VEGETATION

Introduction

This section describes the existing vegetation conditions of the Logan Creek Area and how the Proposed Action, no action, and other alternatives would affect the various components of this resource. The area directly, indirectly, and cumulatively affected by the Proposed Action and its alternatives is defined by the National Forest System lands and other ownership within the Logan Creek drainage and its tributaries, and is displayed on the Vicinity Map, Figure 1-1, in Chapter 1. The effects analysis focuses on stands proposed for treatment in Management Areas 2C, 4, 5, 7, 12, 13, 13A, 15, and 15B as described in the Flathead National Forest LRMP. The project area includes approximately 61,260 acres, 48,400 acres of which are on national forest land. The effects of past, present, and reasonably foreseeable management actions within this area were analyzed.

Since the late 1950s, timber production has been the major land use activity on National Forest System lands in the Logan Creek Area. Road building and salvage harvest continued into the 1980s in response to heavy mortality of lodgepole pine from the mountain pine beetle. Timber harvesting on State and private lands has also occurred throughout this period.

Differences Between the DEIS and FEIS

This Vegetation section of the FEIS differs from the same section in the DEIS in that analysis for the new Alternative F was included. Also, some paragraphs were rearranged to create a more logical flow of ideas. A few sentences were added in several places to better explain various points. A new literature citation was added (Green *et al*. 1992). The section on “Burning with No Associated Harvest” in the “Effects Common to All Action Alternatives” was inadvertently omitted from the DEIS and was added to the FEIS.

Two notable changes occur in the FEIS version of the Vegetation section. One is that a section entitled “Historical Conditions and Methodology” was added to the Affected Environment portion. The other change is that the environmental consequences of all the action alternatives were presented under each of the parameters relevant to vegetation. This reorganization was done to avoid redundancy and to enable readers to more easily compare the effects of the action alternatives.

Information Sources

This analysis area coincides with that used for the Logan Creek Ecosystem Analysis at the Watershed Scale (Logan Creek EAWS) completed in 2001 (Exhibit A-1). Information collected for the EAWS as well as existing Forest Service databases provided the information used to characterize the affected environment for vegetation within the project boundaries.

The Forest Service Natural Resource Information System (NRIS) database was the primary source of data used to describe existing vegetation conditions. It contains such information as stand age, species composition, and average diameter. This database is used as a reference tool by Forest Service employees, other agencies, and the public. It provides consistent baseline data and standards from which to assess field related conditions and to make natural resource decisions. Summaries of vegetation characteristics for stands proposed for treatment are located in the project file (Exhibit P-4). Aerial photos taken in 1997 were interpreted and used to classify vegetation and geomorphological characteristics in the analysis area. These data are stored in the Flathead National Forest computer system and accessible with Geographic Information System (GIS) software.

Analysis Area

The analysis area used to examine the impacts of the proposed action and associated alternatives on vegetation resources is displayed on Figure 1-1. It encompasses the upper Logan Creek drainage, excluding Sheppard and Griffin Creek, for a total of approximately 61,260 acres. The Flathead National Forest administers 79 percent of this area, private land accounts for about 10 percent of the area, and the remainder is evenly split between corporate and state lands. Elevation ranges from 3100 feet at Round Meadow to 6300 feet at Ashley Mountain. The effects analysis focuses on all the proposed activities that may have any measurable effects on vegetation structure, composition, or distribution within the defined area.

Within the analysis area, a number of vegetation parameters would be affected by implementation of the alternatives, so they will each be analyzed. Vegetative Structure and Composition, Insect and Disease, Threatened and Sensitive Plants, and Noxious Weeds will be discussed at the landscape and stand level to facilitate analysis of direct, indirect, and cumulative effects. Past, present, and reasonably foreseeable activities are identified and considered in the analysis of effects. Refer to the Fire and Fuels, Old Growth, Riparian, and Snag and Downed Wood wildlife habitat sections for further information on vegetation.

Affected Environment

Vegetative Structure and Composition

Potential Vegetation Group (PVG)

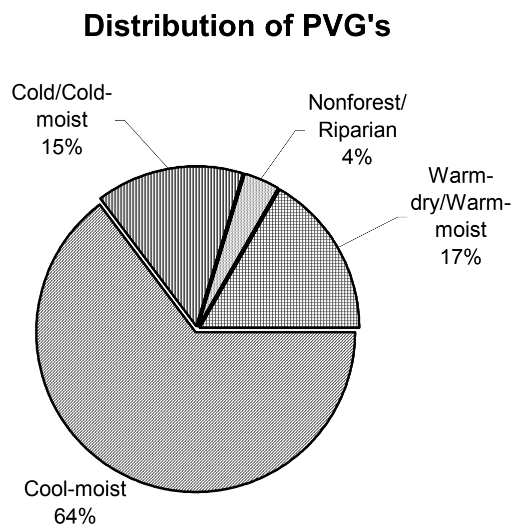
Forest vegetation develops through continually changing ecological processes involving soils, weather, and disturbance patterns. Vegetation attributes such as stand age and type of current vegetation community can also influence vegetation development. The Logan Creek landscape and the processes at work there are best examined by using a land classification system (Pfister et al., 1977). A classification system describes relatively homogeneous physiographic units that are best characterized by identifying the potential vegetation that will occupy the site in the final stage of succession. Such units are termed Potential Vegetation Groups (PVGs), and they display similarity in potential natural vegetation, nutrient cycling, successional change, productivity, and fire behavior. Four PVGs have been identified in the Logan

Creek area and have been mapped, and cover percentages for each type have been calculated (Exhibit P-7, Figure 3-1).

Cool Moist

This PVG represents the cool moist potential vegetation group between 3600 and 6000 feet in elevation. This is the dominant PVG in the analysis area due to its relatively rolling topography and environmental conditions. It covers 64 percent of the analysis area (Figure 3-1). Average annual precipitation for this PVG is 30 inches.

Figure 3-1



The majority of the stands in this PVG are comprised of mixed conifer species: Douglas-fir, subalpine fir, Engelmann spruce, western larch, and lodgepole pine. There are inclusions of wet or riparian type habitats that are dominated by climax species such as subalpine fir and Engelmann spruce. This PVG tends to occupy most aspects due to the elevation and climate; however, vegetation attributes can vary some based on aspect direction. On northern and eastern aspects, age classes in mid-to late-successional stages tend to be single to multi-structured. These stands develop as a result of stand-replacement fires. The mid- to late-seral stands on the south and west slopes were primarily generated by mixed-severity fires with more vertical structure resulting from fire survivors. Tree density is typically high, reflecting favorable climatic and soil conditions. This PVG is one of the more vegetatively productive areas on the Tally Lake Ranger District. In early-seral stages, understory plants (forbs and shrubs) are abundant depending on the intensity of past fires, timber management, and seed availability.

Warm Dry to Warm Moist

This PVG occurs in valley bottoms and uplands and covers 17 percent of the Logan Creek landscape (Figure 3-1). The elevation ranges from 3400 to 5500 feet on south aspects. It is composed of glacial moraine and glacial fluvial landforms with moderately warm, dry, and warm moist coniferous vegetation. Dense coniferous forest and occasional meadow openings dominate this type of PVG. The existing cover is a combination of Douglas-fir, western larch, lodgepole pine, subalpine fir, and Engelmann spruce, with minor amounts of western red cedar, grand fir, and white pine. These stands develop primarily as a result of mixed-severity fires where numerous remnant trees survive multiple disturbance events. Late successional stands consist of multiple vegetation layers with long-lived shade intolerant emergent trees.

Cold to Cold Moist

This PVG is located in the upper subalpine setting of the Logan Creek landscape and occurs in the highest elevations for this landscape; most sites are above 4500 feet in elevation. It is typified by cold and moist conditions and low to moderate solar input. The climate is characterized by a short growing season with early summer frost. Annual precipitation ranges from 30 to 60 inches and falls mostly in the form of snow. Soil moisture is typically good during the summer months; however, a period of successive drought years has rendered most sites abnormally dry.

Subalpine fir and Engelmann spruce is the dominant forest type in this zone. Associated species include lodgepole pine and to a lesser degree western larch and Douglas-fir. Common indicator plants and shrubs include beargrass, false huckleberry, elk sedge, and whortleberry.

Fire is the primary disturbance process, usually preceded by drought and insect or disease events. Lightning-caused fires are the most common causes of wildland fires. Due to the complex interactions between moisture and temperature, fire ecology and fire regime can be described as long interval stand replacement. Cool and moist conditions coupled with broken topography and lush understories undoubtedly limit fire spread and create a mosaic of patches where nonlethal and mixed severity fires occurred.

Riparian Vegetation

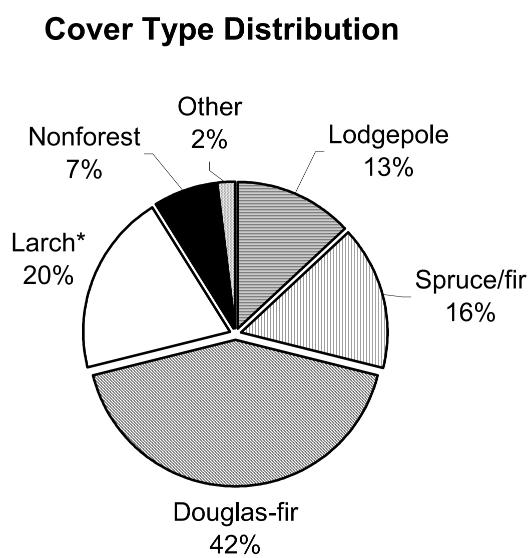
None of the activities included in the proposed action or its alternatives would affect the structure or composition of riparian areas. There would be no ground-disturbing activities, harvesting, or burning. Shrubs would be planted in a few isolated places to augment existing wildlife browse, but that action would not change the structure and function of the riparian ecosystem.

Cover Type

Cover type describes the dominant tree species that currently occupies a forested area. Within the Logan Creek Area, the Douglas-fir type comprises about 42 percent of the trees. The next most abundant cover type is western larch at 20 percent, which has Douglas-fir as the primary associate. The fact that approximately 60 percent of the landscape is dominated by Douglas-fir is of premier concern. When a landscape is so skewed toward a single species, especially in mature or older forests, it becomes vulnerable to natural agents of change, such as insect epidemics, and mortality from diseases, or fire. Figure 3-2 displays the distribution of cover types for both national forest and private lands within the analysis area.

For the purposes of this assessment, the cover types will be grouped into three distinct classes: (1) Douglas-fir/Western Larch, (2) lodgepole pine, and (3) spruce/subalpine fir. A subsequent section describing stand groups will provide a detailed description of the existing condition of the cover types by stand group.

Figure 3-2



* Douglas-fir is the primary associate of larch.

Distribution of Successional Stages

Successional stages refer to the developmental stages of a forest and can be described in terms of vegetative structure, which is the mix and distribution of tree sizes, layers, conditions, and ages in a forest. The Upper Columbia River Basin Assessment (UCRB) and Amendment 21 to the Flathead Land and Resource Management Plan (LRMP) divide vegetative structure into three different successional stages. These stages are described as early-, mid-, and late-seral/structure (Figure 3-3). The distribution of these successional stages and other parameters relevant to historical vegetative conditions were evaluated for relatively large-scale land areas called hydrologic units. Logan Creek was divided into five hydrologic units that have similar biophysical and climatic characteristics as other hydrologic units in the UCRB. Exhibit P-23 demonstrates the current and historical distribution of structure/successional stages. In all hydrologic units, the percent of land in older, more dense forest is at or above the historical mean and median and at the high end of historical conditions. Specific findings are as follows:

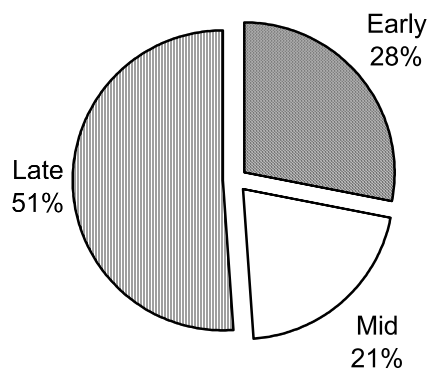
- The early-seral/structural stage describes a young forest of forbs, grasses, shrubs, tree seedlings, and saplings. It covers 28 percent of all ownerships in the Logan Creek area.

- The mid-seral/structural stage describes a "young to middle-aged" forest where the trees are between 30 and 120 years old and the average diameter ranges from 5 to 18 inches. This stage includes pole size and larger diameter trees usually at low risk from natural disturbances, such as insects, diseases, windstorms, or severe fires. It is 21 percent of all ownerships in the analysis area.

- Late-seral/structural stage describes a mature forest in which the kinds of changes that were ongoing in the previous 120 years begin to slow down, creating some level of stability for a time. This stage contains large mature trees that are susceptible to natural disturbances and multi-layered canopies. Old growth conditions can develop during this stage (Green et al. 1992). Large live trees, large snags, and downed logs are abundant enough to provide habitat for a variety of old growth dependent fauna. It comprises 51 percent of all ownerships in the analysis area.

Figure 3-3

Seral/Successional Stage Distribution



Historical Conditions and Methodology

The evaluation of how closely the Logan Creek Area emulates historical vegetative conditions relied on a process developed by Hessburg et al. 1999 used to evaluate the natural variation in landscapes in the Upper Columbia River Basin (UCRB). The product of this evaluation is frequently referred to as the historic range of variability (HRV) and described characteristics of land areas called *hydrologic units*. As previously mentioned, the Logan Creek Analysis

Area was divided into five hydrological units that have similar biophysical and climatic characteristics as other hydrologic units in the UCRB. Various parameters of the Logan Creek hydrologic units were then compared with average conditions for similar watersheds within the UCRB.

