acres of post-fire salvage was completed on State and Weyerhaeuser land in 2018. None of the salvage overlaps in time or space with the Swamp Eddy project. Salvage operations applied appropriate stream buffers, erosion control measures, and other resource protections recommended in the scientific literature, which essentially eliminated the potential for sediment delivery from salvage harvest into streams. Prior to salvage haul activities, road maintenance including road surface reshaping, spot graveling, drainage maintenance and improvement was conducted. These actions complemented the burned area emergency response (BAER) work completed after the fire, which included 25 miles of storm-proofing drainage maintenance and 32 culvert upgrades. Best management practice measures installed along haul routes would still be in place during the Swamp Eddy project. On road segments that would be used by both project, BMP measures would be maintained through the life of the Swamp Eddy project.

Although livestock grazing has impacted water resources in the past, it is currently halted in the burned area until it recovers. In addition, an exclosure was constructed around a wetland in 2012 to keep livestock out. The Swamp Eddy project is unlikely to contribute to the past effects of grazing because no harvest would occur within stream buffers and best management practice measures would be installed on roads prior to haul.

Timber harvest and associated road construction on State and Weyerhaeuser lands within the last decade likely had limited short-term effects to water resources because these landowners employ best management practices and have high rankings on State BMP audits. They also follow state streamside management zone (SMZ) requirements. Adverse cumulative effects of these past actions and the Swamp Eddy project are unlikely. As previously described, road-related sediment delivery following the Swamp Eddy project would be less than the existing condition. The water yield analysis considered past harvest on all ownerships and proposed harvest in Swamp Eddy. The projected reduced forest canopy conditions resulting from the project combined with the existing condition would be below the thresholds that research indicates would result in detrimental changes in water yield.

In upper the Swamp Creek watershed under Forest Service jurisdiction, PacFish/InFish biological opinion monitoring (PIBO) measurements and observations indicate an improving trend in aquatic parameters. Cumulatively, considering the Swamp Eddy project and all other activities, watershed health, stream condition, and aquatic habitat are most likely maintained or slightly improved due to road maintenance work (specifically improved drainage), culvert upgrades, road decommissioning, and grazing improvements.

Biological Determination of Effects on Sensitive and Listed Species

The project would not affect the viability of westslope cutthroat trout or result in a trend toward Federal listing of this species under the Endangered Species Act for the reasons stated above.

The project would have no effect on bull trout or bull trout critical habitat. This species is not present in project area streams. If the low quantity of project-generated sediment delivery occurring more than 5 miles upstream of the Clark Fork River were to eventually enter the river, it would be so diluted and negligible that there would be no effects to the species or designated critical habitat.

Regulatory and Forest Plan Consistency

The project is consistent with the Lolo Forest Plan.

- Best management practices have been incorporated into the project and would be applied to assure that water quality is maintained at a level that is adequate for the protection and use of the National Forest and that meets or exceeds Federal and State standards. (Forest-wide standard 15, Forest Plan, page II-12)
- Project-related increases in water yield would be immeasurable so channel damage would not occur as a result of land management activities. (Forest-wide standard 19, Forest Plan, page II-12)
- The project is consistent with Endangered Species Act recovery goals. The project was designed to be compatible with the habitat needs of bull trout in Clark Fork River through resource protection measures, best management practices, and project design. (Forest-wide standard 24, Forest Plan, pages II-13 to 14)
- The project was designed to have minimum impacts on the aquatic ecosystem and would not cause permanent or long-term unnatural stress. (Forest-wide standard 28, Forest Plan, page II-14)
    - Aquatic insect density or diversity are not expected to change because the relatively small amount of sediment delivered during project implementation would most likely occur during periods of high runoff that correspond to high stream flows, which would quickly dilute the sediment. If any impacts to macroinvertebrates were to occur, they would likely be indistinguishable from natural fluctuations in population (McElravy et al. l989; Gravelle et al. 2009).
    - Fish populations would not be reduced.
    - It is unlikely that intragravel sediment accumulations would be affected due to the stream types, the relatively short duration of the activities, and low magnitude, timing, and intensity of the project-generated sediment.
    - Channel structure would not be adversely affected because there would be no measurable change to water yield. The relatively small quantity of fine sediment generated by road-related activities would not cause aggradation or changes to channel morphology (Megahan and King 2004).

The project is consistent with the Inland Native Fish Strategy (amended to the Forest Plan in 1995) requirements and direction.

Thompson Project Area TMDL (2014)
Swamp Creek is a water quality limited stream with a designated TMDL reduction for sediment. Specific road treatments have been recently employed and are also prescribed in the Swamp Eddy project that would lead to a substantive number of culvert upgrades, road decommissioning, and drainage improvements. BMPs would be employed to further reduce sedimentation from forest road activities. Forestry BMPs and streamside protective buffers would be applied to retain large woody debris and aquatic habitat and detain sediment production. With these actions, the project would mitigate potential aquatic issues and meet standards for the Clean Water Act. Following project implementation, road-related sediment delivery in Swamp Creek would be reduced below existing conditions.

3.5 Wildlife

Issues Raised in Public Comment

- Regeneration harvest could adversely affect wildlife cover/security, particularly considering past harvest on State and private industrial timber lands.
- Timber harvest and road construction could adversely affect environmental resources, including water quality, aquatic habitat, and wildlife habitat.

The Lolo National Forest provides habitat for many different species of wildlife, several of which occur within the Swamp Eddy project area. The presence or absence of these species depends on the amount, distribution, and quality of each animal's preferred habitat. Some of these species are affected by hunting or trapping, which is regulated by Montana Fish, Wildlife and Parks (Montana FWP). This analysis focuses on species listed as federally threatened or endangered on the Lolo National Forest (USDI-FWS 2016) and Forest Service sensitive species (USDA-FS 2013). The table below provides a list of species, preferred habitat, whether the habitat or species are present in the project area, and whether detailed analysis was conducted for that species. If a species or their habitat does not occur within the project area, no further analysis was conducted. Management Indicator Species (MIS)[14] including elk, northern goshawk, and pileated woodpecker are addressed to determine project compliance with Lolo Forest Plan standards and management area direction (USDA-FS 1986).

Table 3.5-1: Wildlife Species Considered in the Swamp Eddy Analysis

Species	Status on Forest	Preferred Habitats	Species Present in Analysis Area	Habitat Present in Analysis Area
Grizzly Bear	Threatened	Alpine/subalpine coniferous forest, lower elevation riparian areas in spring, lack of human disturbance.	In May 2019, a radio-collared male bear passed through the eastern end of the project area.	Yes, suitable habitat is present. Project area is outside grizzly recovery zones but is within an area mapped by the U.S. Fish and Wildlife Service where "bears may be present".
Canada Lynx	Threatened	Subalpine fir habitat types (including cover types with pure or mixed subalpine fir, lodgepole pine, Douglas-fir, grand fir, western larch, and hardwoods) above 4,000 feet in elevation, vertical structural diversity in the understory (down logs, seedling/saplings, shrubs, forbs) for foraging and denning	Snow tracking and bait station surveys over the last 20 years have not detected the species in the project area.	Yes, suitable habitat is present. Project area is not within designated critical habitat.

[14] Management Indicator Species are species identified in the Lolo Forest Plan that are used to monitor the effects of planned management activities on viable populations of wildlife or fish including those that are socially or economically important (Lolo Forest Plan, page VII-15).

Species	Status on Forest	Preferred Habitats	Species Present in Analysis Area	Habitat Present in Analysis Area
Yellow-billed Cuckoo	Threatened	Riparian willow-cottonwood forests along low-gradient rivers and streams, and in open riverine valleys that provide wide floodplain conditions (greater than 325 feet). The optimal size of habitat patches is generally greater than 200 acres in extent and have dense canopy closure and high foliage volumes of willows and cottonwoods. (79 FR 48551)	No records of species presence in Sanders County	No. **Dropped from further review. No effect.**
Wolverine	Proposed	High elevations centered near the tree line in coniferous forests, rock alpine habitat above tree line, cirque basins, and avalanche chutes that have food sources. Deep, persistent, and reliable spring snow cover (to mid-May) is the best predictor of wolverine occurrence.	No observations within or near the project area.	Suitable habitat (reliable spring snow cover) limited to the upper reaches of West Fork Swamp Creek.
Gray Wolf	Sensitive	Habitat generalists.	Wolves have been observed in project area.	Yes, suitable habitat present.
Fisher	Sensitive	Moist mixed coniferous forested types (including mature and old-growth spruce/fir forests at low- to mid-elevations), riparian/forest ecotones.	Snow tracking and bait station surveys conducted in 2015 detected one fisher within project area (Bemish Creek).	Yes, suitable habitat present.
Northern Bog Lemming	Sensitive	Wet riparian sedge meadows, bog fens with extensive sphagnum moss mats.	Species not present.	No. **Dropped from further review. No impact.**
Townsend's Big-Eared Bat	Sensitive	Roosts in caves, mines, rocks and buildings. Snag roosting habitat also important. Forages over tree canopy, wet meadows, riparian areas and open water.	Species not present.	No. **Dropped from further review. No impact.**
Peregrine Falcon	Sensitive	Cliff nesting (ledges); riparian foraging (small bird species prey).	Species not present.	No. **Dropped from further review. No impact.**
Bald Eagle	Sensitive	Nesting platforms near a large open water bodies (greater than 80 acres) or major river system; available fish and water bird species prey, secure nesting habitat.	An eagle nest is located near the mouth of Swamp dispersed recreation site along the Clark Fork River.	Yes, suitable habitat present within ¼ mile of Clark Fork River.

Species	Status on Forest	Preferred Habitats	Species Present in Analysis Area	Habitat Present in Analysis Area
Black-backed Woodpecker	Sensitive	Burned forests or less typically, coniferous forests with high insect infestations (i.e. bark beetles)	Species likely present within 2017 Sheep Gap Fire perimeter.	Yes, suitable habitat is present within the portion of the project area burned by the 2017 Sheep Gap Fire. No project activities other than road work and use would occur within fire perimeter.
Common loon	Sensitive	Lake habitat. Secure nesting and brood rearing areas.	Species not present.	No. **Dropped from further review. No impact.**
Flammulated Owl	Sensitive	Mature (greater than 9 inches diameter breast height (dbh)) and old-growth ponderosa pine with abundant moth species prey. Secure nesting habitat (greater than 35% canopy cover).	Species detected within project area.	Yes, suitable habitat present.
Harlequin Duck	Sensitive	During the breeding season, found near large, fast flowing mountain streams.	No observations within the project area.	Marginal habitat located within a 1-mile segment of lower Swamp Creek where no activities would occur. **Dropped from further review. No impact.**
Coeur d'Alene Salamander	Sensitive	Wet, fractured, moss-covered rock, waterfalls	No observations within the project area.	Potential habitat is located within small, steep tributary drainages in West Fork Swamp and Dee Creeks, where no project activities would occur. **Dropped from further review. No impact.**
Northern Leopard Frog	Sensitive	Typically in or adjacent to permanent slow moving or standing water bodies with considerable vegetation	Species not present.	No. **Dropped from further review. No impact.**
Boreal Toad	Sensitive	Variable including; wetlands, forests, woodlands, sagebrush, meadows and floodplains. Overwinters in caverns or rodent burrows	No toads detected within project area	Yes, suitable habitat present.

Species	Status on Forest	Preferred Habitats	Species Present in Analysis Area	Habitat Present in Analysis Area
Bighorn Sheep	Sensitive	Inhabits steep, rocky open slopes	Occasionally, sheep have been observed on the edge of the project area along the CC Divide between Combest and Miller Creeks in the eastern portion of the project area.	Limited suitable habitat is located in the eastern end of the project area.
Northern Goshawk	MIS	West of Continental Divide: Stands with mean diameter of greater than 10 inches, crown closures of at least 40% and elevations below 6,200 feet. Foraging habitat is variable but typically in mature stands with dense canopies fairly open understories	Surveys detected species presence within project area.	Yes, suitable habitat present.
Pileated Woodpecker	MIS	Moderately warm, dry Douglas-fir/ponderosa pine; moderately cool, dry Douglas-fir; moist mid-elevation spruce/grand fir. Large, soft snags (greater than 21 inches diameter breast height).	Yes, species present	Yes, suitable habitat present.
Elk	MIS	Habitat generalists, secure habitat during the hunting season, secure winter range.	Yes, species present	Yes, suitable habitat present

Threatened Species

The Endangered Species Act (ESA, PL 93-205, as amended) regulates threatened and endangered species management. Under ESA, the Forest Service shall carry out recovery programs developed by the U.S. Fish and Wildlife Service (USFWS) and must prepare a biological assessment for any action that is likely to affect a listed species or its habitat (16 USC 1536(c)). Forest Plan standard 24 (page II-13) states that all threatened and endangered species will be managed for recovery. Standard 27 (page II-14) states that management practices in essential habitat for threatened and endangered species must be compatible with the species' needs. Management guidelines for project-level planning for threatened and endangered species are outlined in species-specific recovery plans and/or conservation strategies.

In accordance with Section 7(c) of ESA, the U.S. Fish and Wildlife Service determined that the following listed threatened wildlife species may be present on the Lolo National Forest: Canada lynx and grizzly bear. In addition, wolverine, which is currently proposed for listing, may be present. There is no designated critical habitat for any species within the project area.

Grizzly Bear

Grizzly bear was listed as threatened under the Endangered Species Act in 1975. The Lolo National Forest encompasses portions of three grizzly bear recovery areas, the Northern Continental Divide, Cabinet-Yaak, and Bitterroot. The Swamp Eddy project area is not located within a grizzly bear recovery area. The Mount Headley Bear Management Unit (#22) of the Cabinet-Yaak Grizzly Bear Recovery Zone is the nearest to the Swamp Eddy project area. It is located across the Clark Fork River, Highway 200, and a main railway.

The project area is located within an area mapped by the USFWS (2017) where bears may be present. In May 2019, a radio-collared male grizzly bear that originated from the Cabinet-Yaak Recovery Zone was documented within the project area near Patrick's Knob. Six days later, it was located approximately 20 miles to the southwest near I-90, outside the project area. This evidence suggests that individual bears may occasionally pass through the project area.

Grizzly bears are opportunistic omnivores (Schwartz et al. 2003) and feed on an array of animals and plants. Their opportunistic selection of food items has permitted bears to occupy a great variety of vegetation types in North America (Herrero 1972). In Montana, grizzly bears use meadows, seeps, riparian zones, mixed shrub fields, closed timber, open timber, snow chutes, and alpine habitats. Habitat use is highly variable between areas, seasons, local populations, and individuals (Servheen 1983, Craighead and Mitchell 1982, Aune et al. 1984). The Swamp Eddy project area would likely provide suitable foraging habitat for grizzly bears.

For this analysis, the following factors are used to evaluate the project's potential effects on grizzly bears:

- Open road density: Studies indicate that bears change use patterns within their home ranges to avoid roaded areas (Mace and Waller 1997, Wakkkinen and Kasworm 1997). Open roads increase risk of bear mortality.
- Vegetative cover: Grizzly foraging behavior is typically associated with more open habitats but bears generally forage in areas with some type of hiding cover nearby (Servheen 1983, Waller and Mace 1997).
- Human developed sites. These sites can affect grizzly bears through food conditioning issues resulting in conflicts and bear use patterns that may avoid higher human use areas.
- Riparian areas: These areas are important for their use as both travel corridors and high use foraging areas (Servheen 1983).
- Disturbance

Direct and Indirect Effects

The project would not likely adversely affect grizzly bears because:

- In the occasional event that a bear was present during implementation, temporary displacement could occur, but there are suitable, undisturbed habitats available for a bear to move to.
- None of the proposed activities would preclude grizzly bear use or movement within the area.
    - Vegetation treatments would maintain a mosaic of forested cover. Harvest treatments would increase grass/forb/shrub production (Zager et al. 1983; Kerns et al. 2004) and maintain forested connectivity that may provide a bear moving through the area with foraging opportunities and cover. Studies indicate that grizzly bears in Montana do well in areas with a diversity of habitat types, including those with cover and those without (Servheen 1983, Waller and Mace 1997). Grizzly foraging behavior is typically associated with more open habitats but bears generally forage in areas with some type of hiding cover nearby, especially during the day (ibid.).

    - Open road density would essentially remain the same; therefore, existing security would be maintained.
    - Riparian areas would be protected and unaffected by vegetation treatments (see Resource Protection Measures in Chapter 2).

- Food/wildlife attractant storage restrictions apply on all NFS lands on the Lolo National Forest.

Open Road Density
The project would not measurably change open road density. Although one mile of existing non-system road would be added to the National Forest road system and be kept open yearlong to public motorized use, this use is already occurring. These roads are primarily located at the mouth of Swamp dispersed recreation site, where public use is ongoing between a paved county road and the Clark Fork River.

The 2.6 miles of temporary roads constructed for this project would remain closed to public motorized use during the life of the project and would be recontoured, prohibiting all motorized use following project completion.

Vegetative Cover
Changes in hiding cover can affect bears if they are at a higher risk of being shot (e.g. along an open road). However, the potential impacts of altering cover are mitigated because vegetative cover (trees and/or shrubs) would be retained in all harvest units to varying degrees, which would maintain the overall forested nature of the area.

Regeneration harvest would occur on approximately 1256 acres (4 percent of the project area). Although these treated areas would generally appear as openings in the forest, they would still retain some vegetative cover, including overstory trees. Regeneration harvest treatments are dispersed within the project area and nested among forested areas. Therefore, the forested nature of the affected portion of the project area would be maintained.

Human Developed Sites
The project would not increase the potential for human/bear interactions at the mouth of Swamp dispersed recreation site because use levels are not expected to measurably increase. Activities at this site are prescribed to address resource concerns and would not likely attract more visitors. In 2011, the Lolo National Forest implemented an expanded food/wildlife attractant storage order requiring all users of the National Forest to properly store all attractants in a “bear resistant” manner. This storage is required by the public, Forest Service personnel, and contractors. The food storage order reduces the risk of bear/human conflicts. Thus, the project would not result in adverse effects associated with attractants.

Riparian Areas
Cover and forage in riparian areas would not be affected because no vegetation management activities would occur within Riparian Habitat Conservation Areas (see Resource Protection Measures in Chapter 2).

Disturbance
Individual grizzly bears could be occasionally present within the Swamp Eddy area during project implementation. The likelihood of directly affecting even one bear is low. Direct effects, if they should occur, would be in the form of disturbance and displacement caused by mechanical treatments, prescribed burning, and road work. Most project activities would occur between June and October

over about a 10-year period (including post-harvest activities), although operations may not occur every year within that timeframe. If a bear were present during project implementation, it could be temporarily displaced. The effects would be discountable because activities would not occur all at once but would be separated in time and space such that large portions of the project area would provide suitable areas for displaced individuals. Because grizzly bears are habitat generalists and opportunistic omnivores, a displaced individual could easily find alternate suitable areas to forage within the area.

The temporary increase in traffic associated with project activities (generally from June to October) would not rise to a level that would cause a barrier to animal movement (Mace and Manley 1993).

Cumulative Effects

Past regeneration timber harvest in the project area (except for the Sheep Gap post-fire salvage discussed below) occurred more than 20 years ago. These areas have regenerated and contribute to the mosaic of vegetative cover in the project area.

The 2017 Sheep Gap Fire burned approximately 55 percent of the Swamp Eddy project area. About 10,000 acres (36 percent of the project area) burned at high severity, resulting in a short-term reduction of hiding cover due to the loss of live vegetation. Regeneration of trees and understory vegetation would provide sufficient cover within about 10-15 years. Post-fire salvage is occurring on approximately 2000 acres of the burned area (about 13 percent) within the Swamp Eddy project area. Salvage operations are primarily within high severity burn areas where hiding cover was reduced by the fire. Research indicates that salvage does not preclude the development of post-fire cover (Peterson and Dodson 2016, Knapp and Ritchie 2016). Therefore, salvaged areas are expected to develop sufficient cover within the 10-15 year timeframe as described above for high severity burned areas.

Timber harvest proposed in the Swamp Eddy project would regenerate another 4 percent of the project area, outside the Sheep Gap Fire perimeter. Although some trees and shrubs would be retained in all harvest units to varying degrees, hiding cover would be reduced for approximately 10-15 years until trees and other vegetation regenerate to a height that would conceal a bear.

Cumulatively, approximately 40 percent of the project area would have reduced hiding cover for the next 10-15 years. Since the forested connectivity of the project area would be maintained on the remaining 60 percent (nearly 17,000 acres), individual bears could find foraging opportunities and cover as they move through the area.

Because post-fire salvage work will be completed before implementation of the Swamp Eddy project, there will be no cumulative effects from potential disturbance or displacement.

The forests on the industrial timber land and state land adjacent to the project area have a mosaic of variable tree densities resulting from past harvest. The hiding cover was reduced in areas of heavier harvest, however trees and shrubs are growing in the openings, which will soon provide adequate concealment for large mammals, like bears.

Forest Plan Consistency

The project is consistent with the Forest Plan. The rationale for the determination of effects demonstrates project consistency with Forest Plan forest-wide standards 24 (page II-13) and 27 (page II-14) that state federally listed species will be managed for recovery, with management practices in essential habitat compatible with the species' needs.