The scientific community has approved of the process of comparing vegetative parameters of the Logan Creek hydrologic units to those from similar watersheds across the Upper Columbia River Basin to determine whether the Logan hydrologic units are within the historic range of variability. The assumption that validates this comparison is that by amassing data over an area as large as the UCRB, the full range of conditions and distribution of conditions that would occur naturally would be represented. The data upon which the following results are based can be found in Exhibit P-23.

The current proportion of vegetation cover types, structure classes, and patterns within the Logan Creek Area vary widely from the range of historical conditions. Some ecologically substantial changes have been detected, as discussed below. Consistent with findings from the UCRB study, the Logan Creek results suggest that the overall integrity of the forestland in the Logan Creek Area is fairly low and the functioning of ecological processes have declined as a result of fire exclusion, road density, and harvest patterns. Some Logan hydrologic units are near the historical mean or median value for a particular vegetative condition; others are at or near the maximum or minimum amount found historically. Variation among hydrologic units is desirable as it adds to the vegetative diversity of the landscape at the larger scale. Specific vegetation conditions of interest or concern--as well as areas of opportunity for changes--are further discussed below. One important point to note is that historically, the Logan Creek Area was occupied by an average of 20 percent and a maximum of 40 percent of the Douglas-fir cover type; currently, about 60 percent of the analysis area is occupied by the Douglas-fir cover type.

Vegetation Structure and Pattern in the Logan Creek Area

Stand Initiation Class. The UCRB study refers to stands of this type as *open, seedling/sapling forest*. This FEIS refers to them as *early successional stage stands.* Under the natural disturbance regimes in this landscape (mainly large-scale fire), at any one point in time the amount of area in an open, seedling stage of forest development could range from about 5 percent up to 60 to 80 percent within any particular hydrologic unit. Fires created large openings, which were soon regenerated with a diversity of tree species. Mean total fire disturbance size historically was 11,568 acres, ranging from 2718 to 37,474 acres (Tally Lake District Fire Atlas). Currently, the percent of Logan Creek hydrologic units in the stand initiation class ranges from 12 to 30 percent, which would imply that the Logan Creek area historically had more acres in the early successional stage. HRV analysis revealed average patch sizes from 100 to 600 acres, which is substantially larger than patches from recent known fires in the area. Presently, average patch size is at or below the historical minimum in the stand initiation structure class. A patch refers to the segment of a particular successional stage left undisturbed.

Though the amount of young, open forest structure class is within the desired historical ranges, the sizes of these forest patches are much smaller than those that existed historically, primarily the result of timber harvesting creating small openings. This reflects the lack of fire in this landscape over the past 60 years, and highlights the differences in patch size that result from fire and past timber harvesting as disturbance processes.

Young Forest Multi-Story Class. The UCRB study refers to stands of this type as *young forest multi-story class,* but this FEIS refers to them as stands in the *mid-or late- successional stages.* Evers and Star-Logan hydrologic units are at historical maximum for this structure type. Upper Logan, Tally Lake, and Sanko hydrologic units are below the historical median and mean. In the absence of other management objectives, vegetative manipulation in the Upper Logan, Tally Lake, and Sanko hydrologic units would make these have less than 80 percent of the historical minimum for this stage, which would cause them to be at the lower end of the range of historical variability.

Closed Canopy, Stem Exclusion Class. The UCRB study refers to stands of this type as *closed canopy, stem exclusion class,* but the FEIS refers to them as stands in the *mid- or late-successional stages*. This kind of forest has closely spaced trees, and tree crowns create a completely closed canopy. So little light reaches the ground that no seedlings and little vegetation can grow there. The Tally Lake and Sanko hydrologic units are above historic averages for this successional stage. Conversely, open canopy structures exist in below average amounts in Evers, Upper Logan, and star Lower Logan hydrologic units, but could be created by thinning the closed canopy stands.

Insects, Diseases, and Windthrow

Insects and diseases are natural components of a healthy ecosystem. In most sustainable forest ecosystems, they are the major nutrient recyclers for soils and provide food and habitat for a variety of birds, amphibians, reptiles, and mammals. Insects and diseases commonly cause mortality in large forested areas and can affect a number of resource values. These effects relate directly to those described in the purpose and need for management actions described in Chapter 1. The following discussion focuses on some of the most prevalent insects and tree diseases that can noticeably impact forest vegetation.

Douglas-fir Bark Beetle (*Dendroctonus pseudotsugae*). – This insect species is of greatest concern due to the amount of mortality it has caused and the potential it has to inflict mortality on the forest ecosystem. Endemic occurrences of Douglas-fir bark beetles (DFBB) are common and integral to the functioning of an ecosystem; however, when environmental conditions are suitable, insect populations can become widespread. A DFBB epidemic has been building over the past few years and is currently affecting the Logan Creek drainage.

The Douglas-fir beetle infests and kills Douglas-fir throughout most of its range in western North America. Normally, at endemic population levels, beetles infest scattered trees, especially those weakened by such factors as defoliation, root disease, fire-scorch, or windfall. When and where such susceptible trees become abundant, beetle populations can build up rapidly and spread to adjacent live trees. During outbreaks, they may commonly kill groups of 100 trees or more. Outbreaks of longest duration coincide with drought.

The Douglas-fir beetle has a one-year life cycle. In this region, adult beetle flight season lasts from mid-April through July. Adult beetles are strong fliers, capable of flying for several

miles in search of mates and breeding sites. Once the female beetle finds a suitable host tree, she emits a pheromone that attracts the male beetles as well as more female beetles. Thousands of beetles can be attracted to one tree, initiating a mass attack. Once mated, the females bore into the moist inner bark layer and lay eggs. The larvae that hatch bore outward from the egg galleries, feasting on the inner bark, and kill the tree by girdling. Later in the year, the larvae pupate and develop into adults, which then over-winter in the tree. The following spring, this new adult generation emerges to begin the cycle again.
Because beetles need sufficient inner bark thickness to support their brood, they usually attack trees over 8 inches in diameter. They prefer to attack stressed and weakened trees, such as those recently damaged or killed by fire, drought, other insects, or diseases. If stressed trees are not available, they will attack more healthy trees, even trees in stands normally considered low risk (i.e., smaller diameter or low numbers of larger diameter Douglas-fir). Beetle brood success in these types of stands will depend on individual tree vigor and number of attacking beetles.

Natural predators of the beetle include various bird species (woodpeckers and other insect-eating birds), insect predator beetles, and parasites. These organisms can help to maintain beetle numbers at endemic population levels. During outbreaks when beetle numbers increase, natural enemies impact beetle populations to a substantially lesser degree.

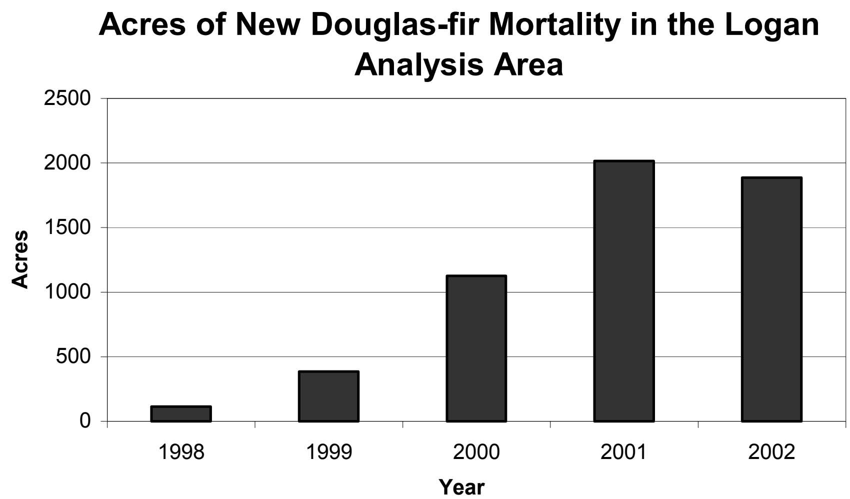
Aerial detection for insects and diseases, including the DFBB, has occurred in the Logan Creek drainage since about 1968. Insect populations are annually monitored. Results of these surveys indicate DFBB populations have been increasing for the past four years (Figure 3-4) (Exhibit P-1).

With the continuation of regional drought and fire activity in 1994 and 2000, DFBB populations have increased to epidemic proportions in many areas around the region. In 2001, aerial surveys showed more than 200,500 acres infested with DFBB across the Northern Region (Montana, North Idaho). In western Montana alone the infested area increased to 82,000 acres (Gibson 2002). The number of acres infested has been steadily increasing since the late 1990s and can be attributed to unusually high amounts of wind-thrown and winter damaged trees, and drought has made it worse. The current infestation is killing more Douglas-fir than anytime since the early 1950s (FHP 2000). Continued drought and mild winters, combined with an abundance of host material, has favored the beetle and prolonged the outbreak.

The potential for a DFBB epidemic to occur can be evaluated in terms of risk and hazard. The risk of a DFBB epidemic relates to the population of bark beetles in the vicinity. If bark beetle populations are high or just above endemic levels, then the risk of future mortality to Douglas-fir trees and an epidemic population has been elevated.

In addition to aerial detection, on-the-ground brood sampling surveys have revealed high brood to parent ratios, ranging from 12:1 to 2:1 (Exhibit P-1). Brood-to-parent ratios greater than 2:1 increase the probability bark beetles will occur in the following year. Given these existing trends, there appears to be a high risk for the continued spread of DFBB in the Logan Creek area.

Figure 3-4



The second element of a potential bark beetle epidemic to initiate, or in this case persist, is hazard. Warm dry conditions throughout the year are considered to be an environmental hazard for DFBB. Precipitation for the past four years has been below average, causing moisture stress in trees. Stressed trees are more vulnerable to insect invasion. The potential mortality to Douglas-fir will continue to increase as long as drought conditions persist.

Another aspect of environmental hazard refers to the amount of breeding and feeding habitat available for bark beetles. Entomologists have developed a model for rating DFBB hazard based on habitat conditions (Negron et al. 1999, Randall and Tensmeyer 1999). The hazard rating measures the ability of a stand to support a population of DFBB based on characteristics such as number of Douglas-fir per acre, stand age, and average tree diameter. Hazard levels are categorized as very low, low, moderate, and high. Logan Creek was evaluated in terms of this hazard rating system (Table 3-1).

Table 3-1. Hazard Rating for Douglas-fir Bark Beetle on National Forest System lands in the Logan Creek area.

Douglas-fir Beetle Hazard Rating	Acres	Percent of National Forest at Risk
1-3 = Very Low	12,235	25%
4-6 = Low	10,301	21%
7-9 = Moderate	4,792	10%
10-11 = High	3,361	7%

Exhibit P-1

Of the 48,400 acres of National Forest System land in the Logan Creek area, 30,689 acres were determined to have some level of hazard. Based on aerial detection surveys and ground surveys, most of the DFBB infestation occurs in stands with a hazard rating of moderate to high. However, due to the high-risk conditions that currently exist (i.e., high populations and extended drought), even stands rated as low hazard are becoming infested with DFBB. Taking a conservative approach to assessing and quantifying the potential for future mortality, 18,454 acres of National Forest System land in the Logan Creek area currently fall within a low to high hazard rating. Since 1998 a total of 5525 of these acres have been infested, leaving almost 13,000 acres vulnerable to DFBB attack.

Risk and hazard ratings for DFBB in the Logan Creek area indicate a potential for high Douglas-fir mortality. The most effective actions available for managing actual or potential beetle infestations are derived from efforts aimed at preventing outbreaks rather than suppressing them (Samman and Logan 2000). This involves modifying live susceptible stands, to the extent possible, to make them less vulnerable before a disturbance occurs that could trigger a beetle attack. Actions may include altering tree densities and species composition. Once an outbreak occurs, removal of infested and potentially susceptible trees is the most effective action to take to minimize beetle impacts. A less effective strategy for reducing mortality in the short term utilizes pheromones to trap and repel beetles, burning/peeling infested logs to destroy brood, and chemical treatments. All these methods have been tested and are applicable in the proper circumstances. Many of these strategies would be employed in this project.

Mountain Pine Beetle *(Dendroctonus ponderosae* Hopkins*)* - Mountain pine beetles lay eggs in the inner bark of primarily larger lodgepole pine trees. The larvae feed on tree phloem as they mature, often killing the host tree. Mountain pine beetles attack and kill individual stressed trees and are usually present in endemic levels. They serve to thin dense stands, create snags in the short term and small openings in the canopy in the long term, add woody material to the forest floor, and provide food for some birds and insects. As the host tree matures, especially in dense stands, the bark beetle populations can increase to epidemic levels, killing all or most lodgepole pine in an area. This relationship between lodgepole pine and mountain pine beetle is fairly well understood (Cole and Amman 1983, Cole et al. 1985, McGregor and Cole 1985).

Within the Logan Creek Area, lodgepole pine stands comprise about eight percent of the analysis area. Portions of the drainage endured intense infestations of mountain pine beetle in the 1970s and 1980s. In these areas, 50 to 80 percent of the lodgepole pine was killed, leaving heavy fuel loadings as the dead trees fell. Because fuel loadings are still high, many of the stands that were not harvested are highly susceptible to intense, stand-replacing fires.

Spruce Beetle *(Dendroctonus rufipennis* Kirby*)* - Spruce bark beetle has a two-year life cycle, overwintering as larvae under the bark the first winter after attack. Larvae feed in the spring, and then pupate in galleries during late spring/early summer. Emergence for attack and construction of egg galleries occurs from mid-May to June the second year. Engelmann spruce is the primary host tree. Generally, the largest and oldest trees are most vulnerable, especially immediately after a blowdown.

Western Balsam Bark Beetle *(Dryocoetes confuses* Swaine*)*- This insect is the most conspicuous of the complex of bark beetles affecting conifers in the northern region due to the retention of bright red dead foliage. They are responsible for high amounts of tree mortality in subalpine fir stands. Low populations maintain themselves in trees weakened by old age and root disease, storm-damaged trees, or slash. Older stands of subalpine fir are widely represented in the analysis area, posing an increasing risk of mortality from this insect.

Root Diseases - Several species of tree root pathogens are present in the Logan Creek area. They primarily affect Douglas-fir and subalpine fir. As trees are killed by root disease, they fall and create small openings in the forest canopy. Grasses, shrubs, and tree seedlings become established in these openings. Root disease persists and will eventually kill the seedlings of species susceptible to the disease; however, seedlings from nonsusceptible species also regenerate in these openings and create a mixed species forest. In a natural fire regime, these sites were periodically recycled by fire. Root diseases, including *Armillaria ostoyae, Phellinus weirii, Phaeolus schweinitzii*, and *Heterobasidion annosum*, presently exist in more than half of the stands in late- seral/structural stands throughout the analysis area.

Dwarf Mistletoe *(Arceuthobium americanum and A. douglasii)* - Lodgepole pine dwarf mistletoe and Douglas-fir dwarf mistletoe occur throughout the Logan Creek area. This parasitic plant can cause growth loss and stress, which can lead to bark beetle invasions and subsequent mortality. Historically, fires kept this disease at low levels; however, recent fire suppression has allowed this disease to become more widespread.

Windthrow - Evidence of windthrow can be found in the analysis area. Landtype 14 (Martinson and Basko 1998), with a spruce and subalpine fir component, is generally most vulnerable, especially if there is an abrupt edge. Trees on ridgetops adjacent to openings, regardless of landtype, are also very susceptible to windthrow. Windthrow has occurred to individual trees, small clumps, or larger patches.

Forest Fragmentation

Forest fragmentation typically refers to human-caused isolation or breaking apart of large forest tracts, although openings in the forest canopy can be created by natural events such as fire, windthrow, or pathogen outbreaks that provide a diversity of naturally occurring habitats.

Forest fragmentation modifies the landscape matrix in numerous ways. It increases the number of landscape patches and the amount of edge environment. Interior habitat is decreased and becomes more isolated. Habitat fragmentation can change the composition, number, and distribution of the flora and fauna present in a given area. Generally speaking, those species restricted to the original habitat would decline in number, while those able to adapt to the fragmented habitat would increase. The spatial arrangement of organisms and their habitats can also influence population dynamics such as competition, predation, parasitism, and mutualism. For more information about fragmentation of late-seral/structural stage habitats, see the "Old Growth Habitat and Old Growth Associated Wildlife Species" section of this chapter.

The parameters used to describe fragmentation include mean patch size, number of patches, and the linear distance of edge. Scientifically based timber management and effective fire suppression began around 1940. Data collected during this time provides us with reliable information about historical patch sizes that can be compared with existing patch sizes.

The distribution of successional stages across the landscape has changed considerably over time (Table 3-2). The average size of early-seral patches indicates the effect of policies that required harvest units to be less than 40 acres. This reduces the amount of important interior forest habitat. Consequently, there is a need to increase the average patch size and decrease the number of patches.

Table 3-2. Patch Characteristics Of Early, Mid And Late-Seral/Structural Stages, 2002

Seral/Structural Stage	Patch Size (acres)	Total Perimeter (miles)
Early	80	720,525
Mid	118	408,856
Late	426	793,538

Past Timber Management

Timber harvest on National Forest System lands in the Logan Creek area has occurred to varying degrees since the turn of the century. In the early 1900s, timber harvest probably consisted of removing individual or small groups of large western larch, Douglas-fir, Engelmann spruce, and lesser amounts of ponderosa pine. Since the 1960s, even-aged timber management activities such as clearcutting, seedtree, and shelterwood harvests more substantially influenced stand structure and fuel levels. Table 3-3 below displays the acres of various regeneration harvests in the decades since 1960.

Table 3-3. Acres of Regeneration Harvest In Logan Creek Drainage by Decade*

Harvest Method	1960s	1970s	1980s	1990s	2000s	TOTALS	%NF**
Clearcut	1440	1099	1504	602	0	**4645**	**10**
Seed Tree	1008	2586	2700	1221	15	**7530**	**16**
Shelterwood	0	1896	729	320	21	**2966**	**6**
TOTALS	**2448**	**5581**	**4933**	**2143**	**36**	**15141**	**31**

*Exhibit P-2

**Calculations are based on 48,400 acres of National Forest System land.

Timber management that removes some trees in a stand while leaving the majority intact is referred to as intermediate harvest. Examples include commercial thin, liberation harvest, and salvage. These types of harvest methods reduce fuel to some degree; however, as growth and development progresses over time, vertical structure contributes to the fuel complex in the form of green trees and shrubs. Tree species that dominate the understory are primarily shade tolerant and relatively short-lived. The following table displays the number of acres affected by these types of harvest methods.

Table 3-4. Acres of Intermediate Harvest In Logan Creek Drainage By Decade*

Harvest Method	1960s	1970s	1980s	1990s	2000s	TOTALS	%NF
Liberation Cut	372	1262	415	164	0	**2213**	**4.5**
Commercial Thin	0	0	267	16	32	**315**	**0.6**
Sanitation Salvage	0	399	114	482	0	**995**	**2.0**
Selection Cut	0	354	26	0	631	**1011**	**2.0**
Special Cut	0	0	0	0	0	**0**	**0**
TOTALS	**372**	**2015**	**822**	**662**	**663**	**4534**	**9.1**

*Exhibit P-2

Reforestation - On National Forest System land, reforestation efforts in previously harvested stands have been successful. The National Forest Management Act of 1976 included requirements to assure forestlands meet reforestation objectives within five years after final harvest. Regeneration indices for the Logan Creek Area show an 86 percent success rate in meeting these reforestation objectives since 1986 (Exhibit P-6).

Some units were allowed to naturally regenerate while others were planted. Naturally regenerated units were certified as meeting stocking objectives an average of 5.58 years following final harvest. Planted units were certified an average of 6.23 years following final harvest. The longer certification time for the planted units as compared to the naturally regenerated units resulted mostly from planting some units only after natural regeneration appeared to be ineffective. If planting had been used initially, the average time to certification for planted units would have been less.

Stand Level Conditions

Current stand conditions of sites proposed for treatment in the Logan Creek area were characterized by stand type. Stands were grouped based on dominant tree species, habitat type, successional structure stage, and historical fire regime. Stands within a group can be expected to undergo similar successional changes and respond similarly to disturbances. These groupings will be the basis for describing changes on the landscape in the Environmental Consequences section of this chapter.

Lodgepole Pine Stand Group

The overstory of these currently unmanaged stands are dominated by lodgepole pine. Essentially all of these stands originated in 1910 and 1926 and are therefore mid-successional in their development. Stands are dominated by pole-sized to small sawtimber with varying tree densities ranging from well-stocked to densely overstocked. Stands with an average diameter at breast height (DBH) of five to seven inches are heavily stocked with trees, and growth is equal to mortality. Dense stocking results in many small diameter stems that succumb to snow loads or possibly mountain pine beetles, creating a profile of continuous horizontal and vertical dead fuel. A portion of this stand group is in riparian ecosystems.

Stands in the group are primarily in the cool-moist to cool-dry habitat types. In this group, where there are sufficient openings in the canopy, an understory of grouse whortleberry, twinflower, kinnikinnick, and alder exists, as well as subalpine fir and Engelmann spruce. On the warmer and drier sites, beargrass, pinegrass, and buffaloberry cover the forest floor.

Within this group, stands have experienced thinning from mortality by mountain pine beetle in the late 1970s and early 1980s. These stands have a greater average DBH ranging from seven to nine inches. This mortality has increased the accumulation of standing and down dead fuel.

Canopy cover ranges from 30 to 70 percent. Fuel Model 10 (USDA Forest Service 1982) characterizes the current fuel profile for this type of stand. Fuel loading in tons per acre varies widely in this fuel model. The heaviest fuel accumulations are on the north and east aspects where moisture regimes allow sufficient growth to make trees susceptible to mountain pine beetle. These conditions have resulted in partial stand mortality and large amounts of dead, standing, and down trees. On south and west aspects, growth potential is less; however, stand density is greater and natural thinning has caused mortality in primarily smaller diameter trees.

Stands in this group are primarily even-aged and resulted from stand replacement fires. However, the aspect and topography of the area would support a mixed-severity fire regime. Based on the environmental conditions and evidence of fire-scarred trees, it is reasonable to classify the area as a mixed-severity type. This implies that historical disturbance processes included light to moderate severity fires as well as the severe stand replacement type indicative of the last disturbance. The north and east aspects appear to support historical lethal stand replacement fire regimes.

Historically, these stands become susceptible to mountain pine beetle after about 80 years (Cole and Amman 1983). These stands are now about 70 years old. Based on history of fire as evidenced by sampling fire scars in the drainage, the interval between fires in the mixed-severity regime is directly correlated to the susceptibility of stands to mountain pine beetle occurrence; i.e., the longer the interval between fires, the more susceptible that stand is to mountain pine beetle attack.

Spruce/Subalpine Fir Stand Group

This group includes unmanaged stands dominated by Engelmann spruce and subalpine fir. This group usually occupies moist sites at lower elevations, stream bottoms, and basins characterized by slow drainage and accumulation of cold air. The subalpine fir element, on the other hand, extends above the spruce-fir zone and may form pure stands that are either seral or climax. Some stands have minor amounts of Douglas-fir and western larch as well as lodgepole pine. The age and size of trees in these stands is highly variable. These stands are in cool-moist to cold-dry habitat types and are located in the upper elevations of the watershed with predominantly north and east aspects. They can also be found in moist riparian sites. The historical disturbance regime can be described as long interval stand replacement.

Stands proposed for treatment are primarily in the mid-to-late stage of successional development, with few sites in the old growth stage. Old growth stands proposed for treatment are currently deteriorating primarily from insect or disease infestation that jeopardizes their future ability to function as old growth habitat. *(NOTE: At the time of implementation, if these old growth stands retain their old growth status, these stands would not be included in any action alternative.)*

Canopy cover ranges from 30 to 70 percent. Fuel Model 10 (USDA Forest Service 1982) characterizes the current fuel profile for this type of stand. While fuel loading in tons per acre varies widely in this fuel model, overall fuel levels are highest among the unmanaged late successional fuel types. Root disease, blowdown, and bark beetles have caused continuous mortality to varying degrees in all the stands in the proposed action.

Mixed-Conifer Stand Group

This group is the most widely represented and complex of all the stand groups due to its species variation, structure, and disturbance regime. A combination of species is found in these types of stands. Typically, Douglas-fir is the primary species in these stands along with western larch. Lodgepole pine, subalpine fir, cedar, and Engelmann spruce are other common associates. In this group, western larch and lodgepole pine are always seral species that, historically, have been maintained by wildland fire. Larch develops in mixed-species stands, secures an early height advantage over its competition, and continues to outgrow them for nearly a century unless weakened by insects or disease. During the understory re-initiation phase of stand development on warm dry sites, Douglas-fir, subalpine fir, and spruce dominate the understory forming multi-strata stands in the absence of disturbance.

Structural/successional stages represented in this group include the early, mid, and late-seral, and the old-growth stage with 10 to 70 percent canopy cover.

- Mid-seral stands in this stand group are primarily even-aged stands approximately 70 years old and ranging in size from 6 to 12 inches DBH. They are typically single strata with few emergent trees. In most cases, growth equals mortality in terms of cubic foot volume.
- Late-seral stands range in age from 80 to 180 years old with two or more age classes. Structure is diverse having generally two strata, but in many cases three or four. With each stratum, tree diameters change. Trees in the upper level strata range from 18 to 30 inches DBH. Middle to lower level strata tree diameters range from saplings to 18 inches DBH.
- Old growth stands in the mixed conifer type resemble the late-seral stands except for: (1) more large trees, (2) a wider range of ages and heights, (3) foliage better distributed vertically, (4) a greater amount of decadence (snags or coarse woody debris), and (5) more small gaps or openings in the forest canopy. In the old growth stage, dominant overstory tree ages are greater than 180 years and commonly exceed 250 years.

All old growth stands identified in this stand group meet the Western Montana Zone old growth definitions (Green et al. 1992); Appendix C, Flathead LRMP, Amendment #21).

Both the cool-to-cold moist and warm moist to warm dry PVG types are represented in this stand group. The cool-to-cold moist type has a greater representation of spruce and subalpine fir in all strata, while the warm dry type has a greater representation of Douglas-fir and ponderosa pine. The response to disturbance, whether from blowdown, harvesting, or fire, is somewhat different in that the shrub-forb colonizers are different. The vegetative response to disturbance in cool-to-cold moist types would result in greater amounts of grouse whortleberry, false huckleberry, lodgepole pine, and associate species. The vegetative response to disturbances in warm dry types would result in a greater representation of pinegrass, beargrass, Douglas-fir, ponderosa pine, and other associated species. Complete descriptions of these plant associations can be found in Pfister et al. (1977).