Canada Lynx

The USFWS listed Canada lynx as a threatened species in March 2000. They determined that the main threat to lynx was "the lack of guidance for conservation of lynx and snowshoe hare habitat in National Forest Land and Resource Plans and BLM Land Use Plans" (USDI -FWS 2000a). In 2001, the Forest Service signed a Lynx Conservation Agreement with the USFWS indicating that the Lynx Conservation Assessment and Strategy (LCAS) (Ruediger et al. 2000) would be used as the guiding document during project analysis. In March 2007, 18 Forest Plans (including the Lolo National Forest) were amended with the Northern Rockies Lynx Management Direction (NRLMD) Record of Decision (ROD) [USDA-FS 2007]. The NRLMD describes the habitat management considerations needed to ensure lynx recovery. The NRLMD provides standards and guidelines to apply to lynx habitat.

In their 2017 review of Canada lynx status, the USFWS recommended that the species be delisted because it no longer meets the definition of Endangered or Threatened (USDI FWS 2017). The Northern Rockies lynx population was identified as "very likely to persist" in the near term (2025) and at mid-century (2050) (ibid.).

The Swamp Eddy project area overlaps a portion of the Superior lynx analysis unit (LAU)[15]. LAUs are mapped on a broader scale than lynx habitat and thus contain many areas that are not suitable for lynx use. The project area is not located within designated lynx critical habitat (79 FR 54782, September 12, 2014). The nearest critical habitat is over 30 miles away.

The Lolo National Forest is considered occupied lynx habitat. However, no lynx were detected within the project area during recent carnivore track and bait surveys. The only recorded observation in the project area is from 1982.

Intensive track surveys conducted by the Rocky Mountain Research Station across western Montana, including portions of the Lolo National Forest, have shown that lynx are uncommon to absent in many parts of this region. The Yaak (about 100 miles northwest of the Swamp Eddy project area) and the Clearwater Valley near Seeley Lake (about 80 miles east of the Swamp Eddy project area) are the primary strongholds for lynx in northwest Montana (Squires, Lynx Research Progress Report, 2006). Squires et al. (2013) do not include the Plains/Thompson Falls Ranger District in their map of lynx habitat in the Northern Rockies. On the Plains/Thompson Falls Ranger District, sightings of lynx and/or their tracks are rare, and evidence of breeding is unavailable. The Swamp Eddy project area contains relatively little preferred habitat as described below due to existing forest types, terrain, and climatic conditions. In 2016, U.S. Fish and Wildlife Service biologists visited Swamp Eddy with Forest Service personnel and concluded the habitat was generally of poor quality for the same reasons (consultation notes June 29, 2016 in Project File).

Habitat Factors

Lynx occupy large home ranges, use a variety of habitats, and can make long distance movements. They typically inhabit gentle, rolling topography (Maletzke et al. 2008, Squires et al. 2013). Across its range, dense horizontal cover, persistent snow, and moderate to high snowshoe hare densities (greater than 0.2 hares/acre) are common attributes of lynx habitat. The elevation at which lynx habitat occurs depends on local moisture patterns and temperatures, and varies across the range of the species. Spruce-fir forests are the primary vegetation type that characterizes lynx habitat in the contiguous

[15] LAUs approximate the area used by individual lynx and are the units used to analyze the effects of a project (USDA-FS 2007, FEIS Vol. I, p. 370).

United States (Koehler 1990a, Apps 2000, McKelvey et al. 2000b, Koehler et al. 2008, Moen et al. 2008, Vashon et al. 2008a, Squires et al. 2010).

In the western United States, most lynx occurrences (83 percent) are associated with Rocky Mountain conifer forest, and most (77 percent) fall within the 4,920–6,560 foot elevation zone (McKelvey et al. 2000b). Engelmann spruce, subalpine fir, and lodgepole pine forest cover types occurring on cold, moist vegetation types provide habitat for lynx (Aubry et al. 2000). Dry forest cover types (e.g., ponderosa pine, dry Douglas-fir) do not provide lynx habitat (Koehler et al. 2008, Maletzke et al. 2008; Squires et al. 2010).

Denning Habitat
Denning habitat includes mature and old growth forests with plenty of coarse woody debris. It can also include young regenerating forests with piles of coarse woody debris, or areas where down trees are jack-strawed (USDA-FS 2007; Moen et al. 2008, Squires et al. 2008, Olson et al. 2011). One important aspect of this definition is that denning habitat is not separate from other types of lynx habitat such as foraging habitat but is a structural subset in a wide variety of stand conditions. Nearly 9,300 acres within the Superior LAU are mapped as mature, multistory stands after the Sheep Gap Fire. Burned areas are not currently suitable denning habitat. However, coarse woody debris will increase over time as fire-killed trees fall.

Several studies, (Moen et al. 2008, Olsen et al. 2011, and Squires et al. 2008) across a variety of regions where lynx occur, have not found that denning habitat is a limiting factor because those habitat elements are common in most areas. More specifically, Squires et al. (2008), in a study of lynx denning in western Montana, concluded that den availability was not limited within female home ranges. Thus, denning habitat will not be discussed in further detail.

Foraging Habitat
Lynx foraging habitat is defined as habitat that supports snowshoe hares, the primary prey of lynx (USDA FS 2013 (LCAS 2013)). Squires et al. (2010) recommends a habitat mosaic of abundant and spatially well-distributed patches of mature, multilayer forests and younger forest stands.

During winter, lynx in Montana select mature, multistoried forests composed of large-diameter trees with high horizontal cover. These forests are predominately Engelmann spruce and subalpine fir in the overstory with some mixed conifers including lodgepole pine, Douglas-fir, and western larch (Squires et al. 2010).

During summer, lynx broaden their habitat use to include early succession – stand initiation forest with high horizontal cover from abundant shrubs, abundant small-diameter trees, and dense spruce-fir saplings (ibid.). Field observations indicate that stand initiation forests between roughly 20 and 30 years old have usually developed horizontal cover favorable to snowshoe hares on the Plains/Thompson Falls Ranger District. In addition, stands that are in the early initiation stage, typically aged between 0-20 years old, will become foraging habitat when dense horizontal vegetative cover develops (USDA-FS 2007, 2013). These stands are only temporarily unsuitable because they will mature into suitable habitat within a few years.

Table 3.5-2: Lynx Habitat Conditions within the Entire Superior LAU and within the Swamp Eddy portion of the LAU

Area	LAU Size (acres)	Total Lynx Habitat (acres)	Foraging Habitat			Other Habitat[2]
			***Currently* Providing Yearlong Hare Habitat**		***Will soon* Provide Yearlong Hare Habitat**	**Not Providing Hare Habitat**
			Stand Initiation (20-30 years old) (acres)	**Mature Multi-story Spruce/Sub-alpine Fir** (acres)	**Early Stand Initiation[1]** (0-20 years old) (acres)	**Stem Exclusion and Intermediate**
Superior LAU	44,673	19,540	585 (3%)	9,267 (47%)	4,387 (22%)	5,373 (27%)
Swamp Eddy	20,658	10,996	83 (0.7%)	4,733 (44%)	3,357 (31%)	2,585 (24%)

[1]Early stand initiation structural stage where the trees have not grown tall enough to protrude above the snow during winter.

[2]Other habitat includes the stem exclusion and intermediate stages. In the stem exclusion stage, the tree crowns lift and lower branches self-prune, thus growing above the reach of snowshoe hares (USDA FS 2013). These stands have very few tall shrubs or saplings in the understory. In this area, once a stand is in the stem exclusion stage, it has a limited potential to develop into mature multi-story habitat unless disturbance (e.g. wildfire, prescribed burning, or mechanical treatment) occurs. The intermediate stage is comprised primarily of stands that have matured past the stand initiation stages, are not structurally in the stem exclusion stage but have not yet developed into mature multi-storied stands. Lynx can readily travel through these stands and may occasionally forage in them even though snowshoe hare numbers are rather low.

Linkage, Habitat Connectivity, and Lynx Movement

The NRLMD (USDA-FS 2007) definition states that: "A linkage area provides connectivity between blocks of lynx habitat. Linkage areas occur both within and between geographic areas, where basins, valleys, or agricultural lands separate blocks of lynx habitat, or where lynx habitat naturally narrows between blocks." Squires et al. (2013) highlights the importance of maintaining connectivity between the lynx populations throughout the Northern Rockies as a part of conserving lynx in this southern portion of their range by maintaining genetic diversity. Lynx habitat in the southern portion of their range is inherently patchier than the northern boreal forests because of the steep topography and moisture gradients that produce more varied stand conditions. Blocks of lynx habitat may simply be divided by naturally occurring lower elevation habitat that does not provide extensive cover.

The NRLMD mapped potential linkage areas. This mapping exercise focused on potential locations where lynx could likely cross highways. There is one mapped NRLMD linkage area that crosses the Clark Fork River and Highway 200 to the northwest of the project area at Eddy Creek. No activities that could affect the ability of lynx to move through the linkage area would occur. Prescribed burning in unit MS1 would be completed within a few days. The potential effects to lynx and the mapped linkage area are discountable because lynx are uncommon in this area, project-related disturbance in this area would be very short-term, and vegetative cover would remain to provide for lynx movement.

Habitat connectivity is defined as those areas that consist of an adequate amount of vegetation cover arranged in a way that allows lynx to move around (NRLMD definition). Maintaining habitat connectivity means providing enough of this cover to conserve lynx. It does not mean to keep the status quo (see NRLMD definition of habitat connectivity). Habitat connectivity can be maintained as long as there is enough cover for lynx to move through an area (NRLMD FEIS, Volume 2, response to comment, p 23).

Human Use
The NRLMD provides a rather comprehensive list of human activities that could impact lynx habitat. However, most of the NRLMD (USDA-FS 2007) human use activities do not apply to the Superior LAU because few of the listed activities occur in or are proposed in this LAU. For example, there are no existing or planned ski areas or mineral and energy development sites.

<u>Roads</u>
There is no recommended road density for lynx habitat. Alexander et al. (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. The average traffic volume on the open roads within the Superior LAU likely averages about 2-3 vehicles per day with a high of about 30 vehicles per day during the busiest part of the hunting season.

In their extensive studies, Squires et al. (2010) found that lynx did not avoid gravel forest roads and further concluded that low vehicular use had little effect on lynx resource-selection patterns in Montana. Because the roads within the Superior LAU are mostly at a standard that is even lower than graveled roads and have traffic volumes well-below the estimated threshold for impeding movement, the existing road system likely has little effect on lynx habitat use.

<u>Displacement Due to Human Activities</u>
Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat et al. 2000).

Direct and Indirect Effects

The project would not adversely affect lynx because:

- The project would maintain all elements necessary for lynx to move across the landscape. Vegetation treatments would maintain a mosaic of forested cover to provide for lynx travel. Regeneration harvest activities would not create conditions that are unsuitable for lynx travel (Squires et al. 2013).
- The potential for affecting even one individual lynx is relatively low because the species is uncommon in this part of the Lolo National Forest.
- The project area and in general, the lower Clark Fork River valley, contains relatively poor quality lynx habitat due to naturally existing forest types, terrain, and climatic conditions.
- The project is consistent with all standards and guidelines for vegetation management projects as outlined in the NRLMD (see Wildlife report in the Project File for complete description of consistency with all NRLMD standards and guidelines). The project is also consistent with the recommendations in the scientific literature of maintaining a habitat mosaic of abundant and spatially well-distributed patches of mature multistory forests and younger forest stands for foraging habitat (e.g. Squires et al. 2010 and 2013).
- Treatments would not reduce the quantity or quality of existing foraging habitat. Therefore, lynx productivity would not be adversely affected. Following implementation of the project, the project area and Superior LAU would continue to provide for the biological needs of lynx and snowshoe hares.

Foraging Habitat
This analysis focuses primarily on regeneration harvest because it has the potential to modify lynx habitat structural stages. Although intermediate harvest treatments would reduce tree densities and increase the average tree diameter within stands, they would not change the structural stage of the habitat. Prescribed burning would also not change the structural stage of the habitat. Road management activities would not notably alter lynx habitat (Ruggiero et al. 1999).

Regeneration harvest would convert approximately 294 acres of non-foraging (other) habitat to early stand initiation stage and would become future lynx foraging habitat once these stands become about 20 years old. This would increase the percentage of lynx habitat within the Superior LAU in the early stand initiation stage from 22 to 24 percent, below the threshold outlined in the NRLMD.

Regeneration treatments would provide some additional young stands and maintain a mosaic of vegetative conditions in these LAUs. Squires et al. (2010) find that landscapes with a variety of forest age classes are more likely to provide foraging habitat through all seasons.

Outside the LAU, most proposed vegetation treatments would occur primarily in ponderosa pine/dry Douglas-fir forest types that do not provide lynx habitat (Koehler et al. 2000, Maletzke et al. 2008, Squires et al. 2010).

Habitat Connectivity
Lynx do not require dense forests as travel corridors, but use a variety of forest cover types (NRLMD 2007, Squires et al. 2013). All proposed treatments would maintain a mosaic of forested cover to provide for lynx travel. All riparian areas would be buffered from management activities (see Resource Protection Measures in Chapter 2). None of the proposed activities would create any large barren areas that Squires et al. (2013) suggest impede lynx movement. Barriers can include areas with limited cover such as open grassland but the authors also indicate that major, high volume highways could be a threat to lynx connectivity. There are no high volume highways within the Superior LAU.

Disturbance
The potential for directly affecting a lynx is relatively low since they are uncommon in this part of the Forest. If a lynx were present in the Swamp Eddy project area during project implementation, it could be temporarily displaced. However, effects to lynx would be discountable and insignificant. Activities would not occur everywhere all at once, but instead would be dispersed across the area in time and space. Project activities would likely occur from June to October during daylight hours over a 10-year period (including post-harvest operations). Temporary displacement of a lynx would not affect species productivity because existing foraging habitat would remain relatively unaffected, denning habitat would remain abundant, connectivity between habitats would be maintained, and there would be large suitable, undisturbed areas within the Superior LAU and adjacent LAUs for displacement.

Cumulative Effects

The project would not individually or cumulatively adversely affect lynx productivity, survival, movement, dispersal, or habitat.

The 2017 Sheep Gap Fire modified the lynx habitat within the Superior LAU by reducing the amount of mature multistory and stand initiation structural stages and increasing the amount of early stand initiation structural stage. Post-fire salvage removed dead trees from unsuitable habitats where the fire converted stands to the early stand initiation stage. Therefore, salvage did not affect foraging habitat.

The Swamp Eddy project would not be implemented until after post-fire salvage is completed. Therefore, there would be no overlap of potential disturbance and resulting displacement.

Timber harvest is occurring in the 12 Tamarack project area, which also overlaps a portion of the Superior LAU, over the CC Divide to the south of Swamp Eddy. Cumulative effects of this project have been considered in relation to the NRLMD standards (see below). The lynx habitat conditions displayed in Table 3.5-2 reflect the effects of both the Sheep Gap Fire and the 12 Tamarack project. The 12 Tamarack harvest will be completed in approximately 2026 which means it would be operating concurrent with the Swamp Eddy project, which would be sold in 2021. Cumulative disturbance effects to individual lynx would be discountable because the species is uncommon in this area and there are ample areas within the LAU and adjacent LAUs for displacement.

The management actions that have had an influence on lynx habitat are primarily timber harvest. However, the LAU that overlaps the project area contains a mosaic of mature, multi-story forests and younger forest stands for foraging habitat (Table 3.5-2). As described above, the Swamp Eddy project would not adversely affect the quantity or quality of lynx foraging habitat. Regeneration harvest on about 2 percent of the non-foraging lynx habitat (stem exclusion and intermediate structural stages) within the LAUs would create future lynx foraging habitat once these stands become about 20 years old.

The existing open road system may have had some impact on lynx through providing access for trapping before lynx were listed as a threatened species. As described above, temporary roads would be closed to public motorized use during implementation and closed to all motorized use following project completion. Because the scientific literature concludes that forest roads with low vehicular traffic have little effect on lynx behavioral patterns (Squires et al. 2010), the 2.6 miles of temporary road construction included in the project would unlikely have any measurable cumulative effect on the species.

Management actions on other ownerships outside the project area likely have had no measurable effect to lynx because they are located in lower elevation dry forest types that do not provide lynx habitat (Koehler et al. 2000, Maletzke et al. 2008, Squires et al. 2010).

Forest Plan Consistency

The project is consistent with the applicable standards of the NRLMD (USDA FS 2007) as described below and in more detail in the Project File.

The NRLMD (USDA FS 2007) standards which apply to foraging habitat are:

- VEG S1 - *If more than 30 percent of the lynx habitat in a LAU is currently in an early stand initiation stage (that does not yet provide winter snowshoe hare habitat), no additional habitat may be regenerated by vegetation management projects.*

  As displayed in Table 3.5-2, 22 percent of the lynx habitat in the Superior LAU is currently in the early stand initiation stage. Regeneration harvest on 294 acres of non-foraging habitat would increase this percentage to 24 percent, below the threshold described in the NRLMD standard.

  Kosterman (2014) reported that optimal female lynx home ranges contain greater than 50 percent mature forest and approximately 10-15 percent young regenerating forest. Kosterman et al. (2018) suggest the probability of producing a litter is highest for females that had core-use areas with 12-20 percent of small diameter regenerating forests and high connectivity of mature forests. The description of young regenerating forest and small diameter regenerating forests do not match the forest types defined in the NRLMD or Lynx Conservation Strategy

(2013). Therefore, comparisons between the results reported in Kosterman (2014)/Kosterman et al. (2018) and LAUs measured by the NRLMD standards are inconclusive.

- VEG S2 - *Timber management projects shall not regenerate more than 15 percent of lynx habitat on NFS lands within a LAU in a 10-year period.*

  Within the last decade, 188 acres (1 percent) of lynx habitat within the Superior LAU has been regenerated through timber harvest. The project would regenerate an additional 294 acres (1.5 percent) of lynx habitat. Cumulatively, 2.5 percent of the lynx habitat within the Superior LAU would be regenerated on NFS land, well within the VEG S2 standard.

- VEG S5 – *Pre-commercial thinning projects that reduce snowshoe hare habitat may occur from the stand initiation stage structural stage until the stands no longer provide winter snowshoe hare habitat only* under certain conditions.

  The 278 acres of pre-commercial (non-commercial) thinning included in the project would occur in dry ponderosa pine stands, which are not considered snowshoe hare or lynx habitat (Koehler et al. 2008, Maletzke et al. 2008, Squires et al. 2010). Therefore, this activity would not reduce snowshoe hare habitat. The project is consistent with the VEG S5 standard.

- VEG S6 - *Vegetation management projects that reduce snowshoe hare habitat in multi-story mature or late successional forests are only allowed in limited areas. Note: Timber harvest is allowed in areas that have potential to improve winter snowshoe hare habitat but presently have poorly developed understories that lack dense horizontal cover.*

  By project design, no vegetation management activities would occur in mature multi-story foraging habitat. Vegetation treatment areas were evaluated to determine if any of the stands qualified as mature multistory lynx habitat. None met the definition of mature multistory lynx habitat because they lacked essential habitat components (such as two-story vegetation conditions, horizontal cover, prevalent spruce-fir component).

The NRLMD (USDA FS 2007) standard which applies to habitat connectivity is:

- *ALL S1: New or expanded permanent developments (e.g. campgrounds, ski areas) and vegetation management projects must maintain habitat connectivity.*

  This analysis considered the juxtaposition of existing development and vegetation structure. The Lolo Forest Plan, amended in 1995 by the Inland Fish Strategy, provides direction to retain existing riparian habitat/cover which provides for lynx movement between and within vegetation management units (NRLMD FEIS p. 97-98). Generally, vegetation treatments do not impede lynx movement (NRLMD FEIS, Vol 2. Response to Comments p. 54). Within the Swamp Eddy project area and Superior LAU, there are no large barren areas that Squires et al. (2013) found were a barrier to lynx movement. Given that no new expanded permanent developments would occur, and a mosaic of forested cover would remain on the landscape for lynx travel, the project would be consistent with NRLMD standard ALL S1.

The rationale for the determination of effects also demonstrates project consistency with Forest Plan forest-wide standards 24 (page II-13) and 27 (page II-14) that state federally listed species will be managed for recovery, with management practices in essential habitat compatible with the species' needs.

Wolverine

In February 2013, the U.S. Fish and Wildlife Service listed wolverine as a proposed threatened species (Federal Register 78:7864-7890, February 4, 2013). They concluded that while wolverines appear stable to expanding, the primary threats to the contiguous U.S. population are the risk of eventual habitat and range loss due to climate warming, with secondary threats from trapping/wolverine harvest, with potential threats from disturbance associated with human developments [e.g. houses and ski areas] and transportation corridors [e.g. interstate highways and high volume secondary highways], and loss of genetic stochasticity due to isolation between snowy habitats caused by climate change (Federal Register 78:7864-7890, 2013). The USFWS specifically mentions that forestry-related management practices are not likely a factor contributing to the decline (78 FR 7879). Timber management, winter elk security, thermal cover, or over-the-snow uses managed by the Forest Service were not identified as threats to the U.S. population (78 FR 7878-79).

On August 13, 2014, after considering the best available science, the USFWS declared that listing the wolverine as a threatened species was not warranted because they determined the effects of climate change are not likely to place the wolverine in danger of extinction now or in the foreseeable future (79 FR 47522). Thus, the USFWS withdrew its proposed listing rule.