The mixed-conifer type is dominated by the mixed severity fire regime. Mixed-severity fire regimes typically create mixed species stands. The relatively frequent disturbances cause regeneration events that initiate early-seral species such as larch, lodgepole pine, and to a lesser degree Douglas-fir.

Past, Present, and Reasonably Foreseeable, and Similar Actions Considered for Cumulative Effects

Past Activities

Approximately 31 percent of the National Forest System lands within the Logan Creek area have been harvested in some manner. Past timber management activity in the cumulative effects area was described in detail under the Past Timber Management section of this chapter.

Associated with past timber management is precommercial thinning, a treatment that reduces tree density in stands about 15 to 20 years old. Approximately 4300 acres have been precommercially thinned within the analysis area since the 1960s.

Development of private lands within the analysis area has been occurring for the last century and has increased in the past two decades. Private land development converts forested lands to low-density forests or grasslands and roads.

Firewood cutting primarily affects forests within 200 feet of roads open year-round or seasonally. Larch and Douglas-fir are preferred for firewood collection, but lodgepole pine and other dead species are also removed due to high demand. The amount of acres with in the Logan Creek area affected by this activity is unknown.

Other Present Activities

Precommercial thinning has been authorized on 319 acres in the Logan Creek area for the year 2003. Firewood cutting would continue on an undetermined number of acres near open roads.

Reasonably Foreseeable Activities

Firewood cutting is anticipated to continue along seasonal and year-round open roads. This activity has the potential to reduce coarse down woody material, snags, and fuel within 200 feet of open roads.

Private in-holdings within the Logan Creek drainage have been subdivided and sold in the recent past. This process is anticipated to continue. As a result more forest vegetation will be removed to accommodate new landowner’s objectives. Furthermore, increased residential development elevates the importance of fuel reduction to reduce the potential loss of life and property.

Plum Creek Timber Company is planning to harvest 850 acres in eight different units using the selection method. This activity would take place on Plum Creek land in the southern portion of the analysis area.

REGULATORY FRAMEWORK

Biodiversity. The National Forest Management Act (NFMA) requires Forest Plans "preserve and enhance the diversity of plant and animal communities...so that it is at least as great as that which can be expected in the natural forest" (36 CFR 219.27). Additional direction states that "management prescriptions, where appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities, including endemic and desirable naturalized plant and animal species, so that it is at least as great as that which could be expected in a natural forest and the diversity of tree species is similar to that existing in the planning area." Flathead Forest Plan goals also include maintaining a diversity of vegetation and habitats across the forest to meet the needs of a variety of wildlife species, and to provide for a sustained yield of timber products (Forest Plan page II-5).

Implementation regulations for the NFMA specify, "fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." In order to ensure that viable populations will be maintained, habitat must be provided to support at least a minimum number of reproductive individuals. The habitat must be well distributed so that those individuals can interact with others in the planning area.

The National Forest Management Act (NFMA) (16 USC 1604). The NFMA requires that "timber will be harvested from National Forest System lands only where there is assurance that such lands can be restocked within five years of harvest." Determination of adequate stocking would be based on regeneration surveys conducted one, three, and five years following tree planting or site preparation for natural regeneration. These survey results would be compared to minimum desired stocking levels identified in the harvest prescription for each unit.

Flathead National Forest Land and Resource Management Plan. The Forest Plan provides goals, objectives, and standards for the protection, improvement, and management of all resources (Forest Plan Chapters II and III) including vegetation management. Amendments to the Forest Plan provide updated guidance for management of particular resources. The most recent and pertinent amendment related to vegetation management is Amendment 21, with the Final Environmental Impact Statement published September of 1998 and the Record of Decision on January 14, 1999. This Decision revises Forest Plan goals, objectives, standards, and guidelines for vegetation management and particularly for the management of old growth forests and their associated wildlife species.

Fire Suppression Direction. The LRMP, Appendix G, Fire Management Direction, provides direction on the appropriate suppression or management response for each wildland fire ignition. All wildland fires require an appropriate suppression response of control, confinement, or containment strategies within all the management areas (see Appendix B) represented in the analysis area. These appropriate management responses and strategies are designed to provide for adequate protection, maintenance, and enhancement of resource values and attain land management goals and objectives in a cost effective manner. The unique set of resource values to be protected or managed from the effects of wildland fire ignitions for the analysis area are described and spatially displayed in Exhibit O-11, Values to be Protected.

Forest Service Manual Direction 2471.1. The size of harvest openings created through even-aged silviculture in the Northern Region will be normally 40 acres or less. Creation of larger openings will require Regional Forester approval. Documentation of the request to the Regional Forester and approval is included in Exhibit P-25.

Environmental Consequences

This section describes the effects on vegetation from implementation of the alternatives. Alternative A (No Action) provides a baseline for comparison of effects from the action alternatives. The effects of Alternative A represent potential natural changes over time. The effects on vegetation are discussed as changes over time for each forest stand group. Effects from the treatments proposed in the action alternatives relate to changes in:

- stand structure (tree retention)
- species composition
- successional stages
- potential for mortality from Douglas-fir bark beetle
- noxious weeds *(described in a separate section of this FEIS)*
- threatened and sensitive plants *(described in a separate section of this FEIS)*
- potential for wildland fire and hazardous fuel reduction *(described in a separate section of this FEIS)*

The effects of each alternative are also summarized for specific components of the vegetation resource, including reforestation, opening size, and habitat fragmentation.

The description of effects in this section incorporates the most recent research literature, stand data, and monitoring results.

Alternative A – No-Action

Direct and Indirect Effects of No Action

Alternative A would have no short-term effects on vegetation and would allow some natural processes such as growth and mortality to continue over time. Successional change and disturbance are the basic processes in species composition, structure, and function of plant communities. In a simplified model of forest succession, the forest progresses through stages, generally described in chronological terms such as early; mid-seral; late-seral; and old growth, a subset of late-seral (refer to the Affected Environment section above for a description of successional stages).

If this alternative were selected, no new timber harvest, burning, thinning, or road construction and reclamation would occur at this time on National Forest System land. The Forest Service policy to suppress wildland fires would continue within the analysis area. Assuming fire suppression and no harvesting would occur, lots of biomass would accumulate causing stand replacement fires where mixed-severity fires used to historically occur. A stand replacement fire would kill 95 percent or more of the trees. This inaction would increase the probability of mortality to large old trees that have survived numerous fires. Continued fire suppression would also extend the interval between stand-replacement fires, allowing live and dead fuel to accumulate and increasing the shift to shade tolerant tree species.

The proposed Logan Creek project proposes treatments in all successional stages of lodgepole pine cover types. *Cover type* refers to the plant species forming the plurality of composition across a given area (Helms 1998). The potential for a mountain pine beetle infestation would increase greatly in the next 10 years as many stands age beyond 80 to 90 years (McGregor et al. 1985). Historically, a stand-replacement fire follows mountain pine beetle infestations before the stand is converted to shade tolerant species. In the absence of an insect epidemic, specifically a mountain pine beetle infestation, tree mortality would be nearly indistinguishable at the stand level, but cumulatively would create sufficient fuel to support an active crown fire. Total stand mortality would exceed growth. Very dense lodgepole pine stands would remain stagnant with low vigor. With no disturbance, species composition would gradually shift to shade-tolerant species as "understory reinitiation" (Oliver and Larsen 1996) occurs. Understory reinitiation refers to the trees that become established on the forest floor, underneath an existing forest canopy.

In spruce and subalpine fir cover types, species composition would remain essentially the same over time. Lodgepole pine would disappear in the mid-seral stage of succession, and subalpine fir and other tolerant trees species would dominate. Taking no action (Alternative A) would result in increased physiological stress and the potential for extensive tree mortality by a variety of insects and diseases (Biondi 1996 *in* Arno et al., 1999). In mid- to late-seral types, root disease and associated bark beetles would increase. Elevated levels of western balsam bark beetle and spruce bark beetle would probably continue and expand as subalpine fir and spruce age and become more extensive. For the time period analyzed in this EIS, mid- and late-successional stage stands would largely remain the same in terms of their overstory and understory species composition and average size.

Mixed conifer stands in the mid-seral stage of succession would differentiate over time by forming a multilayered forest. Natural thinning would eliminate some of the overstory shade-intolerant tree species, and the understory would contain one or two layers of shade-tolerant tree species, such as subalpine fir, spruce, or Douglas-fir. Extended periods with dense conifers and no natural disturbance would cause early-seral herbaceous and shrub species to decline. In the late-seral and old growth stages, advanced shade tolerant regeneration would occupy more and more of the stand until they dominate, leaving only a few remnant intolerant trees remain in the overstory.

The extensiveness of the Douglas-fir cover type, which is a part of the mixed conifer classification discussed above, was presented in the EAWS as an important finding. To reiterate briefly, historically the Logan Creek area was occupied by an average of 20 percent and a maximum of 40 percent of the Douglas-fir cover type. Currently, about 60 percent of the watershed is occupied by the Douglas-fir cover type. The implications of having so much Douglas-fir, especially in the late-seral stage of succession, are clearly described in the Vegetation Affected Environment section of Chapter 3 in this document. With no action, the existing Douglas-fir bark beetle population would likely continue to cause mortality in Douglas-fir, and root disease centers would expand, also causing mortality.

Precommercial thinning would not occur with the no-action alternative. This would result in many dense stands of mixed species that would stagnate at worst or grow well below site potential over the next 10 to 20 years. Differentiation in growth of individual trees would be delayed indefinitely or extended substantially. It would also take longer for these presently young stands to grow into large trees, increasing the amount of time until one or more of the attributes of old growth are realized. The return on the reforestation investment in the current stands would diminish due to the delayed time until merchantable wood products are removed. Also, the ability to control species composition and future insect and disease outbreaks would be forgone.

All these stand groups have evolved with disturbance as a common and recurring process. Stand-replacement fire regime types of disturbance are approaching or have exceeded their historical average disturbance return interval. The mixed-severity fire regime types have generally exceeded their historical average disturbance return interval. As mentioned above, the presence of bark beetles, root disease, and windthrow suggest the incipient stage of some type of disturbance, likely insect or disease followed by fire. Accumulated fuel from natural processes currently jeopardizes the adjacent private residences and the safety of their occupants from future wildland fire. This trend would continue to intensify with no action and likely become more severe.

As mentioned in the "Affected Environment" section, hazard and risk factors suggest a high potential for future mortality from Douglas-fir bark beetle. With high existing bark beetle populations, residual effects of lingering drought conditions, and at least 8000 acres currently at moderate to high risk of beetle attack (Table 3-1), it is reasonable to anticipate additional mortality if no action is taken (Exhibit P-1). In the past two years, Douglas-fir bark beetles have affected an average of approximately 2000 acres per year. While it is nearly impossible to predict the weather for the upcoming year, a continuation of the mortality experienced in that period will more than likely occur should weather conditions of the past few years persist. The southern 60 percent of the analysis area has seen the most Douglas-fir bark beetle mortality and evenly distributed. As mentioned earlier, infestations do not kill all host trees. Generally, bark beetles kill clusters or clumps of trees with a dozen trees or so, unless the stand has root disease. In that case, the bark beetle will follow the root disease until host trees are completely unavailable.

If no action were taken, the fragmented nature of the landscape would also persist in the short-term. In the absence of a disturbance caused by insects, disease, fire, or wind, forest growth would cause early- and mid-successional stage patches to merge into late-seral stands, thereby reducing the effect of forest fragmentation. It is estimated this process would take 50 to 100 years.

Cumulative Effects of No Action

Vegetation Management - Regeneration harvests have been conducted on 15,141 acres of National Forest System lands in the Logan Creek area since the 1960s. When combined with other ownerships, approximately 18,016 acres (29 percent of the analysis area) have been harvested using an even-aged silvicultural system (Exhibit P-2). Many of these harvests have contributed to a pattern of 5 to 200-acre patches of seedling and sapling sized stands across the landscape. All of the acres on National Forest System land have been or are in the process of becoming reforested.

The distribution of acres among successional stages in the short-term would remain the same as described in the Affected Environment section of this chapter. However, high levels of fuels would eventually result from no disturbance. Eventually, the ecological processes and biological potential of the ecological systems in the Logan Creek area would be substantially disrupted as a result of a severe fire, insect, disease, or wind disturbances with associated loss of soil and nutrients. The eventual accumulation fuel could exaggerate the potential for a high-severity fire (Quigley and Arbelbide 1997).

The following table displays the distribution of successional stages on National Forest System lands, private land, and collectively on all ownerships. Private land includes industrial/corporate forestlands, Montana Department of Natural Resources and Conservation forestland, and small private ownership.

The value of analyzing and disclosing seral stage relates to the stated purpose and need of the Logan Creek project, which is to restore forest structure within the Logan Creek landscape. The assessment of the Logan Creek watershed (Exhibit A-1) indicated forest structures and composition in many places have changed from what they were historically. Because forest structure is a function of plant succession and seral stages describe the different phases of succession, the effect of proposed treatments will be disclosed in three seral stage categories: early, mid, and late.

Table 3-5. Existing Distribution of Seral/Structural Stages in Logan Creek on National Forest, Private Land, and Both Ownerships.

Seral/Structural Stage	Percent of National Forest Land	Acres of National Forest Land	Percent of Private Land	Acres of Private Land	Percent of all Ownership	Acres of all Ownership
Non-forest	6	2,841	4	492	5	3,333
Early	25	12,156	30	3749	26	15,905
Mid	17	8,121	31	4060	20	12,181
Late	52	25,129	36	4665	40	29,794
Total						61,257

Exhibit P-10

Douglas-fir Bark Beetle - Over the past five years, Douglas-fir bark beetles infested approximately 5500 acres. In the past two years alone, 3800 acres were infested. As mentioned above, if drought conditions persist, another 1500 to 2000 acres could be infested per year over the next few with no change to the vulnerability of the 13,000 acres that are at risk of beetle infestation.

The accumulation of dead trees has both positive and negative repercussions to a variety of resources that will be discussed in the Fire and Fuels sections of this document.

Reforestation - The regeneration of conifers would occur very gradually over the next several decades in the absence of wildland fire or other site-disturbing activities. Subalpine fir, spruce, and to a lesser extent Douglas-fir would regenerate under the partial shade of the existing overstory and the down logs of beetle-killed lodgepole pine and mixed species. Small amounts of lodgepole pine, larch, and Douglas-fir may also regenerate on the exposed mineral soil on and near root mounds created by blown down trees.

Ongoing reforestation activities in past harvest units would continue. Monitoring planted and naturally regenerated stands would continue. Interplanting would likely occur to achieve target stocking levels and productive potential.

REGULATORY CONSISTENCY

Selection of this alternative would be inconsistent with the LRMP stated resource goals for timber (LRMP pg. II-5) and the goals and standards of the predominant management area within the Logan Creek drainage (LRMP pg III-70 and 71). The acres required to be managed to achieve a long-term sustained yield of forest products while protecting the soil and water resources (LRMP pg II-8 and 9 and 36CFR 219.27 (b)(1) would not be met (also see LRMP, Appendix I, pg 1). In the absence of management actions, bark beetle mortality and fuel accumulations are sufficient to replace entire stands through wildland fires. These fires could be extensive and severe enough to preclude meeting legal requirements for resource protection in the National Forest Management Act (NFMA)(36 CFR 219.27 (a)(2) and specifically for wildlife, watershed, and visual quality (36 CFR 219.27(a)(4, 5, 6, 7)).

Effects Common to All Action Alternatives

Precommercial Thinning

All action alternatives propose precommercial thinning, which would occur only in sapling-sized stands (1 to 5 inches DBH) in the early-seral stage of succession. Trees are about 10 to 25 feet tall and approximately 15 to 20 years old. Stand density ranges from 2000 to 7000 trees per acre. Stand density after thinning would range from 300 to 400 of the most vigorously growing trees of all species. While stem density would be reduced, these stands would still function as an early successional stand. The process of stem exclusion that would occur naturally is artificially replaced. This management activity represents an opportunity to achieve the desired species composition and greatest possible diameter growth.

Thinning would generate slash consisting of fine, highly flammable fuels for a period of about three years. To reduce the potential for wildland fire to spread to private property, thinning slash in a 100-foot strip would be piled and burned to create a fuel break adjacent to private property.

Alternatives B, C, and E propose that 3,783 acres be precommercially thinned. Alternatives D and F propose that only 310 acres be precommercially thinned because of concern for lynx habitat. The difference between alternatives is the degree to which effects from precommercial thinning occurs, which is directly related to the number of acres treated.

Road Access for Current and Future Management

Road access for current and future vegetation management activities would change by reclaiming some existing roads and by building new temporary and specified or system roads. Roads and their management indirectly affect the condition of vegetation. The presence or absence of a road influences the ability of firefighters to suppress fires. Fewer roads would likely lead to more burned acres over time. The presence or absence of roads as well as their condition can determine whether a cultural treatment is applied or not. That cultural treatment can influence the health and productivity of a site.

All alternatives would have sufficient road access for precommercial thinning and response to initial attack fire suppression. In addition, all action alternatives propose road reclamation. None of the roads proposed for reclamation are needed to access lands for vegetation management or fire suppression. A reduction in road maintenance costs would offset any additional cost incurred by the government to manage the areas served by these roads. Should disturbances occur that require access, road templates would be left intact to keep costs to a minimum.

New road construction would provide the access necessary to both manage forested stands for long-term health and productivity and to reach areas quickly for fire suppression. Temporary roads would provide access when stand treatments require one entry and later management activities can be accomplished by walking to the area. All temporary roads would be completely obliterated and recontoured. Specified road construction (see above) is necessary for long-term strategic management, such as fire suppression and periodic removal of commercial wood products.

Shrub Planting for Wildlife Habitat

Shrub planting for big game habitat improvement is proposed in some of the harvest units. Shrub planting would usually consist of willow, serviceberry, red-osier dogwood, mountain maple, or redstem ceanothus at a density of about 100 to 300 plants per acre. Shrub planting could take place in some timber harvest units with light and/or moderate tree retention where sufficient soil moisture and light would assure survival. More shrub planting would occur in the vicinity of riparian areas to enhance wildlife browse. Shrub planting would not affect conifer stocking objectives and would be compatible with conifer regeneration strategies. Post-harvest site conditions and natural conifer regeneration success would determine specific areas and planting density. The total maximum area to be treated would range from 100 to 500 acres in each of the action alternatives.

Tally Lake Campground

All alternatives include commercially thinning units 139 and 140, which are located in the Tally Lake Campground. The purpose of these treatments is to:

- reduce the vulnerability of these units to insect infestation.
- maintain the aesthetic qualities of a forested environment.
- provide less competition for resources.
- provide opportunities for regeneration.

To meet visual quality and recreational experience objectives, the prescription would retain about 50 percent canopy cover, leaving some trees in clumps and other areas with selectively chosen trees. This would leave a mixture of all size and species of trees, but favoring larch. Douglas-fir would be left also, but only to fill in canopy cover where needed. Small patch openings created would allow sunlight for young tree seedlings. Planting some ponderosa pine would assure a new generation of trees that are not susceptible to existing bark beetle species.

Burning with No Associated Harvest

The table below displays the distribution of acres by stand group, cover type, and structural stage that all action alternatives propose to burn to retain about 5 to 50 percent of the canopy cover in any area within the maximum perimeter, either dispersed in individual trees or in groups of trees. The maximum perimeter is the largest area that would be allowed to burn before suppression action would occur.

Table 3-6. Burning with No Associated Harvest (Light Dispersed Retention [LDR], Heavy Aggregated Retention [HAR], Heavy Dispersed Retention [HDR])

Stand Groups	Cover Type - Potential Vegetation Group	Successional / Structure Stage	LDR Acres	HAR Acres	HDR Acres
6	Mixed Conifer - W	Late		19	
7	Mixed Conifer - W	Late			282
10	Mixed Conifer - CM	Mid		148	
18	Mixed Conifer - W	Mid			14
20	Lodgepole – C	Early		310	
21	Lodgepole – W	Early	35		
25	Lodgepole - C	Late	64		
28	Lodgepole – CM	Mid			4
31	Lodgepole - W	Mid		21	
33	Lodgepole - W	Mid			19
Total			**99**	**498**	**319**

Exhibit P-3

To reduce fuel continuity, stimulate browse for wildlife species, and reintroduce fire as an ecological process consistent with native disturbance regimes, 566 acres of the total of 916 potential acres identified in Table 3-6 immediately above (50 to 70 percent of the acres) would be burned with no associated commercial harvest. Light intermittent slashing sufficient to carry a low-intensity, low-severity surface fire would occur in each stand. This would retain variable canopy cover as well as most of the original stand. This treatment would improve overall stand vigor and productivity. Table 3-6 discloses the number of acres in each stand group that would be treated.

All action alternatives propose to use wildland fire for beneficial use on a total of 566 acres within 345 acres of early-seral, 206 acres of mid-seral, 365 acres of late-seral stands that would be ideal candidates for this type of treatment. In the mixed-conifer and lodgepole pine cover types that are mid-seral, burning would result in a mosaic of patches or dispersed trees, leaving the largest lodgepole pine, larch, and Douglas-fir. Stand Groups 20 and 21 represent early-seral stands where lodgepole pine is widely spaced with a grass/shrub understory. Burning in this stand group would rejuvenate grasses and shrubs, restoring the vigor of those early-seral species for browse and reduce the number of scattered lodgepole pine. Light slashing and burning in late successional stands would reduce ladder fuels and the potential for crown fires, as well as create isolated opportunities for regeneration of shade-tolerant and shade-intolerant trees.

Fuel reduction in Stand Groups 6, 17, and 38 is proposed by all action alternatives to minimize hazardous fuel accumulation and ladder fuels adjacent to private lands and is summarized in Table 3-7. Due to the forest structure and composition in these stands, only species of trees less than six inches DBH would be cut. Live and dead brush would also be cut. All slash would be hand piled and burned. This type of treatment is only intended to reduce the potential for crown fire and allow firefighters to safely protect dwellings on private land (see Fire and Fuels section). Overstory canopy cover would change very little because only understory trees would be cut. Little to no change in tree growth would result from these treatments. Cutting shrubs could stimulate vegetative reproduction, but this shrub growth would be relatively slow due to canopy shading. Regeneration of conifers would be very slow and consist of shade tolerant subalpine fir, Douglas-fir, and spruce.

Table 3-7. Fuel Reduction by Cutting Trees Less than 6 Inches Diameter, with No Commercial Harvest (Light Dispersed Retention [LDR]), Heavy Dispersed Retention [HDR], and Heavy Aggregated Retention [HAR])

Stand Groups	Cover Type - Potential Vegetation Group	Successional / Structure Stage	LDR Acres	HDR Acres	HAR Acres
6	Mixed Conifer - W	Late			157
17	Mixed Conifer - W	Mid		23	
38	Subalpine fir/spruce - C	Mid	2		
Total			**2**	**23**	**157**

Exhibit P-3

Effects of Individual Action Alternatives

Stand Groups

As described in the Affected Environment section, stands in the Logan Creek area that are in the Proposed Action and the other action alternatives were combined into distinctly unique groups based on four parameters:

- cover type
- the amount and distribution of trees retained
- potential vegetation groups
- successional structure stage

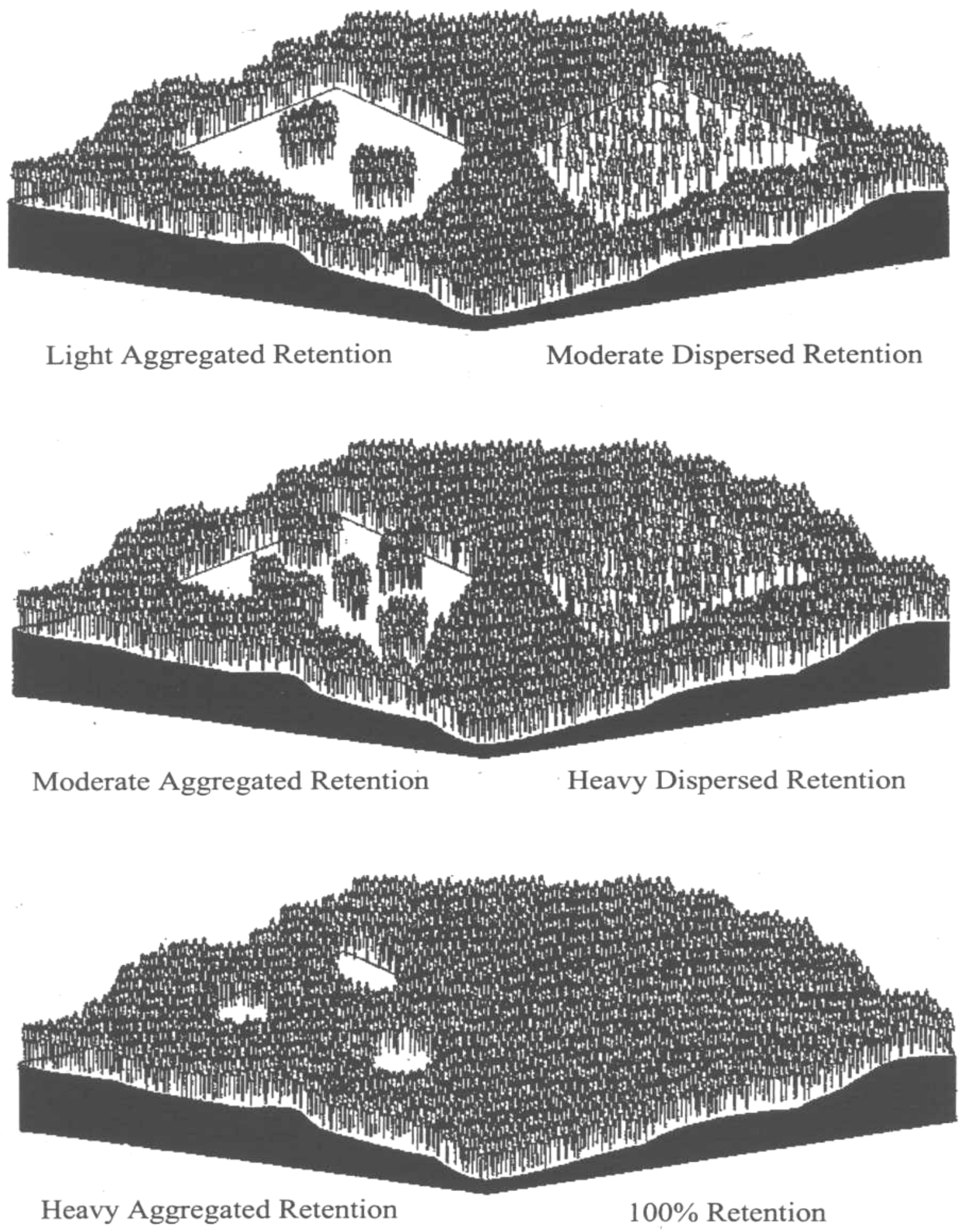
Cover type refers to the plant species forming the plurality of composition across a given area (Helms 1998). The analysis area contains three cover types: lodgepole pine; subalpine fir/Engelmann spruce; and mixed conifer (mixtures of larch, Douglas-fir, and lesser amounts of other tree species).