The U.S. Fish and Wildlife Service's determination was challenged in Court. In April 2016, the District Court of Montana ruled that the USFWS must reconsider protections for wolverines under the Endangered Species Act. Currently, the species is proposed for listing under ESA. Wolverine is also identified as a sensitive species by the Forest Service in the Northern Region.

Track and bait station surveys within the project area did not detect wolverine. There are no recorded observations of the species in Swamp Eddy or adjacent areas. Low detection rates are normal because wolverines naturally occur in low densities with a reported range of one animal per 25 square miles to one animal per 130 square miles (Hornocker and Hash 1981; Hash 1987; Copeland 1996; Inman et al. 2007a). This may be due to their need for large territories and their tendency to defend those territories from other wolverines (79 FR 47530).

Deep, persistent, and reliable spring snow cover (April 15 to May 14) is the best overall predictor of wolverine occurrence in the contiguous United States (Copeland et al. 2010). Wolverine year-round habitat use takes place almost entirely within the area defined by deep, persistent spring snow (78 FR 7868). This is likely related to the wolverine's need for deep snow during the denning period (78 FR 7872). No records exist of wolverines denning anywhere but in snow, despite the wide availability of snow-free denning opportunities within the species range (78 FR 7867). The deep, persistent spring snow area in the Copeland et al. (2010) model captures all known wolverine dens in the contiguous United States (78 FR 7868). Additionally, except for denning females (denning habitat is not considered scarce or limiting to wolverine reproduction), wolverines are occasionally observed in areas outside the modeled deep, persistent snow zone, and factors beyond snow cover may play a role in overall wolverine distribution (79 FR 47534). In the contiguous United States, valley bottom habitat appears to be used only for dispersal movements and not for foraging or reproduction (78 FR 7868).

Within the Swamp Eddy project area, there are approximately 3,456 acres of wolverine habitat located in the upper reaches of West Fork Swamp Creek along the western boundary (Northern Region spring snowpack model, Copeland et al. 2010). Because of their long-range movements, wolverines may travel through the area on occasion.

Direct and Indirect Effects

The project would not lead to a loss of species viability or jeopardize the continued existence of wolverine for the reasons described below.

Because of their naturally low densities and large home ranges, the potential for affecting even one individual wolverine is low. Direct effects, if they should occur, would be in the form of disturbance and displacement caused by mechanical treatments, prescribed burning, and road work. If a wolverine were present during implementation, it could be temporarily displaced. However, effects would be inconsequential due to the flexibility of habitat use shown by wolverines, the large size of their home range, and there are numerous undisturbed areas inside and outside the project area that this wide-ranging, opportunistic omnivore could use for displacement.

Mixed severity prescribed burning (Unit MS1) would overlap about 430 acres of the wolverine habitat located in the upper reaches of West Fork Swamp Creek. Although this activity could result in relatively small patches of tree mortality, it would not change the persistence of spring snow. Therefore, the habitat would be maintained. Prescribed burning would be conducted by aerial ignition, which would be completed within 1-3 days, minimizing disturbance within suitable habitat.

This species is not thought to be dependent on vegetation or habitat features that may be manipulated by land management activities. Wolverines have been documented using both recently logged areas and burned areas (78 FR 7879). It is unlikely that wolverines avoid low-use roads like those in the project area (78 FR 7878). Therefore, vegetation treatments and temporary road construction would not preclude wolverine movement through the area.

Cumulative Effects

Because the direct and indirect effects described above are limited to the point of being inconsequential, cumulative effects would likely be immeasurable.

The 2017 Sheep Gap Fire burned approximately 1,261 acres of low quality wolverine habitat where snow rarely persists between mid-April to mid-May. Post-fire salvage of dead and dying trees will occur on about 6 acres (1 percent) of this low quality habitat prior to implementation of the Swamp Eddy project. Thus, there would be no overlap in time of potential disturbance from the two projects. The combination of post fire-salvage and Swamp Eddy prescribed burning would occur on a relatively small portion of wolverine habitat. Adverse effects to the species are not expected because these activities would not change the presence of spring snow and wolverines are not thought to be dependent on vegetation or habitat features that may be manipulated by land management activities (78 FR 7879).

Activities on adjacent private lands unlikely had or currently have any adverse effects on wolverines because these lands are located at lower elevation that do not have persistent spring snow, where the species is not likely to occur.

Trapping in the project area primarily occurs at low elevations for coyote and other non-game species and is not focused in high elevation areas where wolverines are generally found. Therefore, the potential for non-target capture and mortality of wolverine is low. The project would not increase access for trapping or displace wolverines into lower elevations where trapping occurs.

Sensitive Species

The Forest Service manual and Lolo Forest Plan require the Lolo National Forest to manage for sensitive species. The Forest Service manual defines sensitive species as those plant and animal species identified by a Regional Forester for which population viability is a concern. For species identified as sensitive, the Forest Service shall avoid or minimize impacts to species whose viability has been identified as a concern (FSM 2670.32). Forest Plan standard 27 (at p. II-14) directs the Forest to manage for population viability. The project is consistent with this direction (see summary for each species below).

Gray Wolf

In May 2011, the U.S. Fish and Wildlife Service removed gray wolves in a portion of the Northern Rocky Mountain Distinct Population Segment (DPS) encompassing Idaho, Montana, and parts of Oregon, Washington, and Utah from the Federal List of Endangered and Threatened wildlife species. Wolves in Montana are now managed under the Montana FWP Gray Wolf Management Plan as a hunted and trapped game species. At the end of 2017, Montana FWP confirmed the presence of at least 124 packs, 633 wolves, and 63 breeding pairs in the state, which far exceeds the state's minimum recovery goal of 150 wolves (MTFWP 2018).

The project area is located within Wolf Management Unit 121. There is a wolf pack in the upper Dry Fork Tamarack Creek located over the divide to the south of the Swamp Eddy project area. Wolves and their tracks have been observed within the project area.

Direct and Indirect Effects

The project would not affect species viability or contribute to a trend towards Federal listing for the reasons described below.

If present during project activities, wolves could be temporarily displaced as they may avoid areas with active harvest and road work. However, the effects would be inconsequential because of the wolf's wide-ranging nature (wolf pack home ranges vary from 50 to 200 square miles). Most project activities would occur between June and October over about a 5-year period (post-harvest activities may occur for an additional 5 years). Activities would not occur all at once but would be separated in time and space such that large portions of the project area would provide suitable areas for displaced individuals.

Regeneration harvest along open roads could temporarily improve visibility for hunters, potentially making it easier to harvest a wolf during hunting season. However, effects to the population would be discountable because of the relatively small area affected compared to the landscape, hiding cover would re-establish as vegetation regenerates, public motorized road access would not change, and Montana FWP would continue to regulate the harvest of wolves to maintain a minimum number of breeding pairs.

Cumulative Effects

Post-fire salvage operations will be completed prior to implementation of the Swamp Eddy project. Therefore, there would be no overlap of potential disturbance and resulting displacement effects of the two projects.

The Montana Wolf Conservation Management Plan requires the State to regulate wolf harvest to maintain a minimum number of breeding pairs. Thus, it is highly unlikely that legal hunting would be allowed to lower the wolf population to a point where viability is a concern. Montana FWP also manages deer and elk populations. It is unlikely that the State would manage big game populations to levels so low that wolves would begin switching to alternative prey. The Swamp Eddy project would not increase motorized access for hunting or trapping. The 2.6 miles of temporary road constructed for the project would be closed to public motorized use during implementation and closed (by recontouring) to all motorized use following project completion.

Fisher

Fisher is considered a Montana state species of concern due to limited habitat and/or potentially declining populations. They are also classified as a furbearer and thus population numbers are managed by Montana FWP. The species is legally trapped under a limited quota system. Trapping records indicate that 4 fishers were trapped in Trapping District 1 (where the project is located) in 2016 (most recent data available). District 1 includes Sanders, Flathead, Lake and Lincoln counties.

Fisher was petitioned for listing as a threatened or endangered species in February 2009. In March 2011, the U.S. Fish and Wildlife Service determined that listing was not warranted (76 FR 38504, June 30, 2011). They concluded that the best available scientific and commercial information does not indicate that current or future forest management practices and timber harvest threaten the fisher now, or in the foreseeable future (76 FR 38521). Based on limited survey information, the current distribution of fishers appears similar to the historic distribution in Idaho and Montana. Precise, current fisher population numbers or trends are unknown. Population numbers were not thought to have been historically large because the species is extremely limited in distribution due to its territoriality and large home range size, particularly in naturally fragmented landscapes (Powell and Zielinski 1994).

Research to determine distribution and abundance of fisher using DNA analysis of hair has been ongoing in the Northern Region of the Forest Service since 2007 (Schwartz et al. 2007). Two fishers were detected about 20 miles south of the project area, near the Idaho border. In 2015 before the Sheep Gap Fire, a multi-species carnivore survey detected a fisher in Bemish Creek within the project area. The 2017 Sheep Gap Fire burned at high severity through this drainage and consumed most of the vegetation, reducing the amount of suitable habitat.

Home range of fishers varies in size from 6,400 to 20,480 acres (Jones 1991, Heinemeyer 1993, Ruggiero et al. 1994). Foresman (2012) estimated fisher average home range from 4,480 to 20,480 acres. Optimum habitat is thought to include mature, moist coniferous forest with a complex understory structure, including a woody debris component (ibid., Banci 1989, Powell and Zielinski 1994). Samson (2006b) describes fisher habitat as including the following vegetation dominance groups: 1) yew, 2) tolerant mix of grand fir, cedar, and western hemlock, 3) tolerant grand fir/cedar/hemlock, and 4) cedar. Riparian/forest ecotones in low- to mid-elevation areas that do not accumulate large amounts of snow appear important. A review of the above research suggests that the species uses a diversity of tree age and size class distributions at the patch or stand level that provide sufficient (generally greater than 40 percent) overhead cover (either tree or shrub).

In the Bitterroot Mountains near Lolo Pass, about 60 miles south of the Swamp Eddy project area, Schwartz and others (2013) found that fishers disproportionately used both stand sites and regional landscapes characterized by large diameter trees and avoided areas with ponderosa pine and lodgepole pine. The average maximum tree diameter in used habitats was 42 inches versus 25 inches in unused habitats. The stands most used by fishers were those mature forests with both large and smaller trees, consistent with evidence that fishers need cover for hunting efficiency or predator escape purposes. They also found that fishers clearly avoided openings such as clearcuts and grassy slopes. They also avoided uniform early seral forests, like lodgepole pine stands.

Modeling suggests that central Idaho is the habitat stronghold for fisher in the Forest Service Northern Region. The western boundary of the Lolo National Forest along the Montana/Idaho border (Bitterroot Mountains geographic area) is considered the outermost eastern part of the overall Idaho fisher stronghold habitat range (USDA-FS 2014, unpub.). Compared to this area, the central and eastern portions of the Lolo National Forest (including the Swamp Eddy project area) contain smaller, scattered, and isolated patches of fisher habitat, which likely provide for small localized populations and dispersing individuals (ibid.).

The estimated critical habitat threshold for maintaining a minimum viable population of fisher across all the Northern Region is 100,078 acres (Samson 2006b). The most recent habitat model (Olson 2014 VMAP model) identifies 620,540 acres as having a medium and high probability[16] of providing fisher habitat on the Lolo National Forest. Therefore, habitat on the Lolo National Forest appears more than sufficient to maintain fisher viability across the entire Northern Region.

The Olson model (2014) indicates that the Swamp Eddy project area contained approximately 5,811 acres that had a high probability of providing fisher habitat and an additional 3,682 acres that had a medium probability of providing fisher habitat before the 2017 Sheep Gap Fire. Approximately 2,951 acres of the high probability habitat located in the middle elevations of East and West Forks Swamp Creek, Bemish Creek, and Dee Creek burned at moderate to high severity. Research regarding fisher use of post-fire habitat is limited. Thompson et al. (2011) estimated that habitat burned at high severity takes approximately 45 years to begin providing suitable fisher habitat. Hanson (2013) indicates that post-fire forests (about 12 years old) are selected for at similar to higher levels than adjacent unburned old forests due to the amount of coarse wood from fallen trees. Because fisher habitat (burned or not) is relatively limited in the area, there may not be enough to support year-round fisher use although some individuals may travel through the area.

Direct and Indirect Effects

The project would not contribute to a trend toward federal listing or a loss of species viability because:

- The project area is located outside the fisher stronghold habitat range.
- The potential to negatively impact even one individual fisher is low.
- Approximately 82 percent of the fisher habitat within the project area would be unaffected by harvest activity. Vegetative regrowth in treated areas and the 2017 Sheep Gap Fire would occur over time. Habitat on the Lolo National Forest would remain more than sufficient to maintain fisher viability across the entire Northern Region.
- The project would retain coarse woody debris, snags, and the largest trees appropriate for the forest type, to the extent that the trees promote stands that are resilient to insects and disease.
- Trapper access would not increase. The 2.6 miles of temporary road would be closed to public motorized use during project implementation and closed (through recontouring) to all motorized use following project completion.

Because of their naturally rare and wide distribution and the naturally limited amount of habitat and distribution of suitable habitat (discussed above), the potential to affect even one individual fisher is

[16] High to medium probability fisher habitat is expected to provide the forest composition, vertical and horizontal structure, ecosystem function, and connectivity that characterizes the mature and older forest habitat that fisher select for. Medium probability fisher habitat has lesser amounts of desired habitat characteristics than high probability habitat. Both high and medium values contribute towards overall fisher habitat if both are within potential dispersal distances that fisher use within a home range or may traverse to find and occupy a new home range or territory (Olson et al. 2014).

relatively low. Direct effects, if they should occur, would be in the form of disturbance and displacement caused by mechanical treatments, prescribed burning, and road work. Evidence of fisher response to disturbance and displacement from vegetation management is limited, with mixed conclusions (76 FR 38504). There is no scientific evidence that suggests fisher mortality would occur from proposed activities. Activities would not occur all at once but would be separated in time and space such that large portions of the project area would provide suitable areas for displaced individuals. Therefore, disturbance effects would likely be small in scale at any one time, dispersed over a large area during the life of the project.

Indirect effects to fisher could occur from harvest treatments (Table 3.5-3). Regeneration timber harvest would overlap approximately 14 percent of the suitable fisher habitat within the project area remaining after the 2017 Sheep Gap Fire. The affected habitat would not all be in one area, but scattered in small, disjunct blocks. Although some overstory trees would be retained, the regeneration treatments would reduce canopy cover for several decades until the treated areas regrow with trees and shrubs. Fishers would likely avoid these openings until sufficient cover is restored. However, these relatively small openings in fisher habitat would be nested among forested areas with denser canopy and understory conditions; therefore, the forested nature of the area would be maintained.

Table 3.5-3: Overlap of Fisher Habitat and Swamp Eddy Timber Harvest

Fisher Habitat	Existing habitat on Lolo NF[1] (acres)	Existing habitat in project area (acres)	Regeneration Harvest (acres and percent of post-fire habitat in project area)	Intermediate Harvest (acres and percent of post-fire habitat in project area)
High Probability	273,616	5,811 (pre-fire) 2,860 (post-fire)	389 (14%)	128 (4%)
Medium Probability	432,995	3,682 (pre-fire) 1,971 (post-fire)	272 (14%)	74 (4%)
Total	706,611	9,493 (pre-fire) 4,831 (post-fire)	661 (14%)	202 (4%)

[1]All ownerships

Intermediate harvest (thinning-type treatments) would overlap another 202 acres (4 percent) of fisher habitat in the project area remaining after the 2017 Sheep Gap Fire. These treatments would simplify the forest structure and reduce overhead cover which would likely diminish habitat quality. However, intermediate harvest would generally retain 40-60 percent of the existing tree canopy cover, which maintains at least the 40 percent canopy (tree and shrub) cover that some research indicates would provide sufficient overhead cover for hunting efficiency and predator escape purposes (Jones 1991).

The small tree commercial thinning and low severity prescribed burning would not affect fisher because these treatments would occur outside of fisher habitat in dry ponderosa pine/Douglas-fir forests. Mixed severity prescribed burning would occur on approximately 81 acres (2 percent) of the fisher habitat in the project area. This activity would maintain most of the forest overstory canopy except where the fire may kill groups of trees. In these pockets of tree mortality, future fisher habitat may be improved once dead trees fall creating an abundance of coarse woody debris.

Cumulative Effects

The 2017 Sheep Gap Fire reduced that amount of fisher habitat in the project area by approximately 4,662 acres (49 percent) until forest structure is restored over several decades. Regeneration harvest included in the Swamp Eddy project would further reduce habitat by another 661 acres until vegetative regrowth provides suitable canopy cover over time. Although the 202 acres of intermediate harvested areas could still be used to some degree, their quality as habitat would be diminished. Cumulatively, approximately 44 percent of the pre-fire habitat in the project area would remain available. Despite the temporary reduction of habitat within the Swamp Eddy project area, habitat on the Lolo National Forest would remain more than sufficient to maintain fisher viability across the entire Northern Region as estimated by Samson (2006b).

Post-fire salvage is ongoing in areas that are unsuitable for fishers due to the loss of vegetation from the fire. Although salvage will reduce the amount of future coarse woody debris (used for denning and hunting) on approximately 2000 acres, this material will be abundant on the remaining 13,000 acres once dead trees fall.

Post-fire salvage operations will be completed prior to implementation of the Swamp Eddy project. Therefore, there would be no overlap of potential disturbance and resulting displacement effects of the two projects.

Historical trapping, increased road access, and clearcutting, especially in riparian areas, all likely impacted fisher populations across the western U.S. Fishers were released in some areas of western Montana to augment nearly extinct populations (Powell and Zielinski 1994). Montana FWP regulates trapping of fisher and have reduced quotas over the years, but the species remains vulnerable to trapping pressure. Clearcutting, riparian harvest, and road access have decreased on public lands over the last several decades and has likely stabilized impacts to fisher (summarized in 76 FR 38504, June 30, 2011, including internal citations). Of note, fisher abundance and distribution has increased in concert with the above activities.

Past regeneration harvest occurred on approximately 3,600 acres within the project area outside the Sheep Gap Fire. Some of which may have been located within fisher habitat. However, over 90 percent of this past harvest occurred more than 40 years ago. Treated stands have since revegetated and now likely provide conditions suitable for fisher foraging and travel.

The adjacent private, industrial timber lands, and State land located north of the project area generally occur in drier ponderosa pine habitat types that fishers tend to avoid (Schwartz et al. 2013, Jones and Garton 1994). Potential effects to fisher from activities in these drier areas are discountable.

Bald Eagle

The bald eagle was removed from the Endangered Species List in 2007 and populations have been steadily increasing. The species is protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. In Montana, management is directed by the Montana Bald Eagle Management Plan (Montana Bald Eagle Working Group 1994, updated 2010).

Bald eagles need large water bodies (greater than 80 acres), abundant fish populations, and large trees or structures for nesting. These conditions exist along most of Montana's rivers and lakes. There is one known nest located within prescribed burn unit LS21, adjacent to the Clark Fork River near the mouth of Swamp Creek.

Direct and Indirect Effects

The project would not contribute to a trend toward federal listing or a loss of species viability because there would be no direct or indirect effects to nesting eagles. Prescribed burning in Unit LS21 would not occur when the nest is active (see Resource Protection Measures in Chapter 2). The nest tree would be buffered from prescribed fire to ensure its survival.

Prescribed burning activities occurring over a few days could temporarily disturb individual birds that may be perching along this section of river. However, effects would be discountable because there are suitable roosting trees up and down river where birds could displace to. Prescribed burning would not alter the suitability of eagle habitat.

Recreation activities at the mouth of Swamp dispersed site have been ongoing for decades, thus eagles are habituated to human presence in this location. The project activities to reduce resource damage and provide for public safety would not likely increase or expand existing recreational use. Therefore, activities at the mouth of Swamp dispersed recreation site would not result in additional disturbance to the species.

Cumulative Effects

The 2017 Sheep Gap Fire and post-fire salvage did not affect any known eagle nests. Salvage activities occurred more than ½ mile from documented nest sites and did not disturb nesting birds. There are no reasonably foreseeable actions on NFS lands near the eagle nest.

Temporary disturbance effects to birds from prescribed burning would be negligible, particularly when compared to the traffic on the paved county road adjacent to the Clark Fork River and residential activities on nearby private lands.

Black-backed Woodpecker

In Montana, this species may be potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas. Breeding Bird Survey data for 1966-2015 show a positive, but non-significant trend for this species in the Northern Rockies (Sauer et al. 2017).

Black-backed woodpeckers occupy forested habitats that contain high densities of recently dead or dying trees which woodborer beetles have colonized (Dixon and Saab 2000, Powell 2000). Large expanses of fire-killed trees (generally less than 5 years old) are considered the most suitable habitat in Montana (Hutto 1995). While many studies have shown black-backed woodpeckers primarily use post-fire habitat, some studies have found these woodpeckers in areas without recent fire. For example, both Bonnot (2006) and Goggans et al. (1989) found black-backed woodpeckers within extensive mountain pine beetle outbreaks that occurred in the absence of fires. However, this was not specifically observed on the Lolo National Forest (Cilimburg et al. 2006).

Samson (2006a) estimated that the amount of habitat needed for a minimum viable population of black-backed woodpeckers within the Forest Service Northern Region is 29,405 acres. Habitat suitability modeling predicted about 632,009 acres of post-fire black-backed woodpecker habitat was created in the Northern Region in 2017. This is over 21 times more habitat than Samson's (2006a) estimate for maintaining a viable population in the Northern Region. Modelling predicted that the 2017 Sheep Gap Fire resulted in the creation of 19,486 acres of suitable post-fire habitat on NFS lands. Post-fire salvage removed about 2000 acres (10 percent) of this habitat. The relatively small amount and size of salvage areas and abundant remaining snags retained sufficient black-backed woodpecker habitat, comprising about 59 percent of the estimated 29,405 acres required to support a viable population in the Northern Region.

Direct, Indirect, and Cumulative Effects

The project would have no adverse impacts on the species because none of the Swamp Eddy vegetation treatments would occur within the 2017 Sheep Gap Fire perimeter. Therefore, no post-fire habitat would be affected.

Cumulatively, mixed severity prescribed burning in Unit MS1 may provide a slight benefit to black-backed woodpeckers by contributing a relatively small amount of post-fire habitat to that created by the 2017 Sheep Gap Fire.

Flammulated Owl

In Montana, the species is ranked as being abundant in some areas, but potentially at risk because of limited numbers or breeding habitat (Montana Natural Heritage Program, website accessed 3/12/2019). Globally, this owl is listed as apparently secure, though it may be quite rare in parts of its range (ibid.).

Flammulated owls are small, migratory insectivores that inhabit mountainous forests throughout western North America. In Montana, calling flammulated owls were correlated with the number of ponderosa pine trees greater than 15 inches diameter breast height (dbh); low live basal area, low canopy (less than 40 percent) in ponderosa pine and moderate canopy (less than 70 percent) in sites dominated by Douglas-fir (Wright 1996). They appear to avoid young, dense stands of Douglas-fir, clearcuts, and intensively cutover areas, but they will use thinned or selectively logged stands (McCallum 1994). The Swamp Eddy project area contains approximately 817 acres of existing suitable habitat that currently provides the tree species composition and structure needs for the owl.

Surveys conducted in 2010 detected the species in suitable habitat within a portion of the project area that was since burned by the 2017 Sheep Gap Fire.

Direct and Indirect Effects

The project would not contribute to a trend toward federal listing or a loss of species viability because:

- approximately 99 percent of the existing suitable habitat in the project area would be maintained.
- low severity prescribed burning and thinning would improve the quality of foraging on approximately 94 acres (12 percent) of owl habitat.

Within Unit S70, regeneration harvest would occur on approximately 9 acres (1 percent) of the suitable owl habitat within the project area. Canopy cover on these 9 acres would likely be reduced below suitable levels for occupancy by the species (less than the recommended minimum of 35 percent as summarized in Samson 2006a). This area would be considered unsuitable habitat for several decades until it is regenerated with mature trees. Despite this minor reduction, the amount of suitable flammulated owl habitat would remain abundant following implementation.

Project activities including thinning and low severity prescribed burning would occur on approximately 94 acres (12 percent) of existing habitat. These actions would improve foraging conditions by creating more space between trees for birds to maneuver while feeding. By increasing sunlight to understory, these treatments would also likely increase herbaceous understory plants that support the insects upon which flammulated owls prey.

Flammulated owls are migratory and may reside in the project area from April to August each year. Conclusive studies on the direct impacts of forest management on flammulated owls are lacking. Human-related disturbances that occur during the breeding season in owl territories may disrupt courtship, thus affecting productivity (Linkhart 2001). In a number of studies of other raptor species, disturbances near occupied nests have caused adults to abandon them, resulting in mortality of eggs or newly-hatched young (i.e. Squires and Kennedy 2006). Flammulated owls may (or may not) be vulnerable to disturbance and displacement effects from human-related activities during the breeding season (mid-April through late July). Adult birds could easily disperse to other areas.

Cumulative Effects

Where past regeneration harvest occurred in low elevation, mature stands of ponderosa pine and Douglas-fir, it likely reduced the amount of suitable flammulated owl habitat within the project area and adjacent private lands until regenerated trees reach maturity. In addition, the 2017 Sheep Gap Fire reduced the amount of suitable habitat by approximately 500 acres (45 percent). Post-fire salvage removed snags for potential nesting on about 71 acres (12 percent) of existing post-fire habitat. However, effects were negligible due to the abundance of snags.

Although the project would slightly reduce the amount of suitable habitat by 9 acres (1 percent), the other treatments proposed in flammulated owl habitat would improve foraging conditions on 94 acres as described above. Activities that restore the open character of ponderosa pine and Douglas-fir stands and retain mature large diameter trees are believed to be beneficial for these owls (Linkhart et al. 1998, Goggans 1986).

Boreal Toad

This species is classified as a Species of Concern in Montana, having very limited habitat and/or potentially declining populations in the state; worldwide, it is classified as apparently secure, but may be declining in parts of its range (Montana Natural Heritage Program, Field Guide website accessed 3/12/19).

Boreal toads are found in a wide variety of habitats including wetlands, forests, woodlands, sagebrush, meadows, and floodplains in the mountains and mountain valleys (Reichel and Flath 1995, summarized in Maxell 2000 and Werner et al. 2004). Adult and juvenile toads are freeze-intolerant and overwinter and shelter in underground caverns, or more commonly in rodent burrows. While smaller juveniles are active almost exclusively during the day, adults are usually active at night except during the spring and at higher elevations. Adult boreal toads are largely terrestrial and are known to travel miles from their breeding sites through coniferous forests and subalpine meadows, lakes, ponds, and marshes (Werner et al. 2004).

Boreal toads generally breed in lakes, ponds, and slow streams, laying eggs one to three months after the snow melts (Reichel and Flath 1995, Werner et al., 2004). Timing of breeding is dependent on temperature, snowmelt, and/or the presence of surface water from flooding and takes place from May to July in shallow areas of large and small lakes, beaver ponds, temporary ponds, slow moving streams, and backwater channels of rivers. Adults will move up to four kilometers (about 2.5 miles) away from water after breeding and juveniles will disperse up to four kilometers from their birth place. No toads have been detected within the project area.

Direct and Indirect Effects

The project would not contribute to a trend toward federal listing or a loss of species viability for the reasons outlined below.

No harvest activities would occur within riparian areas, which would protect streamside habitat (see Resource Protection Measures in Chapter 2). Because toads are known to travel along stream areas - especially downstream (Young and Schmetterling 2009), the applied stream buffer would preclude any impacts on toads using this area.

Because the boreal toad is an upland species for the summer and early fall (before underground hibernation), its home range and daily use could overlap somewhat with project activities. Machinery use associated with harvest has the potential to directly harm individual toads (which are likely widely spaced in their upland habitats). However, potential adverse impacts from project activities in non-breeding areas would likely affect only a few individuals, if present, and would not have population-level impacts. Toads are more active at night when project activities would not be occurring, which would further limit potential effects. In addition, these toads have generally high productive rates, which would likely compensate for the mortality of a few (1-2) toads from machinery use, if it were to occur.

Cumulative Effects

The potential effects of the project combined with those of the 2017 Sheep Gap Fire and post-fire salvage would not contribute appreciable cumulative effects to this species or habitat and would not affect species viability.

Bighorn Sheep

In Montana, bighorn sheep are classified as apparently secure, though they may be quite rare in parts of its range, and/or suspected to be declining (Montana Natural Heritage Program, Field Guide website, accessed 3/12/19). Populations of sheep in Montana are highly variable. Some are very stable while others have declined precipitously because of disease outbreaks.

Sheep use primarily occurs outside the Swamp Eddy project area to the east, southeast, south, and southwest of Patrick's Knob. However, sheep occasionally use the project area along the CC Divide near Patrick's Knob and in Combest and Miller Creeks.

This sheep population (known as the Cutoff Herd), which normally contains about 200-300 animals declined sharply between 2012 and 2014. A disease die-off was suspected, but never confirmed and populations dropped to very low levels (below 75-100). In early 2018, transplants into the population occurred. Montana FWP is closely monitoring the population.

Sheep use more open habitats (non-forested), which provide abundant grass and forb forage and allow the species to more easily detect and avoid predation. The Montana FWP Bighorn Sheep Management Plan (2010) identifies several risk factors for the Cutoff population, however, conifer encroachment is the only factor Forest Service management can directly influence. The portion of the project area inhabited by sheep likely has more conifer tree cover than historical conditions, resulting in reduced habitat quality. The 2017 Sheep Gap Fire did not affect the area of sheep use.

Direct and Indirect Effects

The project would not contribute to a trend toward federal listing or a loss of species viability for the reasons described below.

Timber harvest activities, primarily within Units C16, C17, and C18 (approximately 104 acres) and non-commercial thinning work in Units 23, 31, and 33 (approximately 58 acres), could temporarily disturb individual sheep causing them to disperse if they are using the project area during implementation. However, effects would be discountable because the most suitable habitat is located outside the project area and would remain unaffected by project activities, providing ample areas for displacement. These units are located along roads that are open to public motorized use which likely results in a relatively low level of intermittent disturbance. Therefore, noise and human presence are not uncommon in this area.

Approximately 104 acres of regeneration harvest would create more open forest habitat, providing additional suitable foraging areas for sheep. However, because of its relatively small size and location in an occasional use area, benefits to the species would be relatively minor.

Cumulative Effects

Because direct and indirect effects are essentially discountable, cumulative effects, if any, would be immeasurable.

Management Indicator Species

Management indicator species, considered widespread and common animals, were designated in Forest Plans to represent species whose population changes are believed to indicate the effects of management activities on representative wildlife habitats (FSM 2621). The Lolo Forest Plan defines Indicator Species as "species identified in a planning process that are used to monitor the effects of planned management activities on viable populations of wildlife and fish including those that are socially or economically important" (Forest Plan, page VII-15). The Lolo Forest Plan identifies northern goshawk (natural old growth forests), pileated woodpecker (mature old growth with limited management), and elk (big game), as "Management Indicator Species" (MIS) (Forest Plan standard 27, at p. II-14 and Forest Plan Final Environmental Impact Statement, pp. III-28 through III-29).

The Lolo Forest Plan standard 27 states that habitat for management indicator species will be monitored. Elk population data collected by Montana FWP will be compared against habitat data to test elk/habitat relationships. Forest Plan standards 21, 22, and 23 (page II-13) provide for the protection of elk habitat such as wallows and winter range. The Plan further states that as monitoring technology become available for northern goshawk and pileated woodpecker, population trends will be monitored. In the interim, habitat parameters including old growth acres and condition, and snag densities will be monitored as an indicator of population trend. In recent years, both population and habitat have been monitored at a Region-wide scale and a forest scale. This data indicates that population trends for northern goshawk and pileated woodpecker are stable or increasing. Information from these efforts is summarized in the individual species sections below.

Northern Goshawk

The northern goshawk is found throughout North America with breeding documented from Alaska to Newfoundland and south through the Rocky Mountains, Sierra Mountains, and into Mexico. In Region 1, the species breeds in mountainous or coniferous regions throughout western and southern Montana as well as north and north central Idaho. Goshawks winter throughout their breeding range with a portion of the population wintering outside breeding areas (Squires and Reynolds 1997).

According to NatureServe, the northern goshawk is globally secure – common, widespread and abundant. Based on broad-scale habitat and inventory and monitoring assessments conducted in Region 1, breeding goshawks and associated habitats appear widely distributed and relatively abundant on NFS lands, including the Lolo National Forest (Samson 2006a, errata corrected 2008; 2006b; Canfield 2006, Kowalski 2006). In a random sample of goshawks nesting in a heavily managed landscape adjacent to the Lolo National Forest, monitoring showed reproductive rates and nest success above or well within the ranges reported in studies done in less-managed landscapes throughout the western United States (Clough 2000). Results suggest goshawks do well even in managed landscapes. Surveys have detected goshawks in the Swamp Eddy project area. A nest that was previously documented within the area was burned in the 2017 Sheep Gap Fire.

The northern goshawk may prefer mature forests for nesting, but other types of forests are used for foraging (USFWS 1998, Squires and Kennedy 2006, Brewer et al. 2009). Nesting habitats range across a variety of forest types in the Northern Region (Brewer et al. 2009). Nesting habitat criteria includes a tree canopy cover of 60 percent or greater and tree diameter of 10 inches or greater (ibid.). Goshawks will use open areas and edges along with forested habitats when foraging (Squires and Kennedy 2006, Samson 2006b).

Brewer et al. (2009) recommend six nest stands of about 40 acres each or 240 acres of nesting habitat per territory. Goshawk home ranges (territories) are about 5,000 acres (Kennedy 2003). The unburned NFS land in the Swamp Eddy project area is large enough to contain about 3 non-overlapping territories. Outside the Sheep Gap fire perimeter, there are approximately 6,852 acres of suitable nesting habitat. Therefore, the unburned portion of the project area contains nearly 10 times the nesting habitat recommended to support 3 goshawk pairs. Foraging habitat is abundant within the project area. Most of the Sheep Gap Fire area is suitable for foraging.

Direct and Indirect Effects

Regeneration harvest would overlap approximately 559 acres (8 percent) of suitable nesting habitat within the unburned portion of the project area. This type of harvest would reduce canopy cover below 60 percent, which would render these stands unsuitable as nesting habitat until tree crowns return to pre-treatment levels in several decades (Reynolds et al. 1992; Squires and Ruggiero 1996; McGrath et al. 2003).

Intermediate harvest would overlap approximately 363 acres (5 percent) of suitable nesting habitat in the unburned portion of the project area. These treatments would likely reduce the nesting quality because the stands would be more open with fewer canopy layers until the vegetation regrows.

Low severity and mixed severity prescribed burning overlap about 96 acres (1 percent) and 227 acres (3 percent), respectively, of suitable nesting habitat in the unburned portion of the project area. Prescribed fire could potentially reduce the suitability of nesting habitat by reducing the density of understory trees, raising the tree crown height of overstory trees, and/or killing groups of overstory trees.

Post-treatment, 83 percent of the existing suitable nesting habitat would be unaffected. This would still be 8 times the amount of recommended nesting habitat (Reynolds et al. 1992) in the unburned portion of the project area, which would support more nests than the territorial nature of goshawks would tolerate. Thus, effects would be minor given the abundance of nesting habitat distributed throughout the project area.

Foraging habitat consists of such a wide variety of forest types and age classes (including burned areas) that the Swamp Eddy timber harvest would not affect goshawk survival, reproduction, or use of the area. Vegetation activities would reduce the risk of high severity fire in treated areas which would increase the likelihood that suitable habitat would remain available over the long term.

Cumulative Effects

The 2017 Sheep Gap Fire reduced the amount of goshawk habitat within the project area. Tree basal area and canopy cover nesting needs in many stands were reduced to levels not suitable for nesting. Post-fire salvage overlapped approximately 679 acres of suitable nesting habitat that remained after the fire. However, this activity had no effect on the habitat because only dead trees were removed. Therefore, the Swamp Eddy project would have no cumulative effects with the salvage. Although timber harvest would alter about 13 percent of the nesting habitat, it would not individually or cumulatively lead to a loss of species viability because foraging and nesting habitat would remain abundant in the project area. In addition, goshawk habitat is abundant and well-distributed across the Forest and Region – more than sufficient to sustain a viable population.

Pileated Woodpecker

Globally, the pileated woodpecker is considered common, widespread, and abundant (Montana Natural Heritage Program, website accessed 1/15/2019). In Montana, the species is listed potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas (ibid.). Monitoring data indicate that the pileated woodpecker population is relatively abundant and evenly distributed across the Forest and northwest Montana (USDA-FS 2008; http://www.birdsource.org/LBMP/). Several observations of pileated woodpecker have occurred within Swamp Eddy project area and sign from pileated woodpecker excavations into larger dead trees is also common.

Although the pileated woodpecker is most often associated with mature forests (Conner et al. 1976, Conner 1980, Shackelford and Conner 1997), it is able to do well in young and fragmented forests (Mellon et al. 1992), including forested areas with just 10 percent forest cover (Bonar 2001). The nest tree is the most important variable for predicting nesting habitat (Kirk and Naylor 1996, Giese and Cuthbert 2003). In Montana, the species selects western larch for nesting more frequently than other tree species, followed by ponderosa pine, black cottonwood, aspen, western white pine, and Douglas-fir (McClelland and McClelland 1999). Nest tree diameters are generally larger than 15 inches (ibid.), and winter roost trees are generally larger than 10 inches in diameter (Bonar 2001). Live and dead (snags) trees are used for nesting and feeding.

Within the Swamp Eddy project outside the Sheep Gap Fire perimeter, there are approximately 3,973 acres of nesting and foraging habitat plus another 3,526 acres of foraging habitat (Lolo National Forest unpublished data, 2018).

Direct and Indirect Effects

Regeneration timber harvest would overlap approximately 648 acres (16 percent) of suitable nesting habitat within the unburned portion of the project area. Some of the larger trees would be removed which could reduce the number of available nesting and feeding trees. Regenerated areas would still likely provide for foraging but would no longer be suitable for nesting until the vegetation regrows.

Intermediate harvest on 214 acres (5 percent) and prescribed burning on 204 acres (5 percent) of suitable nesting habitat in the unburned portion of the project area would also likely result in the loss of some feeding and nesting trees. However, these treated areas would continue to serve as nesting and foraging habitat. Prescribed fire may also provide additional feeding and nesting habitat by promoting large diameter open stands and producing new snags.

About 74 percent of the suitable nesting habitat in the unburned portion of the project area and all habitat in the burned area would remain unaffected by project activities. Therefore, suitable habitat would remain abundant following implementation of the Swamp Eddy project. Existing snags would not be removed within harvest units; however, some may be felled for worker safety. No existing old growth stands would be affected (see Section 3.2-1).

Cumulative Effects

The diversity of habitats used by this species would enable it to persist through a variety of influences. Pileated woodpecker habitat is abundant and well-distributed across the Region, Forest, and Swamp Eddy project area.

Post-fire salvage reduced nesting habitat by approximately 473 acres, which was approximately 14 percent of the existing nesting habitat within the 20,000 acres of NFS land burned by the Sheep Gap Fire. However, snags, nest sites, roost sites, and foraging trees remain abundant within the burned area.

The project would have no measurable adverse cumulative effects on the species or its habitat at the project area, Forest, or Regional scale due to the extensive amount of available habitat, the relatively small amount being treated compared to the landscape, and the relatively small scale of effects.

Elk

The Forest Service Manual directs Forests to manage for species that are in demand for hunting (FSM 2601.2, 2602, and 2603). The Lolo Forest Plan contains goals, objectives, and standards for big game management that include providing and improving habitat for big game, protecting features such as wallows and mineral licks, managing winter range, providing hunting opportunities and working cooperatively with Montana FWP. Big game on the Plains/Thompson Falls Ranger District primarily refers to elk, white-tailed deer, and mule deer. There are smaller numbers of moose and bighorn sheep. Managing for the requirements for elk generally fulfills the needs of other big game species. The document “Coordinating Elk and Timber Management” (Lyon et al. 1985), as well as the Montana elk management plan (MTFWP 2004), were considered in assessing the effects of timber harvest on elk habitat.

Montana FWP elk monitoring data indicates that hunting district 124 (where the Swamp Eddy project area is located) is at population objective. Hunting regulations within this district have remained essentially the same over the last two decades, which suggests the elk population is stable.

Direct and Indirect Effects

Timber harvest and low severity prescribed burning would improve forage production on approximately 510 acres of winter range areas by increasing understory vegetation growth. Hiding cover would be reduced for roughly 15 years on approximately 50 acres, where regeneration harvest would occur within winter range. However, because cover is currently exceeding desired conditions, treatments would move the cover:forage ratio closer to that which is outlined in the Forest Plan (see below).

Regeneration harvest and mixed severity prescribed burning would improve summer forage conditions on nearly 2000 acres. These treatments would open the tree canopy and increase the sunlight to the forest floor, which would stimulate shrub growth. Hiding cover would be reduced on these acres for approximately 15 years, which would increase the potential for elk to be harvested during hunting season. Elk would be most vulnerable on the 430 acres of regeneration harvest located adjacent to roads open to public motorized use during hunting season. However, effects to the population would be discountable because of the relatively small size of the affected area compared to the landscape, hiding cover would re-establish as vegetation regenerates, public open road access would not change, and Montana FWP regulates elk harvest.

Timber harvest operations and related road work could temporarily disturb elk during implementation. However, these effects would be discountable due to the relatively small footprint of project activities and the availability of ample undisturbed areas for elk to disperse to. Temporary displacement would not lead to mortality or long-term consequences.

Cumulative Effects

The Sheep Gap Fire improved forage conditions, primarily within areas that burned at moderate to high severity. Regenerating grass, forbs, and shrubs will provide an abundant, nutritious food source for the next several years. The Swamp Eddy project would contribute to the trend of improved forage conditions within the area.

Post-fire salvage operations will be completed prior to implementation of the Swamp Eddy project. Therefore, there would be no overlap of potential disturbance and resulting displacement effects of the two projects.

The forests on the industrial timber land and state land adjacent to the project area have a mosaic of variable tree densities resulting from past harvest. The hiding cover was reduced in areas of heavier harvest, however trees and shrubs are growing in the openings, which will soon provide adequate concealment for large mammals, like elk. Despite past harvest activity, elk populations have remained relatively stable.