Retention - Most traditional silvicultural harvests, such as seedtree and shelterwood harvests, and commercial thinning include leaving some trees on site. *Retention* refers to the amount and distribution of trees retained after harvest. There are two basic retention types called *dispersed* and *aggregated*. Each of these two types can be further categorized as *light, moderate*, and *heavy*.

Retained trees can be left evenly "dispersed" throughout the stand or left "aggregated" in clumps. *Heavy Aggregated Retention* would leave at least 50 percent of the area unharvested. Neither light nor moderate aggregated retention prescriptions would be used in this project.

Light Dispersed Retention would leave up to 10 percent of the canopy cover, *Moderate Dispersed Retention* would leave about 25 percent, and *Heavy Dispersed Retention* would leave at least 50 percent. Figure 3-5 presents a graphical representation for these retention levels (Franklin et al., 1997).

Figure 3-5 – Examples of Retention Levels



<u>*Potential Vegetation Group*</u> - The habitat type approach to land classification recognizes units of land having similar biotic potentials and provides a framework for ecologically oriented planning and management (Pfister et al., 1977). *Habitat types* are described by the late-successional or potential plant communities that the site could support if not disturbed.

Potential Vegetation Groups form logical groupings of habitat types. They describe the plant community and site conditions at a larger scale than the stand level.
This analysis recognizes three potential vegetation groups: cool to cold moist, warm dry to warm moist, and riparian.

Successional Structure Stage - As described in the Affected Environment section (Chapter 3, page 3-8), successional stages are grouped into early-, mid-, and late-seral.

Stands within a group progress in a similar manner over time and have a similar response to disturbances. These groupings describe changes and effects to vegetation and the landscape. The following table describes the stand groups by unit numbers.

Table 3-8. Stand Groups involved with Implementation of the Action Alternatives (Exhibit P-3)**.**

Stand Group	**DESCRIPTION** Cover Type, Retention, Successional Stage, Potential Vegetation Group	**Acres**	**Action Alternatives Unit Numbers**
1	Mixed-Conifer, Heavy Aggregated Retention, Late-Seral, Cool-Moist	442	16, 8, 105, 39B, 39A, 39, 45, 43, 44, 60, 62, 70, 67, 68, 68A, 71, 86, 77
2	Mixed-Conifer, Light Dispersed Retention, Late-Seral, Cool-Moist	138	21, 24, 28, 57, 82
3	Mixed-Conifer, Moderate Dispersed Retention, Late-Seral, Cool-Moist	2083	14, 106, 4, 132A, 132, 33, 36, 36A, 42, 134, 47, 47, 47A, 110, 49, 46, 48, 111A, 48, 50, 55A, 32, 53A, 53, 32A, 112A, 59, 127A, 61, 127, 64, 63, 66A, 126A, 126, 101, 72, 69, 73A, 75, 124A, 74A, 74, 73, 131, 78, 79, 114, 80, 117, 91, 120A
4	Mixed-Conifer, Heavy Dispersed Retention, Late-Seral, Cold	39	139
5	Mixed-Conifer, Moderate Dispersed Retention, Late-Seral, Cold	304	102, 115, 137, 137A, 3, 32, 69A, 76, 76B, 7A, 85
6	Mixed-Conifer, Heavy Aggregated Retention, Late-Seral, Warm	21	202
7	Mixed-Conifer, Heavy Dispersed Retention, Late-Seral, Warm	614	128, 200, 201, 203, 300, 40, 71
8	Mixed-Conifer, Light Dispersed Retention, Late-Seral, Warm	12	71A
9	Mixed-Conifer, Moderate Dispersed Retention, Late-Seral, Warm	1203	1, 10, 100, 100A, 109, 11, 112, 112A, 114, 124, 124A, 134, 135, 136, 136A, 138A, 32, 41, 41A, 47, 49, 51, 58, 6, 65, 73A, 74, 76, 76A
10	Mixed-Conifer, Heavy Aggregated Retention, Mid-Seral, Cool-Moist	88	202
11	Mixed-Conifer, Heavy Dispersed Retention, Mid-Seral, Cool-Moist	32	5
12	Mixed-Conifer, Light Dispersed Retention, Mid-Seral, Cool-Moist	90	25, 88
13	Mixed-Conifer, Moderate Dispersed Retention, Mid-Seral, Cool-Moist	128	14, 15, 38, 38A, 48, 56
14	Mixed-Conifer, Heavy Dispersed Retention,	59	202

Stand Group	DESCRIPTION Cover Type, Retention, Successional Stage, Potential Vegetation Group	Acres	Action Alternatives Unit Numbers
	Mid-Seral, Cold		
15	Mixed-Conifer, Light Dispersed Retention, Mid-Seral, Cold	11	23A
16	Mixed-Conifer, Moderate Dispersed Retention, Mid-Seral, Cold	43	33
17	Mixed-Conifer, Heavy Dispersed Retention, Mid-Seral, Warm	136	2, 26, 301
18	Mixed-Conifer, Light Dispersed Retention, Mid-Seral, Warm	14	202
19	Mixed-Conifer, Moderate Dispersed Retention, Mid-Seral, Warm	100	1, 133, 136A
20	Lodgepole Pine, Heavy Aggregated Retention, Early-Seral, Cold	310	202
21	Lodgepole Pine, Light Dispersed Retention, Early-Seral, Warm	35	202
22	Lodgepole Pine, Heavy Dispersed Retention, Late-Seral, Cool-Moist	61	16, 26
23	Lodgepole Pine, Light Dispersed Retention, Late-Seral, Cool-Moist	418	17, 17A, 19A, 20, 30, 50, 52
24	Lodgepole Pine, Moderate Dispersed Retention, Late-Seral, Cool-Moist	330	103, 14, 34, 35, 72
25	Lodgepole Pine, Light Dispersed Retention, Late-Seral, Cold	121	17, 202
26	Lodgepole Pine, Moderate Dispersed Retention, Late-Seral, Cold	75	107, 108
27	Lodgepole Pine, Moderate Dispersed Retention, Late-Seral, Warm	62	29, 54
28	Lodgepole Pine, Heavy Dispersed Retention, Mid-Seral, Cool-Moist	75	16, 203, 8
29	Lodgepole Pine, Light Dispersed Retention, Mid-Seral, Cool-Moist	138	81, 82, 88, 99, 99A
30	Lodgepole Pine, Moderate Dispersed Retention, Mid-Seral, Cool-Moist	84	1, 33, 35
31	Lodgepole Pine, Heavy Aggregated Retention, Mid-Seral, Warm	22	202
32	Lodgepole Pine, Heavy Dispersed Retention, Mid-Seral, Warm	6	140
33	Lodgepole Pine, Light Dispersed Retention, Mid-Seral, Warm	41	202, 21
34	Lodgepole Pine, Moderate Dispersed Retention, Mid-Seral, Warm	65	15
35	Spruce-Fir, Heavy Dispersed Retention, Late-Seral, Cool-Moist	13	67, 87
36	Spruce-Fir, Light Dispersed Retention, Late-Seral, Cool-Moist	55	27, 88
37	Spruce-Fir, Moderate Dispersed Retention, Late-Seral, Cool-Moist	256	101, 101A, 109, 129, 130, 18, 29, 31, 4, 50, 73, 9, 91
38	Spruce-Fir, Light Dispersed Retention, Late-Seral, Cold	2	303
39	Spruce-Fir, Heavy Dispersed Retention, Late-Seral, Warm	19	8
40	Spruce-Fir, Moderate Dispersed Retention, Mid-Seral, Cool-Moist	21	1

Direct and Indirect Effects Specific to the Action Alternatives

The following section discloses and describes the effects of various vegetative management treatments proposed by the action alternatives. Please refer to Exhibit P-3 for detailed stand level information about these treatments and the detailed description of these treatments in Chapter 1 of this EIS. Table 3-9 presents approximate acreages of the various vegetation management treatments and relevant road management actions:

Table 3-9. Vegetation Management Treatments and Relevant Road Management Actions for each of the Action Alternatives (Alternatives B, C, D, E, and F).

Treatment	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Commercial timber harvest, acres	6624	4235	4724	6315	5521
Light dispersed retention (Seed-tree with reserve trees), acres	925	476	232	852	523
Moderate dispersed retention (Shelterwood harvest with reserve trees), acres	4748	2642	2881	4162	3093
Heavy dispersed retention (Commercial thinning), acres	968	1255	1608	1258	1809
Heavy aggregated retention (Group selection), acres	0	0	0	0	96
Spring season prescribed burning, acres	566	566	566	566	566
Fuels treatment without associated commercial harvest, acres	182	182	182	182	182
Precommercial thinning of sapling-sized trees, acres	3783	3783	310	3783	310
Road reclamation, miles	16.2	16.2	16.2	16.6	16.6
New road construction, miles	9.8	6.3	7.0	9.6	8.3

Light Structural Retention from Seed Tree with Reserve Trees Harvest Method

The table below displays by action alternative the distribution of acres by stand group, cover type, and structural stage that would be harvested in such a manner that retains about 10 percent of the canopy cover dispersed among individual trees.

Table 3-10. Light Dispersed Retention [LDR], Acres Proposed by Specific Action Alternatives in Various Stand Groups, Cover Types-Potential Vegetation Groups, and Seral Stages.

Stand Group	Cover Type – PVG	Seral / Structural Stage	LDR Acres, Alt. B	LDR Acres, Alt. C	LDR Acres, Alt. D	LDR Acres, Alt. E	LDR Acres, Alt. F
2	Mixed Conifer – CM	Late	137	79	55	98	97
8	Mixed Conifer – W	Late	12	12	12	0	12
12	Mixed Conifer – CM	Mid	90	12	0	90	79
15	Mixed Conifer – C	Mid	11	11	0	11	11
23	Lodgepole – CM	Late	417	182	120	416	242
25	Lodgepole – C	Late	47	47	0	47	121
29	Lodgepole – CM	Mid	138	63	0	120	104
33	Lodgepole – W	Mid	16	15	14	15	39
36	Subalpine fir/Spruce– CM	Late	55	55	31	55	3
Total			**923**	**476**	**232**	**852**	**708**

Exhibit P-3
PVG – Potential Vegetation Group (CW: cool/moist; W: warm; C: cool)

The action alternatives propose various acreages of light retention treatments in mid-seral stands and late-seral stands. The following table outlines these acreages for each of the action alternatives:

Table 3-11. Acres of Light Dispersed Retention [LDR] in each of Mid-Seral and Late-Seral Stands, by Action Alternative.

Seral Stage	Alt. B, acres	Alt. C, acres	Alt. D, acres	Alt. E, acres	Alt. F, acres
Mid-seral	255	101	14	236	233
Late-seral	668	375	218	616	475
TOTAL	**923**	**476**	**232**	**852**	**708**

The light dispersed retention treatment (seed tree harvest with reserve trees method) would create a new stand of trees, retaining approximately 10 percent canopy cover in the largest older larch and Douglas-fir. Tree species removed would be primarily lodgepole pine, subalpine fir, spruce, and, to a lesser degree, larch and Douglas-fir. The harvested trees would provide forest products, such as sawlogs, house logs, pulpwood, or posts and poles. Light dispersed retention would change the stands from mid- and late-seral stands to the early-successional seedling stage. The species composition would also change. Fewer shade tolerant species would occupy the site and shade-intolerant species would dominate for 20 to 50 years.

Light dispersed retention treatments would resemble the effects of a stand-replacing wildland fire, except that harvesting leaves fewer snags and the reserve trees can be selected and left alive. Should a wildland fire occur, there would be no assurance that any live trees would be left. Also, with harvest, most of the wood and its stored nutrients would be removed for use rather than volatilized and returned to the soil and air. The reserve trees that are retained on-site (approximately five per acre, depending on age and size) would primarily be western larch and Douglas-fir. Other species may be retained to meet density objectives and that are consistent with successional pathways. Reserve trees selected for seedtrees would be the best phenotypes available and the most windfirm. In spite of the windfirmness, it is possible that these trees would blow down. In the event of blowdown, the trees would not be removed and would be left to become woody debris.

Species of trees retained on the site after harvest would vary by cover type. In lodgepole cover types, windfirm larch and Douglas-fir where they exist would be retained as a seed source and for structural diversity dispersed across the harvested area. Reserve trees would provide structural diversity, genetic reserves, snag replacements, visual management, wildlife movement, and to some degree, shade.

The light dispersed retention treatment would leave approximately 5 to 23 tons per acre of downed logs greater than nine inches in diameter where available. Down wood requirements could be achieved with material less than nine inches in diameter; however, the larger diameter material is more effective in meeting fuel reduction objectives. Lesser amounts of woody debris would be left on dry sites, while greater amounts would be left on moderately moist and moist sites. Refer to Regulatory Framework for snag and down wood retention requirements to meet nutrient cycling and other ecosystem functions. Fuel loading from dead, down, and stagnated lodgepole pine, windthrow, root rot, and ladder fuels would be reduced by either excavator piling and subsequent burning of the piles or broadcast burning.