Forest Plan Consistency

The Swamp Eddy project is consistent with the Lolo Forest Plan:

- Wildlife features such as wallows, mineral licks, and seeps would be protected - see design criteria in section 1.4.1). (Forest-wide standard 21, Forest Plan, page II-13).
- A Forest Service wildlife biologist participated in project development to ensure suitable habitat would be maintained for elk. Within areas allocated in the Forest Plan to winter range, project activities were designed to improve the quality of winter range (Forest-wide standard 22, Forest Plan page II-13).
- The principles in the document “Coordinating Elk and Timber Management” (Final Report of the Montana Cooperative Elk-Logging Study, 1970-1985), which summarizes the results of 15 years of interagency elk/logging research, were used in the design and assessment of the Swamp Eddy project. (Forest-wide standard 23, Forest Plan, page II-13)
- Forest Plan management areas (MAs) 18, 22, and 23 contain a standard that requires retaining as a minimum a 50:50 cover:forage ratio, with the majority of cover as thermal cover consisting of trees greater than or equal to 40 feet tall with a crown density greater than or equal to 50 percent. The project area contains approximately 980 acres in MA 18, 2154 acres in MA 23, and no acres within MA 22. Swamp Eddy includes approximately 50 acres of regeneration harvest and 82 acres of intermediate harvest within MAs 18 and 23. In addition, approximately 278 acres of low severity prescribed burning would occur within these MAs. Outside the Sheep Gap Fire area where project activities would occur, winter range areas currently have excessive cover and reduced forage (cover:forage ratio is 90:10). Prescribed treatments would reduce cover and improve forage conditions on treated areas, trending closer to the 50:50 cover:forage ratio.

Migratory Birds

Most native birds in the U.S., including those listed as Forest Service sensitive species are protected under the Migratory Bird Treaty Act. The needs of migratory birds are addressed throughout this analysis, including the individual sections on project impacts to flammulated owl, northern goshawk, and pileated woodpeckers as well as other sections of this EA that address habitat diversity.

Direct, Indirect, and Cumulative Effects

Because of the myriad of species included in the migratory bird group, any habitat modifications could have effects on some species but not others. Timber harvest activities would create disturbance that could temporarily displace birds to unaffected areas. If timber harvest occurs during spring, it could have negative effects on individual nesting birds because nests, eggs and nestlings would be unable to move away from activities. These impacts are unlikely to have population-level effects because: 1) these species are currently abundant enough that loss of some reproduction in a year is insignificant and 2) most species reproduce relatively quickly, enabling them to repopulate a small area easily.

"Migratory birds" include such a wide range of species which use nearly every habitat available in the Northern Region. Managing landscapes to maintain a balance of vegetative conditions within reference conditions can balance the needs of many species. At the same time, avoiding adverse effects on Endangered, Threatened, and sensitive species focuses attention on species where special management may be required. According to Partners in Flight, the Intermountain West area needs restoration work to improve historic structure of ponderosa pine forests, aspen habitats, and riparian habitats to best conserve the suite of birds native to this area (Rich et al. 2004). Therefore, cumulatively, the project would not affect migratory bird populations because of the relatively small scale of the timber harvest activities compared to the landscape, the limited intensity of effects, and the widespread nature of these species.

3.6 Transportation System

Issue Raised in Public Comment
Road closures could affect public access.

Within the Swamp Eddy project area, there are approximately 205 miles of road under Forest Service jurisdiction: 115 miles (56 percent) are system roads and 90 miles (44 percent) are non-system roads. Most non-system roads are narrow, brushed/treed-in roads constructed in the mid-20th century to accommodate the logging equipment of that era. Approximately 71 miles (62 percent) of system roads under Forest Service jurisdiction are currently legally open yearlong or seasonally to public motorized use.

Forest Service policy prescribes the travel analysis process for many purposes (FSH 7709.55). Travel management decisions are to be "informed by travel analysis, as applicable" (FSM 7710.3). Travel management decisions are defined at FSM 7715 and include "adding a route to or removing a route from the forest transportation system, constructing a National Forest System (NFS) road or NFS trail, acquiring an NFS route through a land purchase or exchange, decommissioning a route, approving an area for motor vehicle use, or changing allowed motor vehicle classes or time of year for motor vehicle use." In these instances, "the responsible official has the discretion to determine whether travel analysis at a scale smaller than a ranger district or an administrative unit is needed and the amount of detail that is appropriate and practicable for travel analysis" (FSM 7712.1 (3)).

Following the policy described above, the Forest Service completed a project-specific travel analysis for the Swamp Eddy project area. This analysis identified some roads to be decommissioned and found that some existing undetermined roads need to be added to the specified road system (see Chapter 2 for specific details). As part of this analysis, all roads under Forest Service jurisdiction were analyzed, including system roads and non-system roads. See the Transportation report in the Project File for more detailed information regarding the Travel Analysis.

Direct, Indirect, and Cumulative Effects

Public motorized access would not measurably change in the Swamp Eddy project area. Although 79 miles of road would be decommissioned because they are not needed for forest management, most (73 miles or 92 percent) are non-system roads on which public motorized travel is not permitted and are undrivable due to vegetation growth on the roadway. Road surveys indicated that about 4 miles of road proposed for decommissioning would need physical treatment. The remaining roads are benign and not currently causing any identifiable environmental harm because of their location and well-vegetated condition. Natural processes have essentially decommissioned them already.

Approximately 6 miles of National Forest System road would be decommissioned. Only one mile of which is currently designated open to public motorized use (NFSR 17350). However, this mile of road is not and has not been drivable for at least a decade due to vegetation growing in the roadway. The other 5 miles of system road proposed for decommissioning are gated yearlong and available only for administrative use.

This loss of one mile of open (although undrivable) system road would be offset by the adoption of 1 mile of non-system roads to the National Forest system and designated as open yearlong to public motorized use. However, public use is already occurring on these non-system roads, most of which are located at the mouth of Swamp dispersed recreation site and one segment accesses state land in lower Swamp Creek. Therefore, public motorized access would remain essentially the same as it is now (see Table 3.6-1).

Table 3.6-1: Summary of Changes to Legal Public Motorized Access

Management Action	Miles	Rationale
Adopt non-system roads to the National Forest road system and designated as open yearlong	1	These roads are associated with mouth of Swamp dispersed recreation site and one segment provides access to State land in lower Swamp Creek.
Decommission NFSR 17350, which designated Open yearlong, but not currently drivable	1	Road segment is not needed for long-term management. The roads located upslope (NFSRs 7583 and 17353) are sufficient for logging system access. NFSR 17350 is in the upper end of Bemish Creek between the switchbacks of NFSR 7583, which is open yearlong to public motorized use. Public motorized access would continue to be maintained in the immediate area.

Cumulatively, the project would result in a net gain of 10 miles of road to the National Forest system through the adoption of 16 miles of non-system roads and the decommissioning of approximately 6 miles of existing system road. See Table 2-3 and Appendix B for more details.

Forest Plan Consistency

The project is consistent with the Lolo Forest Plan. A project-specific Travel Analysis was conducted to ensure roads within the project area would be the minimum number and meet the design standards to provide for safety and to meet user and resource needs (Standard 48, page II-17). Roads within the project area would be managed to provide for resource protection, wildlife needs, commodity removal, and a wide range of recreation opportunities (Standard 52, page II-18).

3.7 Economics

Three factors were considered in the economic analysis: project feasibility which addresses only the timber harvest component of this project; financial efficiency, which addresses present net value (PNV) or the net monetary costs and benefits of the project; and economic impacts, which are the effects of this project on local jobs and labor income.

Project feasibility is used to determine if the timber harvest would be feasible, that is, would it sell, given current market conditions. The determination of feasibility relies on a residual value analysis (price of the timber = revenues – costs) that uses local delivered log prices and stump-to-mill costs. The appraised stumpage rate from this analysis is compared to the base rate. The project is considered feasible if the appraised stumpage rate exceeds the base rate.

Financial efficiency provides information relevant to the future financial position of the government as the project is implemented. Financial efficiency considers anticipated Forest Service costs and revenues. PNV is the difference between the present value of the revenues and present value of the costs. PNV converts costs and revenues over the entire time frame of the project into a single figure for a selected year. A positive PNV means that the project would generate more financial revenues than financial costs. The NEPA planning is a sunk cost at the time of the decision and is not included in the PNV analysis.

Financial efficiency analysis is not intended to be a comprehensive analysis that incorporates monetary expressions of all known market and non-market benefits and costs. Many of the values associated with natural resource management are best handled apart from, but in conjunction with, a more limited financial efficiency framework. These non-market benefits and costs associated with the project are discussed throughout the various resource sections of this EA.

Economic impacts are used to evaluate potential direct, indirect, and cumulative effects of the project on the economy. They are measured by estimating the direct jobs and labor income generated by 1) the processing of the timber volume from the project and 2) Forest Service expenditures for contracted other activities. The direct economic and labor income benefit employees and their families and, therefore, directly affect the local economy. Additional indirect and induced multiplier effects (ripple effects) are generated by the direct activities. Indirect effects are felt by the producers of materials used by the directly affected industries. Induced effects occur when employees of the directly and indirectly affected industries spend the wages they receive. Together the direct and multiplier effects comprise the total economic impacts to the local economy.

Economic impacts are estimated using input-output analysis, which is a means of examining relationships within an economy, both between businesses and between businesses and final consumers. It captures all monetary market transactions for consumption in a given time period. The resulting mathematical representation allows one to examine the effect of a change in one or several economic activities on an entire economy, all else constant. The model used for this analysis is the 2015 IMPLAN data in conjunction with response coefficients that relate timber harvest quantity to direct jobs and income (Sorenson et al. 2016). IMPLAN translates changes in final demand for goods and services into resulting changes in economic effects, such as labor income and employment of the affected area’s economy.

Data used to estimate the direct effects from the timber harvesting and processing were provided by the University of Montana’s Bureau of Business and Economic Research (BBER) (Sorenson et al. 2016). This national dataset is broken into multi-state regions and is considered more accurate than that which is available from IMPLAN. The Northern Rockies BBER Region (Montana and Idaho) is used for this analysis. The BBER data represents the results of mill censuses that correlate production, employment, and labor income. The economic impact area for this analysis consists of Sanders and Mineral Counties. Potential limitations of these estimates are the time lag in IMPLAN and the uncertainty of where the timber will ultimately be processed. The analysis assumes the harvested timber volume would be processed in the Sanders and Mineral County impact area. However, if some of the timber were processed outside the region, then a portion of the jobs and income would be lost by this regional economy.

Table 3.7-1 Project Feasibility and Financial Efficiency Summary (2017 dollars)

Category	Measure	Modified Proposed Action
Timber Harvest Information	Acres Harvested*	1,766
	Volume Harvested* (CCF)	22,474
	Base Rates ($/CCF)	$28.51
	Appraised Stumpage Rate ($/CCF)	$29.20
	Predicted High Bid ($/CCF)	$34.85
	Total Revenue	$783,000
Timber Harvest & Required Design Criteria	PNV	$659,000
Timber Harvest & All Other Resource Activities	PNV	-$142,000

* Volume and acres are estimations
CCF= hundred cubic feet

Table 3.7-2: Total Employment and Labor Income over the Life of the Project*

Non-Timber Harvest-related Activities	Modified Proposed Action	
Part and Full Time Jobs Contributed	**Total**	**Annual**
Direct	8	1
Indirect and Induced	1	0
Total	**9**	**1**
Labor Income Contributed ($)		
Direct	$187,000	$21,000
Indirect and Induced	$51,000	$6,000
Total	**$238,000**	**$27,000**
Timber Harvest and Processing		
Part and Full Time Jobs Contributed	**Total**	**Annual**
Direct	58	12
Indirect and Induced	81	16
Total	**139**	**28**
Labor Income Contributed ($)		
Direct	$2,743,000	$549,000
Indirect and Induced	$2,469,000	$494,000
Total	**$5,212,000**	**$1,042,000**
All Activities		
Part and Full Time Jobs Contributed	**Total**	**Annual**
Direct	66	13
Indirect and Induced	82	16
Total	**148**	**29**
Labor Income Contributed ($)		
Direct	$2,931,000	$570,000
Indirect and Induced	$2,520,000	$449,000
Total	**$5,450,000**	**$1,069,000**

* It is important to note that these may not be new jobs or income, but rather jobs and income supported by this project.

Part and Full Time Jobs Contributed is the total full and part-time wage, salaried, and self-employed jobs contributed to the economic impact area from the change in final demand associated with this project.
Labor Income Contributed includes the wages, salaries and benefits of workers who are paid by employers and income paid to proprietors in the economic impact area from the change in final demand associated with this project.
Direct effects represent the impacts for the expenditures and/or production values specified as direct final demand changes.
Indirect effects represent the impacts caused by the iteration of industries purchasing from industries resulting from direct final demand changes.
Induced effects represent the impacts of all local industries caused by the expenditures of new household income generated by the direct and indirect effects of final demand changes.
Total effects are the sum of direct, indirect, and induced effects.

Direct and Indirect Effects

Project Feasibility
The appraised stumpage rate from the feasibility analysis was compared to base rates. As displayed in Table 3.7-1, the appraised stumpage rate is greater than the base rate, indicating that the project is feasible (likely to sell).

Financial Efficiency
The financial efficiency analysis is specific to the timber harvest and other activities (as directed in Forest Service Manual 2400-Timber Management and guidance found in Forest Service Handbook 2409.18). Costs for sale preparation, sale administration, regeneration, and restoration activities are included. If exact costs were not known, the maximum of the cost range was used to produce the most conservative PNV result. If actual costs are lower, all else equal, PNV would be higher than the estimates in Table 3.7-1. The expected revenue for the project is the corresponding predicted high bid from the sale feasibility analysis. The predicted high bid is used for the expected revenue (rather than the appraised stumpage rate) since the predicted high bid is the best estimate of the high bid resulting from the timber sale auction.

Because not all costs of the project are related to the timber sale, two PNVs were calculated. One PNV indicates the financial efficiency of the modified proposed action, including all costs and revenues associated with the timber harvest and required design criteria. A second PNV includes all costs for the modified proposed action with the required design criteria and for the timber harvest and all other resource activities (e.g., non-commercial thinning, prescribed burning, recreation improvements).

Results shown in Table 3.7-1 indicate that the project is financially efficient (positive PNV) for the timber harvest with designed criteria. However, the project is financially inefficient (negative PNV) when the other resource activities are added to the timber harvest.

The decision maker takes many factors into account in making the decision. When evaluating trade-offs, the use of efficiency measures is just one factor that is considered.

Economic Impacts
The project would support existing jobs through timber harvest-related and other non-commercial activities. Table 3.7-2 displays the direct, indirect and induced, and total estimates for employment (part and full-time) and labor income that may be attributed to the project. Since the expenditures occur over time, the estimated impacts of jobs and labor income would be spread out over the life of the project. It is important to note that these may not be new jobs or income, but rather jobs and income that are supported by this project. It is anticipated that the timber harvest would occur over a five-year period, with the other resource activities spread out over four years after harvest. This means

that the impact of timber harvest to jobs and labor income would occur prior to those associated with other resource activities. However, implementation could take longer than anticipated due to unforeseen circumstances.

Cumulative Effects

Management of the Lolo National Forest has an impact on the economies of local counties. However, there are many additional factors that influence and affect the local economies, including changes to industry technologies, management of adjacent National Forests and private lands, economic growth and international trade. The project would provide a variety of opportunities for contracts that may contribute to the local economy and have the potential to attract new business and residents and retain existing businesses and residents.

In addition, there are other foreseeable future Forest Service projects within Sanders County and counties closest to the project area that are in various stages of planning that potentially may add to the Forest's annual timber offerings during the time of implementation of the project. These ongoing and foreseeable projects are expected to add cumulatively to the employment and income of the economic impact area within the life of the Swamp Eddy project.

Forest Plan Consistency

Consistent with the Forest Plan, an economic analysis has been completed that includes the probable marketability (i.e. economic feasibility) of the commercial timber harvest portion of the project (Forest Plan standard 11, page II-11). The project also contributes to one of the Forest Plan's goals to provide a sustained yield of timber and other outputs at a level that will help to support the economic structure of local communities (Forest Plan, page II-1).

3.8 Roadless

The Swamp Eddy project area overlaps approximately 3,702 acres (9 percent) of the 39,640-acre Cherry Peak Inventoried Roadless Area[17] (IRA) and 126 acres (0.7 percent) of the 17,200-acre Patrick's Knob-North Cutoff IRA. No timber harvest, road construction, or reconstruction would occur within the IRAs. However, the project includes the following activities within the IRAs.

Table 3.8-1: Summary of Activities in IRAs

Activity	Cherry Peak IRA	Patrick's Knob-North Cutoff IRA
Prescribed burning (acres)	741	0
Road decommissioning (miles)	0.3	0.8

Contiguous to the Cherry Peak IRA, there is an irregularly-shaped block of unroaded land consisting of approximately 2000 acres. Contiguous to the Patrick's Knob-North Cutoff IRA there is an 80-acre block of unroaded land located between NFSR 7592 and the IRA boundary. No project activities would occur within these unroaded areas.

Direct and Indirect Effects

Although the project includes limited activities within the IRAs, there would be no long-term effects to roadless characteristics. Prescribed burning would have no noticeable effect on roadless character

[17] Inventoried Roadless Areas are areas identified in a set of inventoried roadless area maps, contained in the Forest Service Roadless Area Conservation Final Environmental Impact Statement Volume 2, dated November 2000 (36 CFR 294.11). These areas were originally identified in the 1970s and early 1980s as roadless and evaluated for their suitability as possible wilderness status.

because fire is the primary natural disturbance process that historically occurred on the landscape in this area as evidenced by the 2017 Sheep Gap Fire. The feeling of solitude could be temporarily reduced somewhat during project implementation due to the sound of a helicopter during aerial ignition. The noise would be intermittent during the few days it would take to complete burning operations.

Approximately 1.2 miles of non-system road, consisting of multiple segments, would be decommissioned within the two IRAs. These roads would be administratively decommissioned, meaning that no physical activities would occur on the ground because these roads are vegetated, contain no stream crossings, and pose no identified environmental risk. Because no activities would occur on the ground, road decommissioning would have no effect on existing roadless characteristics. See the Roadless report in the Project File for more detailed information.

Cumulative Effects

There are no reasonably foreseeable future activities within the Cherry Peak or Patrick's Knob-North Cutoff IRAs.

The 2004 Cherry Creek Fire and 2017 Sheep Gap Fire burned at high severity across 6,320 acres (16 percent) of the Cherry Peak IRA. The Swamp Eddy project would apply mixed severity prescribed burning to approximately 741 acres (2 percent) of the IRA, blending into these previous wildfires. Prescribed burning would not create a permanent footprint on the landscape and thus would not contribute any measurable effects to roadless characteristics. Therefore, project activities would not make an irreversible or irretrievable commitment of resources or preclude the area from future wilderness consideration.

Forest Plan and 2001 Roadless Area Conservation Rule[18] Consistency

The project is consistent with the Lolo Forest Plan because prescribed burning and road decommissioning are permitted.

The project also complies with the 2001 Roadless Area Conservation Rule because the Rule does not prohibit prescribed burning or road decommissioning within IRAs.

[18] The 2001 Roadless Area Conservation Rule was adopted by the U.S. Department of Agriculture to conserve Inventoried Roadless Areas on National Forest System lands.

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Appendix A
Maps

NOTE: These maps along with the entire Environmental Assessment are posted on the Lolo National Forest website (https://www.fs.usda.gov/projects/lolo/landmanagement/projects), where viewers can use the “zoom-in” function to see greater detail.

Appendix B
Detailed Vegetation and Road Treatments

Table B-1: Vegetation Treatment Areas

Unit #	Acres[1]	Treatment Type	Logging System[2]
C01	18	Regeneration Cut	Skyline
C02	10	Intermediate Harvest	Skyline
C03	9	Intermediate Harvest	Skyline
C04	25	Intermediate Harvest	Skyline
C05	2	Intermediate Harvest	Tractor
C06	35	Regeneration Cut	Skyline
C07	43	Intermediate Harvest	Skyline
C07X	9	Intermediate Harvest	Skyline
C08	14	Regeneration Cut	Tractor
C09	13	Regeneration Cut	Skyline
C10	28	Regeneration Cut	Skyline
C10X	8	Regeneration Cut	Skyline
C11	7	Intermediate Harvest	Skyline
C12	42	Regeneration Cut	Skyline
C13	26	Non-commercial Thin	--------
C14	62	Regeneration Cut	Skyline
C15	14	Regeneration Cut	Tractor
C16	23	Regeneration Cut	Skyline
C16X	29	Regeneration Cut	Skyline
C17	44	Regeneration Cut	Skyline
C17X	48	Regeneration Cut	Skyline
C18	37	Regeneration Cut	Skyline
C19	26	Intermediate Harvest	Excaline
C20	59	Intermediate Harvest	Skyline
C21	41	Regeneration Cut	Skyline
C22	21	Non-commercial Thin	--------
C23	5	Non-commercial Thin	--------
C24	12	Non-commercial Thin	--------
C25	30	Non-commercial Thin	--------
C26	26	Regeneration Cut	Skyline
C27	19	Regeneration Cut	Skyline
C31	18	Non-commercial Thin	--------
C32	28	Non-commercial Thin	--------
C33	35	Non-commercial Thin	--------
C34	21	Non-commercial Thin	--------

Unit #	Acres[1]	Treatment Type	Logging System[2]
C36	5	Non-commercial Thin	--------
C37	84	Small Tree Commercial Thin	Skyline
C38	26	Non-commercial Thin	--------
C38X	11	Regeneration Cut	Skyline
C39X	27	Regeneration Cut	Skyline
C40X	23	Regeneration Cut	Skyline
C41	11	Non-commercial Thin	--------
C41X	74	Regeneration Cut	Skyline
C42X	96	Regeneration Cut	Skyline
C44X	14	Regeneration Cut	Skyline
C45X	5	Non-commercial Thin	--------
E21	25	Intermediate Harvest	Tractor
S04	43	Regeneration Cut	Skyline
S04X	8	Regeneration Cut	Skyline
S05	14	Intermediate Harvest	Skyline
S06	9	Intermediate Harvest	Skyline
S07	20	Regeneration Cut	Skyline
S08	24	Regeneration Cut	Tractor
S14	57	Small Tree Commercial Thin	Skyline
S17	65	Small Tree Commercial Thin	Skyline
S18	20	Small Tree Commercial Thin	Skyline
S19	21	Non-commercial Thin	--------
S42	29	Regeneration Cut	Skyline
S43	20	Regeneration Cut	Skyline
S44	21	Regeneration Cut	Skyline
S45	26	Regeneration Cut	Skyline
S45X	14	Regeneration Cut	Skyline
S46	22	Intermediate Harvest	Skyline
S46X	23	Intermediate Harvest	Skyline
S54	21	Regeneration Cut	Skyline
S56	15	Non-commercial Thin	--------
S57	7	Regeneration Cut	Tractor
S67	23	Regeneration Cut	Skyline
S69	17	Regeneration Cut	Skyline
S70	24	Regeneration Cut	Skyline
S71	23	Regeneration Cut	Skyline
S72	19	Regeneration Cut	Skyline
S74	18	Regeneration Cut	Skyline
S74X	7	Regeneration Cut	Skyline
S89	19	Regeneration Cut	Excaline

Unit #	Acres[1]	Treatment Type	Logging System[2]
S90X	30	Regeneration Cut	Skyline
S91X	26	Regeneration Cut	Skyline
S92X	30	Regeneration Cut	Skyline
S96X	26	Regeneration Cut	Tractor
S97X	12	Regeneration Cut	Skyline
LS12	16	Low Severity Burn	--------
LS14	212	Low Severity Burn	--------
LS15	112	Low Severity Burn	--------
LS16	112	Low Severity Burn	--------
LS17	15	Low Severity Burn	--------
LS18	23	Low Severity Burn	--------
LS19	46	Low Severity Burn	--------
LS20	28	Low Severity Burn	--------
LS21	124	Low Severity Burn	--------
MS1	741	Mixed Severity Burn	--------

[1]Acres are approximate
[2]Equipment reflects the primary yarding system. Units may contain incidental areas that would require another type of equipment.

Vegetation Treatment Descriptions:

Intermediate Timber Harvest treatments (e.g. commercial thinning) are designed to enhance growth, quality, vigor, and composition of the existing stand. Generally smaller trees are removed from the lower and main canopy, retaining the larger trees of desired fire-tolerant species with gaps between the crowns. Within some stands, prescribed fire would be applied following harvest activities.

Small Tree Commercial Thinning would occur within ponderosa pine plantations that originated from timber harvest and subsequent planting in the 1960s. Today, these stands are densely stocked with trees that range in size from 5 to 10 inches in diameter and are at high risk to insect-induced mortality. Commercial thinning would remove smaller trees from the lower and main canopy.

Regeneration Timber Harvest treatments are designed to replace the existing stand with a stand that has a species composition and stocking density that meets desired future conditions specified in management objectives. Regeneration harvests are proposed where stand conditions (insects, disease, blowdown, etc.) do not meet and are not projected to meet desired conditions and where intermediate harvest cannot alter stand development to a desired condition. Prescribed fire would be applied following harvest to reduce fuel and prepare the site for natural regeneration or planting. Natural regeneration is expected at various densities and species, and most of these units would be planted to ensure regeneration of larch, ponderosa pine, and blister rust-resistant white pine.

Due to existing conditions (i.e. insects and disease) and project objectives (elk summer forage production and re-establishment of varying patch sizes), some of the regeneration harvest treatments would result in forest openings that would exceed the Regional 40-acre opening size limitation (Forest Service Manual 2470, Section 2471.1, Region 1 Supplement 2400-2001-2). To exceed this size, Regional Forester approval is required. These larger openings could range in size from 53 to about 116 acres, mimicking natural disturbance patterns (see Table 2-2). Varying densities of trees would be retained within these areas, from scattered individuals to groups consisting of the largest, healthiest trees.

Non-commercial thinning would occur in young (20-40 years old) stands to remove smaller trees from the lower and main canopy, retaining the larger trees of desired fire-tolerant species with gaps between crowns. This would provide growing space to reduce competitive stress, resulting in trees that grow bigger faster, develop characteristics that increase fire-tolerance both at individual tree and at stand levels, and better resist some of the most damaging insects and diseases. The resulting stand densities would typically be between 110 and 170 trees per acre, but that would vary by species distribution and tree sizes. The trees cut during this process would be left on site and allowed to decompose back into the soil.

Low Severity Prescribed Burn treatments would primarily be low intensity surface fire. This type of burning is proposed on the drier ponderosa pine/Douglas-fir forest types where wildfire historically burned at frequent intervals, with low to mixed severities. This burning would be used to improve big game winter range areas and forest stand resilience.

Mixed Severity Prescribed Burn treatments would be a combination of low to moderate severity surface fire with areas that would likely burn at high severity where surface fuels are heavy. This type of prescribed burning is primarily proposed in mixed conifer forest types where there is existing tree mortality.

Table B-2: Road Treatments

Road #	BMP	EMP	Length (Miles)	Management Action
17318	0.00	0.31	0.31	Decommission: Closure Level 3DN
17350	0.57	1.67	1.10	Decommission: Closure Level 3DN
17350	1.67	1.86	0.19	Decommission: Closure Level 3DN
17356	0.68	0.79	0.11	Add to System: Store Level 3S: Long-term access
17356	0.79	0.91	0.12	Decommission: Closure Level 3DN
18251	1.71	2.58	0.87	Decommission: Closure Level 3DN
18259	0.00	3.13	3.15	Decommission: Closure Level 3DN
18272	0.20	0.43	0.23	Decommission: Closure Level 3DN
18272	0.43	0.53	0.11	Decommission: Closure Level 3DN
18308	0.00	0.64	0.69	Decommission: Closure Level 3DN
35019	0.00	0.19	0.19	Decommission: Closure Level 3D
35020	0.71	0.86	0.15	Add to System: Store Level 3SN: Long-term access
35024	0.00	0.99	0.99	Decommission: Closure Level 3DN
35077	0.15	1.02	0.87	Decommission: Closure Level 3DN
35078	0.00	0.95	0.95	Decommission: Closure Level 3DN
35079	0.00	0.80	0.80	Add to System: Store Level 3SN: Long-term access
35079	0.80	1.07	0.27	Add to System: Store Level 3SN: Long-term access
35079	1.30	1.67	0.37	Decommission: Closure Level 3DN
35080	0.00	0.70	0.70	Add to System: Store Level 3SN: Long-term access
35081	0.00	0.99	0.99	Add to System: Store Level 3S: Long-term access
35082	0.00	0.67	0.67	Decommission: Closure Level 3DN

Road #	BMP	EMP	Length (Miles)	Management Action
35083	0.00	0.08	0.08	Decommission: Closure Level 3DN
35084	0.00	0.55	0.54	Decommission: Closure Level 3DN
35085	0.00	0.39	0.39	Decommission: Closure Level 3DN
35087	0.00	0.17	0.16	Decommission: Closure Level 3DN
35088	0.00	1.52	1.51	Add to System: Store Level 3SN: Long-term access
35089	0.00	0.37	0.36	Decommission: Closure Level 3DN
35090	0.00	0.76	0.76	Decommission: Closure Level 3DN
35091	0.00	1.09	1.09	Decommission: Closure Level 3DN
35092	0.00	1.71	1.71	Decommission: Closure Level 3DN
35093	0.00	0.22	0.22	Decommission: Closure Level 3DN
35094	0.00	0.65	0.65	Decommission: Closure Level 3DN
35095	0.00	1.28	1.28	Decommission: Closure Level 3DN
35096	0.00	0.31	0.31	Add to System: Store Level 3SN: Long-term access
35096	0.31	0.52	0.21	Decommission: Closure Level 3DN
35098	0.00	0.86	0.86	Decommission: Closure Level 3D
35099	0.00	0.23	0.23	Decommission: Closure Level 3DN
35100	0.00	0.35	0.34	Add to System: Yearlong Closure, Map Code A; Long-term access
35101	0.00	1.21	1.21	Decommission: Closure Level 3DN
35103	0.30	0.68	0.38	Decommission: Closure Level 3DN
35104	0.22	0.52	0.30	Decommission: Closure Level 3DN
35143	0.00	0.46	0.46	Decommission: Closure Level 3DN
35143	0.46	1.32	0.86	Decommission: Closure Level 3DN
35144	0.00	0.20	0.20	Decommission: Closure Level 3DN
35161	0.00	0.83	0.83	Decommission: Closure Level 3DN
35168	0.00	0.73	0.73	Decommission: Closure Level 3DN
35169	0.00	0.49	0.49	Decommission: Closure Level 3DN
35382	0.00	0.15	0.15	Decommission: Closure Level 3DN
35383	0.00	0.49	0.49	Decommission: Closure Level 3DN
35384	0.00	1.33	1.32	Add to System: Store Level 3SN: Long-term access
35385	0.42	0.94	0.52	Add to System: Store Level 3SN: Long-term access. Store beyond developed spring.
35385	0.00	0.42	0.52	Add to System: Yearlong Closure, Map Code A. Provides access to developed spring.
35386	0.00	0.23	0.23	Decommission: Closure Level 3DN
35387	0.00	0.48	0.47	Decommission: Closure Level 3DN
35430	0.43	0.87	0.44	Add to System: Store Level 3SN: Long-term access
38594	0.00	0.36	0.36	Decommission: Closure Level 3DN
38595	0.00	0.14	0.14	Add to System: Keep Open for access to mouth of Swamp dispersed recreation site
35019-A	0.00	0.08	0.08	Decommission: Closure Level 3DN

Road #	BMP	EMP	Length (Miles)	Management Action
35019-B	0.00	0.31	0.31	Decommission: Closure Level 3DN
35019-C	0.00	0.10	0.10	Decommission: Closure Level 3DN
35024-A	0.00	1.05	1.05	Decommission: Closure Level 3DN
35024-B	0.00	0.80	0.80	Decommission: Closure Level 3DN
35024-C	0.00	0.40	0.40	Decommission: Closure Level 3DN
35024-D	0.00	0.64	0.64	Add to System: Store Level 3S: Long-term access
35024-E	0.00	0.28	0.28	Add to System: Store Level 3SN: Long-term access
35079-A	0.00	0.30	0.30	Decommission: Closure Level 3DN
35079-A	0.48	0.92	0.44	Decommission: Closure Level 3DN
35080-A	0.00	0.84	0.84	Decommission: Closure Level 3DN
35080-B	0.00	0.44	0.45	Decommission: Closure Level 3DN
35080-C	0.00	0.18	0.18	Decommission: Closure Level 3DN
35080-D	0.00	1.36	1.41	Decommission: Closure Level 3DN
35080-E	0.00	0.44	0.48	Decommission: Closure Level 3DN
35080-F	0.00	2.00	1.99	Decommission: Closure Level 3DN
35080-G	0.00	0.64	0.64	Decommission: Closure Level 3DN
35080-H	0.00	0.53	0.55	Decommission: Closure Level 3DN
35080-I	0.00	0.50	0.50	Decommission: Closure Level 3DN
35080-J	0.00	0.34	0.34	Decommission: Closure Level 3DN
35081-A	0.00	0.37	0.37	Decommission: Closure Level 3DN
35081-B	0.00	0.09	0.09	Decommission: Closure Level 3DN
35081-C	0.00	0.63	0.44	Add to System: Convert to Trail (#385)
35081-C	0.00	0.63	0.19	Decommission: Closure Level 3DN
35082-A	0.00	0.10	0.10	Add to System: Store Level 3SN: Long-term access
35082-B	0.00	0.96	0.96	Decommission: Closure Level 3DN
35082-C	0.00	1.54	1.54	Add to System: Store Level 3SN: Long-term access
35082-D	0.00	0.88	0.88	Decommission: Closure Level 3DN
35082-E	0.00	1.09	1.09	Decommission: Closure Level 3DN
35085-A	0.00	0.28	0.28	Decommission: Closure Level 3DN
35085-B	0.00	0.50	0.50	Decommission: Closure Level 3DN
35085-C	0.00	0.81	0.81	Decommission: Closure Level 3DN
35087-A	0.00	0.23	0.23	Add to System: Store Level 3SN: Long-term access
35087-B	0.00	0.43	0.43	Decommission: Closure Level 3DN
35087-C	0.00	0.44	0.44	Decommission: Closure Level 3DN
35087-D	0.00	0.20	0.20	Decommission: Closure Level 3DN
35088-A	0.00	0.55	0.55	Decommission: Closure Level 3D
35088-B	0.00	0.21	0.21	Decommission: Closure Level 3DN
35089-A	0.00	0.32	0.32	Decommission: Closure Level 3DN
35089-B	0.00	0.22	0.22	Decommission: Closure Level 3DN

Road #	BMP	EMP	Length (Miles)	Management Action
35089-C	0.00	0.56	0.56	Decommission: Closure Level 3DN
35089-D	0.00	0.18	0.18	Decommission: Closure Level 3DN
35089-E	0.00	0.07	0.07	Decommission: Closure Level 3DN
35090-A	0.00	0.80	0.80	Add to System: Store Level 3SN: Long-term access
35090-B	0.00	0.45	0.44	Decommission: Closure Level 3DN
35091-A	0.00	0.74	0.73	Decommission: Closure Level 3DN
35092-A	0.00	1.37	1.37	Decommission: Closure Level 3DN
35092-B	0.00	3.32	3.32	Decommission: Closure Level 3DN
35092-C	0.00	0.44	0.44	Decommission: Closure Level 3DN
35092-D	0.00	1.18	1.18	Decommission: Closure Level 3DN
35092-E	0.00	0.49	0.49	Decommission: Closure Level 3DN
35093-A	0.00	0.82	0.82	Decommission: Closure Level 3DN
35093-B	0.00	0.32	0.32	Decommission: Closure Level 3DN
35093-C	0.00	0.28	0.28	Decommission: Closure Level 3DN
35093-D	0.00	0.34	0.34	Decommission: Closure Level 3DN
35094-A	0.00	0.46	0.46	Decommission: Closure Level 3DN
35094-B	0.00	0.45	0.44	Decommission: Closure Level 3DN
35094-C	0.00	0.23	0.23	Add to System: Store Level 3SN: Long-term access
35094-D	0.00	0.43	0.43	Decommission: Closure Level 3DN
35094-E	0.00	0.15	0.15	Decommission: Closure Level 3DN
35094-F	0.00	0.59	0.59	Decommission: Closure Level 3DN
35094-G	0.00	0.11	0.11	Decommission: Closure Level 3DN
35094-H	0.00	0.52	0.52	Decommission: Closure Level 3DN
35094-I	0.00	0.48	0.48	Decommission: Closure Level 3DN
35095-A	0.00	0.29	0.29	Decommission: Closure Level 3DN
35095-B	0.00	0.61	0.61	Decommission: Closure Level 3DN
35095-C	0.00	0.33	0.33	Decommission: Closure Level 3DN
35095-D	0.00	0.55	0.55	Decommission: Closure Level 3DN
35095-F	0.00	1.22	1.22	Decommission: Closure Level 3DN
35095-G	0.00	0.25	0.25	Add to System: Yearlong Closure, Map Code A; Long-term access
35095-G	0.25	0.44	0.19	Add to System: Yearlong Closure, Map Code A; Long-term access
35096-A	0.00	0.20	0.20	Add to System: Store Level 3SN: Long-term access
35096-B	0.00	0.24	0.24	Decommission: Closure Level 3DN
35096-C	0.00	0.32	0.17	Decommission: Closure Level 3DN
35096-D	0.00	0.33	0.33	Add to System: Store Level 3S: Long-term access
35097-A	0.00	0.41	0.05	Decommission: Closure Level 3DN
35098-A	0.00	0.43	0.43	Decommission: Closure Level 3D
35098-B	0.00	0.22	0.22	Decommission: Closure Level 3DN

Road #	BMP	EMP	Length (Miles)	Management Action
35100-A	0.00	0.42	0.42	Decommission: Closure Level 3DN
35143-A	0.00	0.35	0.35	Decommission: Closure Level 3DN
35143-B	0.00	0.62	0.62	Decommission: Closure Level 3DN
35143-C	0.00	0.71	0.71	Decommission: Closure Level 3DN
35168-A	0.00	0.53	0.53	Add to System: Yearlong Closure, Map Code A; Long-term access
35169-A	0.00	0.34	0.34	Decommission: Closure Level 3DN
35169-B	0.00	0.35	0.35	Decommission: Closure Level 3DN
35382-A	0.00	0.16	0.17	Decommission: Closure Level 3DN
35382-B	0.00	0.28	0.28	Add to System: Keep Open for access to State land
35383-A	0.00	0.46	0.46	Decommission: Closure Level 3DN
35383-B	0.00	0.07	0.06	Decommission: Closure Level 3DN
35384-A	0.00	0.51	0.51	Decommission: Closure Level 3DN
35384-B	0.00	0.55	0.55	Decommission: Closure Level 3DN
35384-C	0.00	0.03	0.03	Decommission: Closure Level 3DN
35385-A	0.10	0.19	0.09	Decommission: Closure Level 3DN
35385-A	0.00	0.10	0.10	Decommission: Closure Level 3DN
35385-B	0.00	0.14	0.21	Add to System: Yearlong Closure, Map Code A; Long-term access
35385-C	0.00	0.08	0.08	Add to System: Yearlong Closure, Map Code A; Long-term access
35385-D	0.00	0.07	0.07	Decommission: Closure Level 3DN
35385-E	0.00	0.18	0.18	Decommission: Closure Level 3DN
35385-F	0.00	0.17	0.17	Decommission: Closure Level 3DN
35385-G	0.00	0.13	0.13	Add to System: Yearlong Closure, Map Code A; Long-term access
35385-H	0.00	0.18	0.18	Decommission: Closure Level 3DN
35385-I	0.00	0.18	0.18	Decommission: Closure Level 3DN
35385-J	0.00	0.15	0.15	Decommission: Closure Level 3DN
35385-K	0.00	0.04	0.04	Decommission: Closure Level 3DN
35385-L	0.00	0.24	0.24	Add to System: Store Level 3SN: Long-term access
35385-M	0.00	0.11	0.11	Decommission: Closure Level 3DN
35385-N	0.00	0.02	0.02	Decommission: Closure Level 3DN
35385-O	0.00	0.02	0.02	Decommission: Closure Level 3DN
35385-P	0.00	0.42	0.42	Add to System: Store Level 3SN: Long-term access
35385-Q	0.00	0.22	0.22	Decommission: Closure Level 3DN
35386-A	0.00	0.79	0.79	Decommission: Closure Level 3DN
35387-A	0.00	0.87	0.87	Decommission: Closure Level 3DN
35387-B	0.00	0.15	0.15	Decommission: Closure Level 3DN
35387-C	0.00	1.12	1.12	Decommission: Closure Level 3DN
35387-D	0.00	0.42	0.42	Decommission: Closure Level 3DN

Road #	BMP	EMP	Length (Miles)	Management Action
35387-E	0.00	0.25	0.25	Decommission: Closure Level 3DN
35387-F	0.00	0.30	0.30	Decommission: Closure Level 3DN
35387-G	0.00	0.41	0.41	Decommission: Closure Level 3DN
35387-H	0.00	0.16	0.16	Decommission: Closure Level 3DN
35387-I	0.00	0.09	0.09	Decommission: Closure Level 3DN
35387-J	0.00	0.32	0.32	Decommission: Closure Level 3DN
35387-K	0.00	0.05	0.05	Decommission: Closure Level 3DN
38595-A	0.00	0.15	0.15	Decommission: Closure Level 3D
38595-B	0.00	0.08	0.08	Add to System: Keep Open for recreation access – mouth of Swamp dispersed recreation site
38595-B	0.08	0.40	0.32	Add to System: Yearlong closure, Map Code A: Long-term access and power line access.
38595-C	0.00	0.19	0.19	Add to System: Keep Open for recreation access – mouth of Swamp dispersed recreation site
38595-D	0.00	0.07	0.07	Add to System: Keep Open for recreation access – mouth of Swamp dispersed recreation site
38595-E	0.00	0.10	0.09	Decommission: Closure Level 3DN
45184-B	0.04	0.08	0.04	Add to System: Store Level 3SN: Long-term access
45199-D	0.10	0.20	0.10	Add to System: Store Level 3SN: Long-term access
J70568	0.00	0.62	0.62	Decommission: Closure Level 3DN
J70569	0.00	0.18	0.18	Decommission: Closure Level 3DN
J70569-A	0.00	0.10	0.10	Decommission: Closure Level 3DN
J70569-B	0.00	0.16	0.16	Decommission: Closure Level 3DN
J70569-C	0.00	0.10	0.10	Decommission: Closure Level 3DN
J70569-D	0.00	0.06	0.06	Decommission: Closure Level 3DN
J70569-E	0.00	0.09	0.08	Decommission: Closure Level 3DN
J70570	0.00	0.50	0.50	Decommission: Closure Level 3DN
J70571	0.00	0.66	0.66	Decommission: Closure Level 5
J70572	0.00	1.09	1.09	Decommission: Closure Level 5
J70573	0.00	0.47	0.47	Decommission: Closure Level 3DN
J70574	0.00	0.20	0.20	Decommission: Closure Level 3DN
J70574-A	0.00	0.15	0.15	Decommission: Closure Level 3DN
J70574-B	0.00	0.22	0.22	Decommission: Closure Level 3DN
J70703	0.00	0.05	0.05	Decommission: Closure Level 3DN

BMP = Beginning mile point
EMP = End mile point

Appendix C
Science Basis for Restoration Treatments

An assortment of scientific literature forms the basis for restoration activities within this project and provides guidance for managing for resilient, fire, insect and disease tolerant forests.