Units adjacent to residential private land would have a zone of very low amounts of residual fuel to minimize the potential for wildland fire spreading onto private land and to facilitate fire suppression. This may compromise ecosystem functions in this low fuel zone to some degree, but is necessary for firefighter safety.

The management objective to reduce the potential for widespread future insect epidemics could be met by converting the species composition in some stands from Douglas-fir to mixed species, minimizing the potential for future Douglas-fir beetle infestations. This is possible because the species that would be managed are not susceptible to Douglas-fir beetles.

Windthrow risk would increase in treated and adjacent stands. Douglas-fir and subalpine fir are the most susceptible to windthrow and breakage, especially in small-diameter trees in dense stands that are opened by harvest. Most windthrow would affect individual trees. This can be mitigated somewhat by locating reserve trees in less wind-prone areas. While windthrow is not desirable, the scattered down trees would add to the accumulation of large woody material for soil and wildlife habitat.

All stand groups with Light Dispersed Retention would be regenerated, either naturally from seed provided by onsite seedtrees or artificially with seedlings, with larch, Douglas-fir, lodgepole pine, ponderosa pine, and western white pine. Site preparation for reforestation would require scarification of the forest floor to expose mineral soil for natural regeneration, either mechanically or by broadcast burning. Successful regeneration of conifers is dependent on this process. Site preparation for artificial regeneration (planting) would also be accomplished by either mechanically piling and burning piles or broadcast burning to reduce competition for sunlight and facilitate hand planting.

Moderate Structural Retention from the Shelterwood with Reserve Trees Harvest Method

The table below displays by action alternative the distribution of acres by stand group, cover type, and structural stage that would be harvested in such a manner that retains about 25 to 35 percent of the canopy cover, either dispersed as individual trees or in groups of trees.

Table 3-12. Moderate Dispersed Retention [MDR], Acres Proposed by Specific Action Alternatives in Various Stand Groups, Cover Types-Potential Vegetation Groups, and Seral Stages.

Stand Group	Cover Type – PVG	Seral / Structural Stage	MDR Acres, Alt. B	MDR Acres, Alt. C	MDR Acres, Alt. D	MDR Acres, Alt. E	MDR Acres, Alt. F
3	Mixed Conifer – CM	Late	2080	892	1352	1746	1813
5	Mixed Conifer – C	Late	307	183	154	303	255
9	Mixed Conifer – W	Late	1197	756	816	1081	973
13	Mixed Conifer – CM	Mid	128	98	101	121	101
16	Mixed Conifer-C	Mid	43	42	0	42	41
19	Mixed Conifer-W	Mid	100	100	45	100	100
24	Lodgepole – CM	Late	329	180	66	319	288
26	Lodgepole-C	Late	75	75	75	75	75
27	Lodgepole-W	Late	62	29	62	62	62
30	Lodgepole-CM	Mid	84	55	0	84	69
34	Lodgepole-W	Mid	66	64	61	0	61
37	Subalpine fir/Spruce CM	Late	256	147	149	208	119
40	Subalpine fir/spruce CM	Mid	21	21	0	21	21
Total			**4748**	**2642**	**2881**	**4162**	**3978**

Exhibit P-3
PVG – Potential Vegetation Group (CW: cool/moist; W: warm; C: cool)

The action alternatives propose various acreages of shelterwood harvest in mid-seral stands and late-seral stands. The following table outlines these acreages for each of the action alternatives:

Table 3-13. Acres of Moderate Dispersed Retention [MDR] in each of Mid-Seral and Late-Seral Stands, by Action Alternative.

Seral Stage	Alt. B, acres	Alt. C, acres	Alt. D, acres	Alt. E, acres	Alt. F, acres
Mid-seral	442	380	207	368	393
Late-seral	4306	2262	2674	3794	3585
TOTAL	**4748**	**2642**	**2881**	**4162**	**3978**

The moderate dispersed retention treatment (shelterwood with reserve tree method) would remove most trees and other vegetation and would provide an environment suitable for regeneration and growing conditions for the new stand. A variety of sizes of leave trees would be randomly distributed throughout the stand. Between 12 and 30 of the largest larch and Douglas-fir trees per acre would be left as reserve trees, providing 25 to 35 percent canopy cover. These trees would offer structural and species diversity, snag replacements, genetic reserves, visual management, shade, and seed sources for the new stand and allow options for future stand management.

Moderate dispersed retention treatment would change stands by removing suppressed and dead or dying lodgepole pine, as well as Douglas-fir, subalpine fir, and spruce. In some cases, suppressed western larch with poor crowns and less than 18 inches DBH would be removed. Harvested trees would provide forest products such as sawlogs, house logs, pulpwood, or posts and poles. These treatments would change the stands from mid- and late-seral stands, to the early-successional seedling stage. The species composition would also change. Fewer shade tolerant species would occupy the site and shade-intolerant species would dominate for 20 to 50 years.

All shelterwood harvests would retain woody material on the ground, somewhere between 5 to 23 tons per acre of the largest down logs greater than nine inches in diameter where available. Down wood requirements could be achieved with material less than nine inches in diameter; however, wood less than nine inches in diameter is less effective in meeting fuel reduction objectives. Lesser amounts of woody debris would be left on dry sites, while greater amounts would be left on moderately moist and moist sites. Refer to Regulatory Framework for snag and down wood retention requirements to meet nutrient cycling and other ecosystem functions.

Reforestation After Harvest of Units with Light and Moderate Retention

All harvested units with light and moderate tree retention would be regenerated after harvest either by planting or by natural regeneration. The following table outlines the type of regeneration planned for each of the action alternatives:

Table 3-14. Reforestation to Occur After Light and Moderate Tree Retention, by Alternative.

Type of Reforestation	Alt. B, acres	Alt. C, acres	Alt. D, Acres	Alt. E, acres	Alt. F, acres
Planting	2915	1557	1613	2518	2155
Natural	2788	1467	1542	2576	1602
TOTAL	**5703**	**3024**	**3155**	**5094**	**3757**

Site preparation for regeneration of the new stand would be accomplished in select units by yarding treetops and branches with the tree as it is removed; i.e., whole tree yarding. The purpose of this is to reduce competition with seedlings. An excavator would then pile the logging residue in excess of desired woody debris and scarify the ground. Scarification provides a suitable site for seeds to germinate and reduces plant competition with seedlings. Piles would be burned when fire hazard and risk of spread is low.

In stands with sufficiently large residual trees and where Douglas-fir and larch are retained, broadcast underburning would accomplish the necessary hazardous fuels reduction and site preparation. In some cases, it would be necessary to yard the unmerchantable material to a landing near the road in order to reduce fuels to levels that protect residual trees. Slashing would proceed all piling and burning to remove suppressed understory tree species that would not grow sufficiently after removing the overstory.

Broadcast burning would remove the needles, twigs, small branches, and shrubs that normally inhibit natural and artificial regeneration, but would retain large woody debris and upper soil layers necessary for maintaining site productivity and other ecological functions. Some conifer species such as larch experience more successful natural regeneration when they can use increased nitrogen available in the soil after fire. While burning needles, twigs, small branches, and shrubs may inhibit regeneration in the short term, there are long-term benefits to soil nutrients in leaving this material for a short period during the wet season. This practice allows important nutrients to decompose and leach into the soil.

Hand scalping of a planting site with no other scarification would occur in units too steep for excavators or not compatible with broadcast burning. Those include units that are too moist; have insufficient access roads; are cost-prohibitive; or have desirable residual vegetation, such as reserve trees or saplings, which could not be reasonably protected.

In places where small needles and branches leftover from logging would not present a fire hazard to private landowners, residue would be left on site for one wet season to enhance site productivity through leaching nitrogen and other nutrients.

Grasses and forbs, along with existing shrubs, still primarily inhabit the site the first year after site preparation. Conifer seedlings and shrub sprouts would likely establish a year or two later. Natural conifer tree regeneration from seedtrees would vary by stand. Where planted, trees would include one or two-year-old seedlings of larch, Douglas-fir, spruce, ponderosa pine, lodgepole pine, and western white pine.

In all stand groups where regeneration is proposed, less than 40 percent of the trees regenerated would be lodgepole pine. The remainder would be larch, Douglas-fir, ponderosa pine, spruce, western white pine, and subalpine fir. This management regime would reduce the susceptibility of treated stands to mountain pine beetle invasion as they mature. The proposed treatments enhance the diversity of plant communities by including indigenous and desirable plant species. The results of these treatments would provide a greater diversity of vegetation species and genetic material than would be expected if unmanaged.

Heavy Structural Retention from Commercial Thinning

The table below displays the distribution of acres by stand group, cover type, and structural stage that would be harvested in such a manner that retains about 50 percent of the canopy cover or acreage, either dispersed in individual trees or in groups of trees.

The action alternatives propose various acreages of commercial thinning in mid-seral stands and late-seral stands. Commercial thinning would remove about 50 percent of the canopy cover, producing a stand exemplifying heavy dispersed retention. Thinning objectives vary by stand group. Each group is discussed individually after the table.

Table 3-15. Heavy Dispersed Retention [HDR], (Intermediate Stand Treatment: Commercial Thinning), Acres Proposed by Specific Action Alternatives in Various Stand Groups, Cover Types-Potential Vegetation Groups, and Successional/Structural Stage.

Stand Group	Cover Type – PVG	Seral / Structural Stage	HDR Acres, Alt. B	HDR Acres, Alt. C	HDR Acres, Alt. D	HDR Acres, Alt. E	HDR Acres, Alt. F
1	Mixed Conifer – CM	Late	440	508	678	678	403
4	Mixed Conifer – C	Late	39	44	139	39	39
7	Mixed Conifer – W	Late	175	214	281	214	613
10	Mixed Conifer-CM	Mid	0	112	0	0	88
11	Mixed Conifer – CM	Mid	33	0	111	39	33
17	Mixed Conifer-W	Mid	114	111	167	111	134
22	Lodgepole-CM	Late	61	61	70	70	61
28	Lodgepole – CM	Mid	69	69	104	69	74
32	Lodgepole-W	Mid	6	6	6	6	6
35	Subalpine fir/Spruce-CM	Late	13	13	33	13	13
39	Subalpine fir/Spruce-W	Late	19	19	19	19	19
Total			**968**	**1255**	**1608**	**1258**	**1483**

Exhibit P-3
PVG – Potential Vegetation Group (CW: cool/moist; W: warm; C: cool)

Groups 10, 11, 17, 28, and 32

Groups 10, 11, 17, 28, and 32 (see Table 3-15 above) represent mid-successional, pole-sized stands suppressed by dense stocking, but with potential to improve or continue growth rates after thinning. The stands would be more open, with a greater proportion of larch and Douglas-fir and less subalpine fir, spruce, and lodgepole pine than currently present.

Thinning would select the healthiest trees with large, well-formed crowns for leave trees. These trees would then have more growing space, light, nutrients, and water to allow them to develop into large, mature overstory trees. Thinning would encourage growth and discourage potential losses from insects, disease, and fire, thus offering options for future management.

The thinned stands would be more resistant to a stand-replacing fire and better able to survive a ground fire. Removing lodgepole pine and Douglas-fir with dwarf mistletoe would reduce the potential to spread the mistletoe. Wider spacing and less lodgepole pine would reduce the risk of future mountain pine beetle epidemics.

Thinning would not change the successional/structural stage of these stands or patches; rather, they would continue to develop as previously described, except with faster growth rates and fewer insect and disease occurrences. To maintain the overstory structure, maintenance burning and/or associated thinning and burning could occur in 10-20 years. Without a major fire, these thinned stands would develop into stands dominated by larch and Douglas-fir with minor amounts of spruce, subalpine fir and lodgepole pine. Eventually, subalpine fir, spruce, and Douglas-fir regeneration would occur from multi-layered stands.

If a major disturbance such as windthrow occurred in this group, the new stands would be even-aged, mixed species with predominance of lodgepole pine, larch, and Douglas-fir. Intermediate harvest would not occur in areas where root disease exists, where stands are under stocked due to high levels of mortality, or in stands vulnerable to blowdown.

Groups 1, 4, 7, 22, 35, and 39

Intermediate stand treatments in Stand Groups 1, 4, 7, 22, 35 and 39 would maintain sufficient structural attributes to continue to function as a late-successional forest community. By removing the shade-tolerant understory as well as the intermediate Douglas-fir and lodgepole pine, these stands would retain the largest larch and Douglas-fir with minor amounts of spruce and subalpine fir, leaving 50 percent canopy cover.

These stands are in a mixed-severity fire regime where historical disturbance patterns typically left survivors or remnant trees. The residual stands would be structurally simplified in the short-term. A simplified structure would be one layer of trees that are dominant or codominant. However, as understory reinitiation occurs, multi-layering would return. Understory reinitiation refers to the new seedlings and saplings that grow under the older trees that were left after harvest. The potential for crown fires and the loss of large old remnant larch and Douglas-fir in these stands would increase as the understory becomes pole-sized. The structure and composition retained after harvest would also resemble the size and species of trees that have survived numerous historical fires.