A consensus exists in describing changes both in wildfire severity and insect and disease effects in low- and mixed-severity fire regimes resulting from past management including fire suppression. Examples are provided below:

- Graham et al. 2004: "Millions of acres of forestland (mainly in dry forests dominated by ponderosa pine and/or Douglas-fir) contain a high accumulation of flammable fuels compared to conditions prior to the 20th century." Low severity fires prior to the 20th century burned regularly in most dry forest ecosystems. They controlled regeneration, promoted fire-tolerant species, maintained open forest structures, reduced forest biomass, and decreased the impacts of insects and diseases. With fire suppression, dense forest structures developed with homogeneous and continuous horizontal and vertical stand structures. "These changes in structure and composition have dramatically altered how wildfires now burn in these forests from how they burned historically."

- Reinhardt et al. 2008: "It is generally accepted that past management practices including the successful suppression of many wildland fires in some western United States ecosystems over the last 70 years have resulted in excessive accumulation of surface and canopy fuels which have, in turn, increased the potential for severe fires."

- Agee and Skinner 2005: "A one-size-fits-all fire exclusion policy was applied to all forests. Protected forests soon had more tree regeneration, and the early fires were easy to suppress with generally light fuel loading. Selective removal of large, fire-resistant trees added to the problem, so that by the late 20th century, we had widespread continuous forests with, on average, smaller trees and much greater fuel loads. Areas that were once forest openings became forested. Fires that once spread as surface fires were now more intense, and capable of jumping into the canopy of the forest as crown fires. This problem continues unabated into the 21st century, not only in high elevation or wet forests where that type of behavior was characteristic, but widely across all forest types."

- Peterson et al. 2005: "Prior to the 20th century, low-intensity fires burned regularly in many arid to semiarid forest ecosystems, with ignitions caused by lightning and humans. Low-intensity fires controlled regeneration of fire-sensitive species (e.g., grand fir), promoted fire-tolerant species (e.g., ponderosa pine, Douglas-fir, western larch), and maintained a variety of forest structures including a higher proportion of low-density stands than currently exists. These fires reduced fuel loading and maintained wildlife habitat for species that require open stand structure. Lower density stands likely had higher general vigor and lesser effects from insects. In many areas, fire exclusion has caused the accumulation of understory vegetation and fuel, greater continuity in vertical and horizontal stand structure, and increased potential for crown fires. Across any particular landscape, there were probably a variety of stand structures, depending on local climate, topography, slope, aspect, and elevation."

- Noss et al. 2006: "Topographically complex western mountain landscapes may be especially prone to mixed-severity fire, because drier south-facing slopes with lower fuel loads can burn at low severity when adjacent, moister north-facing slopes that support higher tree densities experience high-severity fire. The inherent variability of mixed-severity fire regimes precludes easy detection and analysis of the effects of fire exclusion. Exclusion of fire may have allowed tree densities to increase in some areas but post-fire tree density is naturally high in patches killed by high-severity fire. … These are often very complex landscape mosaics; hence, it is necessary to plan and conduct activities at larger spatial scales." "The consequences of many human activities – including fire exclusion, logging, tree planting, and livestock grazing—are most serious in forest types that historically were characterized primarily by low-severity fires…. These surface fires killed few large, fire-resistant trees but killed many smaller trees of all species, helping to maintain open-canopied stands of large old trees. Human activities since European settlement have dramatically modified the fuel structure in these forests."

- Hessburg et al. 2005: "Fire prevention and suppression still persist to this day. While well intentioned, such suppression compounds problems of advancing secondary succession and the extreme fire intolerance and high contagion of large expanses of dry forest. Small fires, if they had been allowed to burn in the early 20th century, or were intentionally lit, would have broken up the dry forest, thereby reducing the size of the area influenced by uncontrolled wildfires in the modern era."

Reference conditions provided by naturally functioning ecosystems are summarized in:

- Losensky 1993: Historic timber inventory data for the St. Joe-Lochsa and Lower Flathead climatic sections indicate the area was historically 42 to 44 percent seedling and sapling stands less than 40 years old, 15 to 17 percent immature forest between 40 and 100 years old, and 39 to 42 percent mature forest over 100 years old.

- Hessburg et al. 1999: Comparison of historic photos to current photos showed few changes in area of cover type in the Lower Clark Fork ERU (Ecologic Reporting Unit). However, changes in forest structure showed "an overall trend toward middle-aged, intermediate forests across the ERU." "Area in stand-initiation structures declined from 32.7 to 9.5 percent of the ERU area….Average area in stem exclusion-open canopy structure declined from 15.7 to 9.2 percent…area in stem exclusion-closed canopy structures substantially increased from 10.3 to 17.6 percent…Area in understory reinitiation structures increased from a historical level of 16.4 percent to 37.7 percent…" Areas in young multistory structures, old single-story structures, and old multistory structures increased slightly. Crown cover showed increasing density. "Area in the 10- to 30-percent crown cover class declined from 6.3 to 2.7 percent… and area in the 40- to 50-percent crown cover class also declined, falling from 21.5 to 9.7 percent…. Area in the 90- to 100-percent crown cover class rose more than twofold from 19.7 to 43.4 percent of the ERU area." "Each change was a predictable consequence of fire exclusion, especially in an area where stand-replacing fire historically played such a significant role."

These authors and others including Baker and Williams (2015), Odion et al. (2014), Schoennagel et al. (2004), and Schoennagel et al. (2016) recommend a variety of management practices to restore resilience to stands and landscapes including providing for open stands, age class diversity, and retention of fire-tolerant trees through a variety of mechanical and prescribed burning treatments.

Clarifications to the frequent low-severity fire model with its image of pre-20th century forest with widely spaced, mature trees (often old growth) over a grassy or herbaceous forest floor are highlighted by Baker et al. (2006), Baker et al. (2001), Baker and Williams (2015), Odion et al. (2014), Sherrif et al. (2014), and Williams and Baker (2014). A variable-severity model may be more appropriate given that dry ponderosa pine forests across the western United States historically experience high-severity fire as well. "In this model, natural fires vary in severity and frequency, sometimes burning at low severity in surface fuels and sometimes burning as high-severity fires in the crowns of trees, or with a mixture of surface and crown fire." (Baker et al. 2006) These descriptions of variable-severity fire are consistent with the fire regimes described in Fischer and Bradley (1987) for western Montana and the inventory-based description of historical conditions provided by Losensky (1993).

Climate Change

Observed climate changes over the past several decades in the western United States include increased seasonal, annual, minimum, and maximum temperatures, altered precipitation patterns, and earlier timing of peak runoff. Predicted changes include additional increases in average temperature over the next 50 years, reduced snowpack, and reductions in runoff and natural water storage (Loehman and Anderson 2009). Globally, climatic changes have a generally positive impact on forest productivity when water is not limiting, but fine-scale trends are difficult to ascertain (Boisevenue and Running 2006). The vigor and sustainability of forest ecosystems are compromised by biotic and abiotic stress complexes. In western North America, increased water deficits accelerate the stress complexes that normally involve some combination of multi-year drought, insects, and fire (McKenzie et al. 2007).

Halofsky et al. (2018) assessed and summarized climate change vulnerability of forests in the Northern Rocky Mountains. Earliest changes in forest vegetation will occur at the ecotones between life forms such as between upper and lower treelines. Changes in ecological disturbances such as wildfire and insect outbreaks will be primary drivers of vegetation changes, so future landscapes may be dominated by younger age class trees.

Bark beetles respond to changing climatic conditions. A changing climate, including elevated temperatures (higher winter minimum and summer maximum temperatures), drought, and elevated carbon dioxide, can directly affect bark beetle development time and survival and perhaps affect host-tree allocation patterns (Raffa et al. 2008; Six et al. 2014; Buotte et al. 2017). Responses to warming will differ among and within bark beetle species because of differences in temperature-dependent life history strategies such as cold-induced mortality and developmental timing. Indirect effects include changes in host-tree vigor and effects on community associates (Bentz et al. 2010). Stress complexes are also region-specific. In the northern Rockies, bark beetles are proliferating and killing millions of acres of forest, setting up the prospect of large, intense fires. The effects of stress complexes will be magnified in a warming climate, so increases in fire superimposed on increased drought and insects may have significant effects on growth, regeneration, distribution, and abundance of forest species (McKenzie et al. 2007). Climate change and bark beetle population models suggest a movement of temperatures suitable for beetles to proliferate to higher latitudes and elevations in the coming century (Bentz et al. 2010; Six et al. 2014).

Tree species distribution is affected by climate. Climate change is expected to affect forests both by movement of suitable environmental conditions and by altering disturbances. Geographic ranges for many tree species are expected to shift northward (Fule 2008). Western larch forests, for example, go through natural cycles of succession, maturity, demise, wildfire, and regeneration. A changing climate will affect each process, starting with demise as plants become more poorly adapted to the climate at the site where they are growing. This demise coupled with a warmer and drier climate provides fuel for wildfire of increasing frequency and severity. The wildfire provides conditions for regeneration of seral species such as larch. Local seed sources may not be best suited for regeneration under changed and changing climatic conditions (Rehfeldt and Jaquish 2010).

Variability of climate affects large wildfires in the western United States. Associations between large fire occurrence and quasi-periodic climatic patterns (e.g. El Nino Southern Oscillation, Pacific Decadal Oscillation) are evident in some regions but difficult to establish in others. While at the regional scale extreme fire weather is the dominant influence on area burned and fire severity, increased temperatures in the future likely will result in more fires occurring earlier and later than is typical and will increase the total area burned in some regions (McKenzie et al. 2004). The eleven years when annual fire extent in western Montana and Idaho exceeded the 90th percentile were concentrated in 1900-1934 and 1988-2003 when warm springs were followed by warm, dry summers and the Pacific Decadal Oscillation was positive, which resulted in longer fire seasons. The long period of 1935-1987 of lesser fire extent generally had cool springs, negative Pacific Decadal Oscillation, and a lack of extremely dry summers which contributed to successful active fire suppression. The relationship between climate and large fire extent is consistent with previous centuries in the region, suggesting a strong influence of spring and summer climate on fire activity despite major land-use change and fire suppression efforts. Pierce et al. (2004) showed that millennial-scale climate changes influenced fire behavior. Ponderosa pine forests experienced frequent low-severity fires in colder periods measured in centuries, while warmer periods resulted in severe droughts and stand-replacing fires. Climate projections for warmer springs and continued warm, dry summer suggest forests of the northern Rockies are likely to experience synchronous large fires in the future (Morgan et al. 2008), which Baker (2015) suggests will approach historical scales.

There is evidence of significantly reduced post-wildfire natural regeneration in the early 21st century compared to the late 20th century due to warming temperatures and increased moisture stress on trees (Stevens-Rumann et al. 2018). Dry forests are most prone to conversion to non-forest after wildfires.

Treatments to modify susceptibility to climate change

Reference conditions in a broad sense are useful because they encompass the recent past and evolutionary history. A long-term functional view of reference conditions can provide insights into past forest adaptations and migrations under various climates. Restoration of patterns of burning and fuels and forest structure that reasonably emulate pre-fire exclusion historical conditions is consistent with reducing the susceptibility of these ecosystems to catastrophic loss. Priorities may include fire and thinning treatments of upper elevations to facilitate forest migration (Fule 2008).

Adaptation strategies for conserving native forest vegetation focus on increasing resilience to chronic low soil moisture and increasing environmental disturbances such as wildfire, insects, and nonnative species (Halofsky et al. 2018). Strategies include managing landscapes to reduce the severity and patch size of disturbances, encouraging fire to play a more natural role, and provide areas where fire-sensitive species can persist. Adaptation tactics include stand treatments to reduce stand density and prescribed fire to reduce fuel continuity. Rare species, such as whitebark pine and aspen, will require strategies to encourage regeneration, prevent losses from disturbance, and establishing areas where disturbance is unlikely.

Wildfire Behavior

There is abundant literature on fire behavior, forest structure, forest fuels, fire weather, and other aspects of fuels management. For this discussion of effects, references are limited to some of the more recent publications that for the most part summarize generally accepted principles and caveats from other research study-based and peer reviewed publications. This is appropriate because short of removing all potential fuel from a site, potential fire behavior (intensity) and severity (effect) are dependent on the interaction between fuel, weather, and physical setting (Jain and Graham 2004; Graham et al. 2004). Of those three factors, the only thing humans can alter through management is fuel.

Any particular wildfire's growth and behavior is unique because of the infinite combinations of weather, fuels, and physical settings that can occur over spatial and temporal scales (Graham et al. 2004). Fire behavior is typically described at the stand level, but the spatial arrangement of stands across landscapes affects the growth of large fires (Graham et al. 2004). These variables make it difficult to speak to fire behavior with specificity and certainty. Models exist to predict fire behavior under specific defined conditions, but for each modeled condition there exists infinite unmodeled conditions that may occur when a fire actually starts or spreads to an area. There are, however, useful general concepts concerning the effects of fuels on fire behavior (Agee and Skinner 2005; Graham et al. 1999; Graham et al. 2004; Peterson et al. 2005) as discussed below.

Forest fuel structures typically can be classified as three strata: ground fuel, surface fuel, and crown or canopy fuel (Graham et al. 2004; Agee and Skinner 2005; Peterson et al. 2005; Graham et al. 1999).

Ground fuel consists of duff, roots, buried woody material, and accumulations of needle fall and bark sloughs (Graham et al. 2004). Ground fuels typically burn by smoldering that may last many hours to months (Peterson et al. 2005), leading to soil damage and tree mortality (Graham et al. 2004; Peterson et al. 2005). Rotten ground fuel is ignitable by firebrands thrown ahead of a fire front, which increases spotting of small fires (Graham et al. 2004).

Surface fuel consists of grasses, shrubs, litter, and woody material (Graham et al. 2004) such as sound and rotten logs and stumps (Peterson et al. 2005). Surface fuels release energy at highly variable rates ranging from high rates during a relatively short period when fine fuels are flaming and low rates during a longer period when smoldering and glowing combustion consumes larger fuel (Graham et al. 2004). High loadings of surface fuel resulting from blowdown, ice storms, timber harvest, or pre-commercial thinnings have high surface fire intensity that increases the likelihood for igniting overstory crown fuels either through direct ignition or by drying overstory fuels, which leads to torching (Graham et al. 2004).

Crown fuel consists of vines, mosses, needles, branches, and so forth suspended above the ground in trees or other vegetation (Graham et al. 2004). This material is available for crown fires that can be propagated from surface fires through fuel ladders of vertically continuous surface and crown fuels or from crown to crown fire spread (Graham et al. 2004). Crown fuels separated from surface fuels by large gaps are more difficult to ignite because of the distance above surface fires (Graham et al. 2004). Crown fuels require higher intensity surface fires, long duration surface fires that dry the crown fuels, or mass spotting over a large area to ignite (Graham et al. 2004; Agee and Skinner 2005). Once ignited, high density crown fuels are more likely to spread than low density crown fuels (Graham et al. 2004; Agee and Skinner 2005; Peterson et al. 2005).

The presence and density of overstory tree canopies influence surface fuel conditions and burning. Fires burning in open stands have increased rate of spread compared to fires in dense stands under similar conditions due to fine fuel moisture content, surface air temperature, and shading (Graham et al. 2004). Open stands also develop fine fuels such as grasses, forbs and small shrubs more readily than dense stands. These fine fuels can support faster fire spread compared to large woody fuels in dense stands (Graham et al. 2004).

The continuity and density of tree canopies combined with wind and physical setting provide conditions for rapidly moving crown fires that consume needles and branches over large areas (Graham et al. 2004). Initiation and propagation of crown fires is related to canopy base height, canopy bulk density (weight for a given volume), and canopy continuity (Graham et al. 2004). Canopy base height affects how readily fire can transition from surface fire to crown fire (Graham.et al. 2004). Patchiness of the canopy can reduce fire spread (Graham et al. 2004).

Depending on weather and physical setting, surface fires can rapidly spread through dry grass and other surface fuels igniting tree crowns, especially those with low crowns. This torching can progress from individual and small clumps of trees to large groups within a few hours (Graham et al. 2004). Torching and crown fires produce firebrands that are carried by winds hundreds of feet and even miles (Graham et al. 2004). Subsequent ignitions from firebrands can occur in a process that can be repeated numerous times, producing fire fronts that move many miles in a day (Graham et al. 2004).

Treatments to modify fire behavior

The intent of fuel reduction in restoration projects is to modify fuels to reduce fire severity so live trees and understory vegetation are retained to provide resilient recovery of the site. To accomplish this, fuels are manipulated to reduce the likelihood of crown fires and reduce the intensity (the rate fuel is consumed and the amount of heat generated) of surface fires.

Agee and Skinner (2005) summarized the principles of fire hazard reduction in a table reproduced below:

Table D-1: Principles of Fire Hazard Reduction Treatments

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Control easier; less torching	Surface disturbance is less with fire than other techniques
Increase height to live crown	Requires longer flame length to begin torching	Less torching	Opens understory; may allow surface wind to increase.
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels become drier.
Keep big trees of resistant species	Less mortality for the same fire intensity	Generally restores historical structure	Less economical; may keep trees at risk of insect attack

Graham et al. (2004) adds “reduce continuity of the forest canopy” to the list of objective, quantifiable fuel treatment criteria (principles). Peterson et al. (2005) concurs that potentially effective techniques for reducing crown fire occurrence and severity are to reduce surface fuels, increase canopy base height, reduce canopy bulk density, and reduce forest continuity. Charnley et al. (2017), on the other hand, found that diversity in fuel treatments across ownership in itself did not necessarily result in landscapes that are fire-resilient. Jain and Graham (2007) found some notable exceptions to these general concepts when studying over 900 observations in 73 wildfires in the Rocky Mountains. Trees with low canopy base heights (height to live crown) did not have high severity fires in thinned stands, plantations, and other managed stands where surface fuel was modified through slash disposal and site preparation activities. In dense subalpine fir dominated forests with high canopy base heights, burn severity was high because the crowns tend to intercept precipitation and evapotranspiration depletes floor moisture, resulting in dry forest floor conditions. These dry conditions coupled with high surface fuel loads caused crown fires.

There is a wide variety of well-documented and contrasting views on the effects of thinning on fire behavior (Graham et al. 1999; Carey and Schumann 2003). The contradictory views can be explained in part by the loose use of the term “thinning.” Knowing exactly what forest treatments are called “thinnings” can provide more precise predictive power to describe how fires would behave in the resulting stands structures, compositions, and fuels (Graham et al. 1999). This project proposes thinning from below.

There are many different kinds of thinnings, thinning regimes, reserve tree regeneration harvests, and combinations that create a wide variety of stand structures or compositions to meet various objectives. Because there are so many possible stand structures and compositions, there are at least as many ways that stands would respond to fire (Graham et al. 1999). The many stand treatments that may or may not be thinnings but are similar to thinnings alter the stand characteristics that directly influence fire behavior. The crowns of trees removed may significantly contribute to surface fuels with a major impact on expected fire intensities depending on whether and how they are treated. Crown bulk density, which depends on both species composition and stand density, is the primary controlling factor of crown fire behavior (Graham et al. 1999). Crown fires are often considered the primary threat to forest types and human values, and crown fires are the primary challenge for fire management (Graham et al. 2004). Depending on the type, intensity, and extent of thinning or other treatment, fire behavior can be improved or exacerbated (Graham et al. 1999; Graham et al. 2004; Peterson et al. 2005). Thinnings in general would lower crown bulk densities and redistribute fuel loads, thus decreasing fire intensities if the surface fuels are treated. Extreme weather conditions can create fire behavior that would burn through or breach most fuel treatments (Graham et al. 2004). Realistic objectives for fuel treatments include reducing the likelihood of crown fire and other fire behavior that would lead to undesirable future conditions (Graham et al. 2004).

Because surface fuels are drier due to exposure to heat and wind and wind speed is increased in thinned stands, it is critical that surface fuels be treated to minimize fire intensity (Graham et al. 1999; Agee and Skinner 2005; Graham et al. 2004; Peterson et al. 2005). There are numerous studies supporting this. Cram et al. (2006) found that in ponderosa pine forests of New Mexico and Arizona, wildfire severity was reduced in all treated stands compared to untreated stands. Thinning followed by burning was most effective at reducing fire intensity, followed by piling and burning. Lopping and scattering slash had the least effect on reducing fire intensity. Omi et al. (2006) found wildfire severity was often reduced by treatments in Colorado, Arizona, California, Oregon, and Washington. Treatments that included reduction of surface fuels were generally effective, with or without treatment of canopy fuels, but thinning followed by slash treatments produced the most impressive reduction in fire intensity and severity. Thin-only treatments were generally ineffective and in some cases produced greater fire severity than untreated areas. Treatments that included reducing surface fuels were effective up to ten years. On the other hand, Raymond and Peterson (2005) studied two sites burned in the Biscuit Fire in southwest Oregon and found that thinning without treating surface fuels resulted in the highest mortality. Lower mortality was found in untreated stands, and the least mortality was found in stands that were thinned and underburned. Carey and Schumann (2003) summarize a number of studies pointing out the effectiveness of thinning with effective surface fuel treatments and the mixed results of thinning without surface fuel treatments.

Thinning from below (as proposed in this project) and possibly free thinning can most effectively alter fire behavior by decreasing fire intensity (Graham et al. 1999). Low thinning (thinning from below) removes trees from the lower canopy, leaving large trees. Free thinning (crop-tree thinning) releases selected trees while not treating the rest of the stand.

Crown thinning and selection thinning would not reduce crown fire potential because they leave multiple canopy layers (Graham et al. 1999). Crown thinning (thinning from above) removes dominant and codominant trees from the canopy to favor residual trees in the same classes. Selection thinning removes dominant trees to favor smaller trees.

Peterson et al. (2005) summarized the effects of thinning treatments on key components of canopy structure related to crown fire hazard in a table reproduced below:

Table D-2: Effect of Thinning on Key Components of Canopy Structure

Thinning Treatment	Canopy Base Height	Canopy Bulk Density	Canopy Continuity	Overall Effectiveness
Crown	Minimal	Lower in upper canopy but minimal effect in lower canopy	Lower continuity in upper canopy, but minimal effect in lower canopy	May reduce crown fire spread slightly but torching unaffected
Low	Large increase	Large effect in lower canopy, some effect in upper canopy depending on tree sizes removed	Large effect in lower canopy, some effect in upper canopy depending on tree sizes removed	Will greatly reduce crown fire initiation and torching
Selection	None	Lower in upper canopy but minimal effect in lower canopy	Lower continuity in upper canopy but minimal effect in lower canopy	May reduce crown fire spread slightly if many trees removed but torching unaffected
Free	Small to moderate increase, depending on trees removed	Small to moderate decrease throughout canopy, depending on trees removed	Small to moderate decrease throughout canopy, depending on trees removed	May reduce crown fire spread slightly if many trees removed; torching reduced slightly
Geometric (Mechanical*)	None	Small to moderate decrease throughout canopy, depending on spacing and species composition	Small to moderate decrease throughout canopy, depending on spacing and species composition	Crown fire spread and initiation reduced if spacing is sufficiently wide; torching reduced
Variable Density	Increase in patches where trees are removed	Decrease in patches where trees are removed	Moderate to large decrease	Crown fire spread reduced, crown fire initiation reduced somewhat; torching reduced somewhat

*Referred to as 'Mechanical' in Graham et al. 1999

Prescribed burning reduces loading of fine fuels, duff, large woody fuels, rotten material, shrubs, and other live surface fuels that affect spread rate and intensity (Graham et al. 2004). Burning reduces horizontal fuel continuity and disrupts growth, intensity, and spot fire ignition probability of surface fires. Prescribed burning designed to reduce ladder fuels decreases the vertical continuity between surface and canopy fuels. It also scorches the lower branches of trees and effectively raises the live crown base height. Prescribed burning has potential challenges, too (Peterson et al. 2005). Individual and clumps of trees may be killed that were not targeted. Fallen dead branches and boles then can increase surface fuel loads.

Thinning and prescribed burning can modify understory microclimate by allowing increased solar radiation to reach the forest floor, which increases surface temperatures, decreases fine fuel moisture, and decreases relative humidity compared to untreated stands (Graham et al. 2004). These conditions can increase surface fire intensity. All fuel strata need to be managed over time and space to minimize unwanted consequences of wildfire (Graham et al. 2004). Kauffman (2004) argues that restoration of natural fire behavior entails more than simple structural modifications, but requires treatments at landscape scales that incorporate natural and prescribed fire.

There are few studies evaluating the longevity of fuel treatments and their effectiveness at altering fire behavior over time. Various studies have shown that effectiveness of prescribed burning alone decreases significantly over 10 to 20 years (Graham et al. 2004). The longevity of fuel treatments varies with climate, soils, and other factors. The longevity of fine woody fuels from thinning slash is greater on drier sites than on moister sites. Effects likely last longer in areas where vegetation development is slower than in highly productive areas (Graham et al. 2004).

There are several ways fuel treatments could exacerbate wildfire hazard (Keyes and Varner, 2006). Thinning transforms live canopy fuels to dead surface fuels that must be burned or removed. Slash generated from thinning inflates fuelbed depth unless treated. Reducing canopy cover can facilitate drying of dead surface fuels. Thinning can increase subcanopy wind speed, resulting in higher rates of spread and potentially erratic fire behavior. Thinning increases sunlight and wind on the forest floor, resulting in drier duff. Hardwoods and shrubs can stump sprout prolifically, effectively relocating elevated live fuels to the forest floor level. Soil disturbance from thinning can disturb soils and encourage seedling regeneration. Advance regeneration can be released after thinning, resulting in greater vertical continuity of fuels. Thinning increases light available to overstory trees so lower branches are retained longer, compared to lower limbs dying in denser stands and effectively raising crown base height. Fuel management treatments should be designed to minimize these adverse effects, and they should be designed with future maintenance treatments in mind (Keyes and Varner 2006).

A much more thorough discussion of the benefits, opportunities, and trade-offs of fuel treatments in dry mixed-conifer forests that includes this literature and much more is in A Comprehensive Guide to Fuel Management Practices for Dry Mixed Conifer Forests in the Northwestern United States (Jain et al. 2012).

Although there is a good general understanding of the factors that govern fire behavior, the interactions between the factors and the way fire behaves on a landscape are complex. Fire behavior and severity can be understood and predicted in general terms, but exact predictions are not possible (Graham et al. 2004). Given this complexity, focusing on basic scientific principles is important for decision-making and adaptive management over time (Peterson et al. 2005).

Bark Beetle Susceptibility

Western pine beetle populations can reach outbreak levels when ponderosa pine is moisture stressed (Randall 2004). In the first half of the twentieth century, stands of large, old, decadent ponderosa pine were killed by western pine beetles. Large, old, slow-growing ponderosa pine are very susceptible to attack. Large old ponderosa pines surrounded by second growth mixed conifer stands are susceptible. Lately, western pine beetles have been aggressively attacking young second growth stands. Trees are usually killed in groups, usually in stands of dense, over-stocked, even-age ponderosa pine but also in clumps of ponderosa pine in mixed-conifer stands.

Two systems to identify western pine beetle hazard have been developed: one to identify susceptible trees and one to identify susceptible stands (Randall 2004). Individual tree hazard is based on age, crown size, and dominance. Older trees with poor, thin crowns and slow growth rates are most likely to be attacked and killed by the beetle. Stand hazard is based on the average diameter of ponderosa pine trees over 5 inches at dbh (diameter at breast height: 4.5 feet above the ground), stand structure, and the percent basal area of ponderosa pine in the stand. Even-aged stands with more than 120 square feet of basal area per acre of ponderosa pine trees averaging over 10 inches dbh are most likely to be attacked and killed by the beetle.

Mountain pine beetles are attracted to pine trees. A female beetle will land on the tree, begin to tunnel, and release an aggregation pheromone to attract other beetles to the tree. If enough beetles respond, the tree can be overwhelmed in a short time. At this point, the tree will not recover and will die slowly. Outbreaks occur when multiple thresholds involving temperature, host tree abundance and defenses, and beetle brood productivity are surpassed. The primary elements for an outbreak are abundance of suitable hosts and a trigger: warm weather and drought. (Six et al. 2014)

Mountain pine beetles typically attack only pines larger than 6 inches dbh (Six et al. 2014). Lodgepole pine trees over 10 inches tend to be preferred by mountain pine beetles, and they produce brood that attack trees less than 10 inches (Fettig et al. 2013). There are many hazard rating systems, and they commonly are based on the proportion of lodgepole pine over 7 to 8 inches dbh, stand density, and stand age over 80 years. Ponderosa pine trees between 5 and 13 inches tend to be preferred by mountain pine beetles (Fettig et al. 2013). Hazard rating systems for ponderosa pine vary and tend to be based on tree size, stocking levels, and stand structure. Forests comprised mainly of larger diameter pine with homogeneous structure and composition can contribute to the extent and severity of an outbreak once it is initiated. Restoration treatments focused on restoring diverse structures and age classes tend to reduce outbreak severity and extent (Fettig et al. 2013; Six et al. 2014).

Douglas-fir beetles are attracted to wind-throw and trees weakened by fire, drought, defoliation, or root disease (Kegley 2004). Douglas-fir beetle populations expand rapidly in these conditions and subsequent generations attack and kill surrounding healthy green trees. As beetles are forced into increasingly healthier trees, populations decline. Outbreaks typically last from 2 to 4 years. Outbreaks are associated with dense stands, usually with trees over 120 years old.

Stand-level Douglas-fir beetle hazard is based on stand density, percent of Douglas-fir, average stand age, and the average diameter of the Douglas-fir (Kegley 2004). Highest hazard stands are more than 250 square feet of basal area per acre, more than 50 percent Douglas-fir, greater than 120 years old, and greater than 14 inches average dbh (Weatherby and Thier 1993).

Treatments to modify bark beetle susceptibility

Preventing western pine beetle-caused damage in ponderosa pine stands is accomplished by reducing the conditions considered as stand hazards (Randall, 2004). Thinning to reduce the density and increase the vigor of the residual trees results in lower losses to western pine beetles. Thinning to about 90 to 100 square feet per acre is effective, which generally results in removing enough trees so the tree crowns don't touch. Tree removal should focus on trees weakened by defoliation, root disease, lightning, fire, mechanical injury, breakage, attack by other beetles, or root damage.

Creating a mosaic of age, size class and species of trees across the landscape is the best approach to long-term mountain pine beetle management (Forest Health Protection MFO-TR-11-22; Fettig et al. 2013; Six et al. 2014). "Although many stands of ponderosa pine have historically grown in an uneven-aged clumpy distribution, the historical basal areas of these stands were often significantly less and kept in check with frequent ground fires. This clumpy distribution along with single tree and openings resulted in forest resiliency and reduced susceptibility to mountain pine beetles (Kolb et al. 2007). Mountain pine beetles may still attack clumps of pines throughout an area during an outbreak, but the cumulative amount of mortality in thinned areas should be less. Although some clumps of pine can be retained, the number of clumps retained is related to the amount of potential mortality in the units. Whitehead and Russo (2005) and Whitehead (2010) showed that thinning without spacing targets can leave a clumped distribution of residual trees that remain susceptible to bark beetle-caused tree mortality." (Lockman and Sturdevant 2011)

"During the recent mountain pine beetle outbreak on the Helena National Forest in ponderosa pine, mountain pine beetles first became active in clumps and eventually clumps of beetle-killed trees coalesced. There was no mountain pine beetle activity in the thinned approximately 300-acre unit while significant mortality from mountain pine beetles occurred in the adjacent uncut unit." (ibid.)

Figure D-1: Mountain pine beetle activity in a thinned and adjacent unthinned stand on the Helena National Forest. The thinning was completed two years prior to the outbreak in that drainage.

"In uneven-aged stands, competition from a dense understory resulting from fire suppression may stress older trees predisposing them to beetle attacks. Thinning can reduce bark beetle caused tree mortality by reducing tree competition and changing the micro-climate of a stand. Large trees are more likely to survive if moisture availability improves. Also, individual trees can be protected when the microclimate is altered which can negatively affect beetle overwintering survival and reduce beetle attacks on trees (Leslie and Bradley 2001)." (Lockman and Sturdevant 2011)

"Stand susceptibility to mountain pine beetles can also be reduced by lowering stocking densities to targets relative to site carrying capacity. During the current mountain pine beetle outbreak, Oneil (2006) found that the majority of plots attacked by mountain pine beetles were above site carrying capacity as compared to the plots not attacked which were below site carrying capacity. Carrying capacity was a significant predictor even during times of drought. Oneils' work showed that thinning to a basal area target that does not consider carrying capacity would not reduce susceptibility to mountain pine beetle attack under current climate conditions." (Lockman and Sturdevant 2011)

"Treatments aimed at reducing the mid-story may also result in less mountain pine beetle-caused tree mortality following fire. Fire injury can sometimes predispose trees to attack by bark beetle if there is beetle pressure within the treatment unit. Larger, old growth trees often suffer more from fire effects and thinning than mature pines and therefore can be more susceptible to bark beetle following prescribed fire (Kolb et al. 2007)." (Lockman and Sturdevant 2011)

Likewise, in lodgepole pine forests, age-class structure and species composition influence outbreak intensity and severity. Creation of age and size class mosaics ultimately reduce impacts from mountain pine beetles. Maintaining diverse stand structures and planting for species diversity provides resistance and resilience to lodgepole pine-dominated stands (Long et al. 2018). Thinning reduces host availability, reduces competition between trees to increase vigor, and affects microclimate. Thinning from above reduces stand susceptibility by removing the larger trees, but leaves trees with less silvicultural value that are vulnerable to wind throw or snow damage. Thinning from below leaves trees of diameter classes considered more susceptible to attack, but may optimize the effects of microclimate, inter tree spacing, and tree vigor. Economic viability depends on the value of the smaller trees that are removed.

Treatments to reduce mountain pine beetle susceptibility can and should be modified to address specific desired conditions for other resources such as aesthetics, wildlife habitat, and recreation. Landscape management for mountain pine beetles should include varied treatments of the overstory and understory trees including species, sizes, and distribution of retained trees for stand resistance and resiliency, and management should include designated areas where natural processes including bark beetles take place to encourage long-term adaptation (Fettig et al. 2013; Six et al. 2014).

Preventing Douglas-fir beetle outbreaks is accomplished by reducing the conditions considered as stand hazards (Kegley 2004). This includes reducing stocking, reducing the proportion of Douglas-fir, or reducing average stand age or size. In 2006, Forest Health Protection evaluated stands that were thinned during a Douglas-fir beetle outbreak in the Centennial Valley (Lockman and Sturdevant 2011). They found that stands with initial higher basal areas suffered more losses due to Douglas-fir beetle over the course of the outbreak. They also found that clumps of larger Douglas-fir were often the foci for the development of an outbreak in a stand. "If the stands had been thinned prior to the outbreak instead of during the outbreak, more of the larger older trees could have been retained on the sites. Often prescriptions call for leaving mostly larger, older trees in treatment units. This results in a much higher stand hazard rating to Douglas-fir beetle versus leaving an occasional large individual or clump of trees. Negron (1999) found that volume loss on Montana sites was 37.1 square feet/acre in stands with basal areas less than or equal to 115 square feet/acre; 69.3 square feet/acre in stands with between 115 and 230 square feet/acre; and 111.7 square feet/acre in stands greater than 230 square feet/acre."

Treatments in the Swamp Eddy project have the objective of reducing the stocking and proportion of Douglas-fir. The average stand age would not be changed, but the average size would be increased. The improved tree health and vigor and reduced moisture stress provided by reducing stocking would reduce the hazard presented by the larger average size.

Root Disease Susceptibility

Root diseases are the most damaging group of native tree diseases in the Inland Northwest (Lockman 2009). Root disease is caused by a fungus in the roots that kills the roots and causes decay. Trees infected with root disease are unable to take up water and nutrients due to the resulting root damage, leading to outright mortality or increased susceptibility to bark beetle attack (Lockman 2009). In western Montana, root disease patches are characterized by openings in the forest canopy that feature a few conifers that are tolerant to root disease. Mortality can also occur as individual trees or small groups (Byler 1990). Most root diseases spread from the roots of infected trees to the roots of healthy trees, while some spread through spores into injured or harvested trees (Lockman 2009; Lockman 2011).

In a local study of root disease on the Lolo National Forest, specifically *Phellinus weirii* and *Armillaria spp.*, 33 percent of sampled stands had root disease mortality (Byler 1990). The highest incidence of root disease was found on Douglas-fir and subalpine fir habitat type series, followed by the grand fir and hemlock types (Byler 1990). However, all trees are somewhat susceptible to root diseases and young trees are especially vulnerable (Lockman 2009).

The stands now present on Douglas-fir habitat types are very different from those that occupied these sites prior to fire control and timber harvesting of the present century (Byler 1990). Frequent, low-intensity ground fires historically favored the maintenance of old-growth stands composed largely of ponderosa and (or) western larch that are both fire and root disease tolerant (Byler 1990). The hemlock and grand fir habitat type series should be considered at risk of suffering from *Phellinus* and (or) *Armillaria* root disease mortality whenever susceptible Douglas-fir and grand fir are grown there (Byler 1990).

Annosus root disease, caused by the fungus *Heterobasidion irregulare*, can infect and kill ponderosa pine of all ages and sizes (Lockman 2011). As with other root diseases, annosus causes decay in the roots of infected trees, preventing the uptake of water and nutrients, which increases the susceptibility to bark beetle attack and eventually leads to mortality. As decay progresses, the trees become increasingly susceptible to wind throw (Lockman 2011).

The spores of *Heterobasidion irregulare* infect freshly cut stump surfaces and basal wounds. Once established in the root system, the fungus will grow down into the roots and can move from an infected root to the roots of a neighboring pine through root-to-root contact. Trees may decline for many years prior to dying of annosus root disease, being wind thrown, or bark beetle attack. Annosus root disease is a 'disease of the site' and will remain as long as host trees are present within the stand (Lockman 2011).

Treatments to modify root disease susceptibility

Management of disease-prone sites should feature mixed-species stands with large proportions of disease-tolerant serals ponderosa pine, western larch, blister rust-resistant white pine, and others that were historically present (Byler 1990; Morrison 1991). However, all species are susceptible to *Armillaria ostoyae* before age 15. The use of species that are susceptible to moderately susceptible to regenerate diseased sites is not recommended. Residual species must be tolerant or resistant to the root disease on site (Morrison 1991).

Table D-3: Species susceptibility to root diseases reproduced from Morrison 1991

Susceptibility	*P. weirii*	*A. ostoyae*
Susceptible	Douglas-fir, *Abies* spp.	Douglas-fir, *Abies* spp., spruce
Moderately Susceptible	western larch, spruce, hemlock	lodgepole pine, hemlock, cedar
Tolerant	lodgepole pine, white pine, ponderosa pine	ponderosa pine
Resistant	western redcedar	western larch
Immune	Poplar, aspen, birch	

Thinning to provide wide spacing of susceptible species is not effective for managing root disease unless these species are mixed with resistant or immune species. Partial cutting can lead to buildup of inoculum on the site, resulting in few trees reaching maturity if resistant species are not present. Root disease present on the roots of susceptible trees quickly colonize the entire root system following cutting. Without the defenses of the tree reducing its spread, the inoculum is able to rapidly infect neighboring residual trees that share root contact, resulting in mortality some time following harvest (Morrison 2001; Lockman 2009). Harvest should not only remove the infected trees that show symptoms of root disease, but also non-symptomatic trees at the margins of the disease center. In the case of *Armillaria ostoyae*, two trees beyond a tree with visible signs of disease should be removed. In the case of *Phellinus weirii*, three trees beyond the last observed symptomatic tree should be removed (Morrison 1991). If partial harvest is proposed in diseased stands but stump removal is not feasible, the stand should contain two or more species with greater tolerance to root disease (Morrison 1991). Douglas-fir, grand fir, and/or subalpine fir should be less than 30 percent of the residual stand following harvest on sites infected with *Armillaria* spp. However, once the buildup of inoculum has occurred, there are no effective treatments in these diseased, partially cut stands that do not include regenerating the stand. (Lockman 2009).

The application of chemicals, such as borax, to stump tops is an effective treatment to reduce the likelihood of P-type annosus in ponderosa pine (Lockman 2011). This prevents the introduction of the fungus to the site. Stumps must be treated within 24 hours of cutting with an EPA registered product for control of annosus root disease. The current recommendation is to treat all ponderosa pine stumps 12 inches in diameter and larger. The stump treatment does not remove fungus already present in the wood. Stump treatments are recommended on sites with known annosus root disease to prevent further infections. However, stump treatments do not reduce the amount of *Phellinus weirii* or

Armillaria ostoyae in stumps as these diseases spread primarily through root-to-root contact (Morrison 1991).

Prescribed fire does not treat or reduce the amount of inoculum on sites with infected trees or stumps. Fire is only effective in influencing the type of vegetation that returns to the site (Morrison 1991).

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