Groups 1 and 35

In Stand Groups 1 and 35, 93 acres are proposed for sanitation/salvage, leaving greater than 50 percent canopy cover after harvest. The purpose of this harvest is to capture the mortality caused by Douglas-fir bark beetles as well as root disease cause by *Armillaria ostoyae*. Sanitation treatments would remove Douglas-fir trees that are infected and susceptible to root disease. These harvest areas would be reforested by planting species that are not vulnerable to this type of root disease. The effect of this treatment would be to reduce the overall population of Douglas-fir bark beetles and the mortality caused by this insect.

Stand groups with heavy retention after commercial thinning generally would not require reforestation, nor is it an objective, because a fully stocked stand would remain after harvesting. Stand Groups 1 and 35 are an exception due to the need to convert the stand to tree species that are not vulnerable to root disease. In Stand Groups 1 and 35, ponderosa pine, lodgepole pine, and western larch would be planted because they are not susceptible to the existing root disease. In the remaining stand groups, understory reinitiation of conifers can be expected and would meet long-term management objectives for structural diversity. Shade tolerant species such as subalpine fir, Douglas-fir, and spruce are the most likely tree to regenerate. Yarding and piling activities, as well as broadcast burning or burning piles would create a seedbed for shade-tolerant and intolerant plants. Conifer regeneration would vary by stand.

Direct and Indirect Effects of Douglas-fir Bark Beetle Suppression

An effect on vegetation from another of the Logan Creek project objectives, suppressing Douglas-fir bark beetle populations, was analyzed by determining the change in the number of acres at various hazard levels for bark beetle infestation. As mentioned in the Affected Environment section, an evaluation of the National Forest System land within the Logan Creek Area determined the number of acres that currently have various levels of Douglas-fir bark beetle hazard (see Table 3-16). Private land was not evaluated due to a lack of sufficient data on tree size and species composition to make an evaluation.

Table 3-16. Douglas-Fir Beetle Hazard on National Forest Land Before and After Implementation of Each Action Alternative.

	No Hazard	Very Low Hazard	Low Hazard	Moderate Hazard	High Hazard	Total
Current risk of beetle infestation, acres	17,611	12,235	10,301	4792	3361	**48,300**
Current risk of beetle infestation as a % of National Forest	36%	25%	21%	10%	8%	**100%**
Alternative B, acres treated	0	995	1829	969	1202	**4995**
After implementation of Alt. B, acres / % of National Forest	22,606 47%	11,240 23%	8472 18%	3823 8%	2159 4%	**48,300** **100%**
Alternative C, acres treated	0	611	1332	683	854	**3480**
After implementation of Alternative C, acres / % of total area	21,091 45%	11,624 24%	8969 18%	4109 8%	2205 5%	**48,300** **100%**
Alternative D, acres treated	0	734	1388	795	942	**3859**
After implementation of Alternative D, acres / % of total area	21,470 45%	11,501 24%	8913 18%	3997 8%	2419 5%	**48,300** **100%**
Alternative E, acres treated	0	962	1720	915	1165	**4762**
After implementation of Alternative E, acres / % of total area	22,373 47%	11,273 23%	8581 18%	3877 8%	2196 4%	**48,300** **100%**
Alternative F, acres treated	0	1224	1689	880	1265	**5058**
After implementation of Alternative F, acres / % of total area	24,280 50%	11,011 23%	8612 18%	3912 8%	2096 4%	**48,300** **100%**

Exhibit P-1.

All harvest treatments would change the stand structure from any level of hazard to no hazard. All harvest treatments, including heavy dispersed retention, would reduce the number of Douglas-fir trees susceptible to bark beetles. Due to the reduced density of trees, the overall vigor of individual trees would improve, allowing trees to more effectively compete for moisture, nutrients and sunlight. The environment of the stand would also change sufficiently to inhibit invasion and breeding by allowing trees to repel bark beetle invasion. Particular care must be taken in units proposed for broadcast burning activity. In these cases flame lengths and fire intensity must be low enough to minimize scorch on tree boles and crowns that could leave reserve trees vulnerable to insect attack, especially in heavy dispersed retention harvest areas.

The proposed treatments would effectively change the susceptibility of treated stands to Douglas-fir bark beetle. However, there would still be approximately 12 percent of the National Forest System land that could easily support Douglas-fir bark beetle populations (i.e., in the moderate and high hazard categories after implementation of an action alternative), and private land has many acres that are vulnerable. Therefore, these actions may reduce bark beetles, but it would not eliminate them.

Cumulative Effects of Implementation of Any Action Alternative

The following table displays the change in succession/structural stage distribution on National Forest System lands and on all ownerships in the Logan Creek watershed because of treatments proposed by the action alternatives. Each of the action alternatives changes forest structure from mid- and late-successional stages to an early successional stage on approximately 12 percent of National Forest System lands and 10 percent of all land in the Logan Creek drainage. Nonforest areas (approximately 3333 acres), such as roads, lakes, and rock, have been put in a separate category because they are not capable of becoming forested.

Historical distributions of successional stages have varied widely. Based on protocol used in the Upper Columbia River Basin study (Hessburg, et al. 1999), watersheds like Logan Creek historically contained anywhere between 5 percent and 60 to 80 percent in an early seral stage at any given point in time. Mean and medians for early seral stages were between 32 and 39 percent. All action alternatives propose leaving between 32 and 36 percent in the early seral stage. Maintaining an amount of land in a planning unit within the range of historic variation is intended to provide sufficient amounts of habitat with which all species, flora and fauna evolved.

Table 3-17. Cumulative Effect of Each Action Alternative on Seral/Structural Stage Distribution in the Logan Creek Analysis Area, Before and After Implementation.

	Non-Forest	Early Sucessional/ Structure Stage	Mid-Sucessional/ Structure Stage	Late Sucessional/ Structure Stage
Current seral/structural stage distribution on national forest land, acres and percent	2841 6%	12,156 25%	8121 17%	25,129 52%
Current seral/structural stage distribution among all ownerships, acres and percent	3333 5%	15,905 26%	12,181 20%	29,794 49%
Seral/structural stage distribution on national forest land after implementation of Alternative B, on national forest land, acres and percent	2841 6%	17,829 37%	7376 15%	20,201 42%
Alternative B on all Ownership and percent	3333 5%	22,371 36%	10,643 17%	24,866 49%
Seral/structural stage distribution on national forest land after implementation of Alternative C, acres and percent	2841 6%	15,274 32%	7640 16%	22,492 47%
Alternative C on all Ownership and percent	3333 5%	19,816 32%	10,907 18%	27,157 44%
Seral/structural stage distribution on national forest land after implementation of Alternative D, acres and percent	2841 6%	15,269 32%	7900 16%	22,237 46%
Alternative D on all Ownership and percent	3333 5%	19,811 32%	11,167 18%	26,902 44%
Seral/structural stage distribution on national forest land after implementation of Alternative E, acres and percent	2841 6%	17,170 35%	7517 16%	20,719 43%
Alternative E on all Ownership and percent	3333 5%	21,712 35%	10,784 19%	25,384 41%
Seral/structural stage distribution on national forest land after implementation of Alternative F, acres and percent	2841 6%	16,860 35%	7480 15%	21,066 44%
Alternative F on all Ownership and percent	3333 5%	20,609 34%	11,540 19%	25,731 42%

Exhibit P-10.

The change in successional stage distribution across the landscape is one measure to determine the cumulative effects of past and present management activities. Each of the action alternatives reduces the number of acres in the mid- and late-seral stages through regeneration harvests on National Forest System land. Some private landowners are also proposing regeneration harvests on their land in the next two to three years that would increase the number of acres in the early successional stage. The alternatives vary in the number of acres of mid-seral or late-successional forest that would revert to the early successional stage (Table 3-18):

Table 3-18. Acreage of Mid-Seral and Late-seral Stands that would Revert to the Early Successional Stage from Seed Tree and Shelterwood Harvests with Reserve Trees on National Forest and Private Lands in the Logan Creek Analysis Area.

	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Acres in mid-seral successional stage reverting to early successional stage by regeneration harvests on national forest land	745	481	221	604	641
Acres in late-seral successional stage reverting to early successional stage by regeneration harvests on national forest land	4928	2637	2892	4410	4063
Acres of proposed regeneration harvest on private lands reverting stands to early successional stage	793	793	793	793	793

Fragmentation

The intent and purpose of each of the action alternatives is to move landscape patterns to a condition similar to that expected under natural disturbance regimes. These regimes had large unfragmented patches in any given seral stage. The parameters used to evaluate fragmentation were described in the Affected Environment section. The landscape design that best meets project objectives includes small numbers of patches, large mean patch size, few miles of perimeter, and large patches.

The fragmentation analysis provides a measure of cumulative effects of past, present and reasonably foreseeable actions on National Forest and private lands. To evaluate fragmentation effectively when multiple ownerships are involved, all ownerships should be considered. Aerial photo interpretation and personal communication provided the means to classify seral stages on private land. The following table describes the landscape conditions after implementation of each of the action alternatives.

Table 3-19. Fragmentation by Structural Stage for Each of the Action Alternatives.

Fragmentation Parameter	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
EARLY SERAL					
• Number of Patches	472	426	437	528	407
• Mean Patch Size (acres)	52	51	50	45	55
• Total Perimeter (miles)	635	555	560	619	572
• Largest Patch (acres)	2331	2331	2331	2331	2331
MID-SERAL					
• Number of Patches	169	146	146	144	167
• Mean Patch Size (acres)	69	81	83	81	71
• Total Perimeter (miles)	263	268	271	262	270
• Largest Patch (acres)	2630	2630	2630	2630	2630
LATE SERAL					
• Number of Patches	224	149	159	169	204
• Mean Patch Size (acres)	113	186	172	153	132
• Total Perimeter (miles)	532	543	541	538	554
• Largest Patch (acres)	10018	20049	10490	10073	10217

Exhibit P-10

Alternative B. Compared with the existing conditions, Alternative B reduces fragmentation in the early and mid seral stages. This alternative increases early-seral stage patches by locating regeneration harvest units adjacent to existing seedling and sapling sized stands. Every effort was made to minimize further fragmentation of any seral stage block; however, to address the Douglas-fir bark beetle infestation and watershed concerns, various blocks of continuous late-seral patches were fragmented.

The effect of Alternative B on landscape level fragmentation parameters is to reduce the number of early-seral patches and increase the average patch size. These conditions would reduce isolation and associated competition between species and reduce predation, parasitism, and mutualism. In the mid-and late-seral stages, the number of patches would increase, and the average patch size and largest patch would decrease. These trends have the opposite effect as on the early-seral stage. This also tends to reduce the connective corridors between blocks.

Alternative C. Overall, Alternative C improves fragmentation more effectively than any of the alternatives, including the no-action alternative. From implementation of Alternative C, there would be fewer total patches in each seral stage, and average patch size would be larger in the alternative in the early- and late-seral stages. Total perimeter for all seral stages would be the least, and the largest patches would occur from this alternative. These conditions are conducive to reducing isolation and associated competition between species and would reduce predation, parasitism, and mutualism.

Alternative D. Differences in alternatives arise in the number of late-seral patches, where Alternative D has 204 total patches and Alternative C has 183. Because old growth habitat is a part of the late-seral stage, fewer patches suggest larger patches, which are favorable to species that depend on that seral and structure stage of succession.

Another difference between Alternatives D and C is the mean patch size in the mid-seral stage. Alternative D has an average patch size of 80 acres, while Alternative C has 72 acres. This is meaningful when considering that the mid-seral stage patches define the configuration of future late-seral and old growth ecosystems. Therefore, the larger patches available at this stage, the easier it would be to manage for large patches into the future. It also reduces the negative effects of fragmentation such as isolation, predation, parasitism, and mutualism.

Alternative E. The effect of Alternative E on fragmentation is essentially the same as Alternative B. The difference in terms of the number of patches, average patch size, total perimeter, and largest patch are indistinguishable. Therefore, all environmental consequences described in Alternative B apply to this alternative.

Alternative F. The effect of Alternative F on fragmentation is to provide the least number of early seral patches and the largest average patch size. The remaining parameters are essentially the same as Alternative B. The difference in terms of the number of patches, average patch size, total perimeter, and largest patch are indistinguishable. Therefore, all environmental consequences described in Alternative B apply to this alternative.

Pattern and Disturbance

The type, amount, and locations of disturbances that occurred naturally served as a frame of reference for the treatments involved with each of the action alternatives to manage the Logan Creek ecosystems within the range of variability and to sustain native species and ecosystem integrity. An important element of the treatments is the magnitude of change in vegetative structure and composition as reflected by historical events. To achieve the changes that approximate historical events and reduce the potential for undesirable wildland fire, each of the action alternatives includes creating patches of early-seral vegetation structure greater than 40 acres. This proposed pattern of disturbance would shift the landscape toward historical disturbance patterns. In many cases the newly created openings offer a mosaic of scattered trees and/or clumps similar to what wildland fires created historically. Proposed treatments consolidated heavily fragmented areas to manage for large blocks of mature and old forest in the future.

REGULATORY CONSISTENCY

The acreage of some of the treatments involved in each of the action alternatives is not consistent with current Forest Plan direction. Designing the alternatives to more accurately represent historical conditions, reduce fuels, and minimize fragmentation required exceeding Forest Plan (LRMP pg III-70) and Forest Service Manual 2470 for limitations on size of opening. Exceeding the 40-acre size limitation requires Regional Forester approval. This approval would be requested before the Record of Decision is issued.

For each of the action alternatives, proposed harvest activities would occur only on lands suitable for timber management. None would irreversibly damage watershed conditions. Restocking of all units where regeneration harvesting is prescribed would be assured in five years.