Forest Vegetation

Introduction

This section documents the analysis and silvicultural review of forest vegetation associated with the Hemlock Elk Project. The report describes the analysis area(s), the methodologies used, the affected environment, and the environmental consequences of implementing the alternatives to forest vegetation. Detailed information relative to forest vegetation, which is not included in this report, is located in the project file and/or individual stand files located at the Swan Lake Ranger District.

Analysis Area

The analysis area(s) for forest vegetation is varied spatially and temporally based on the forest attribute being analyzed. Scales of the analysis areas were chosen to allow sufficient size and time to illustrate the potential effects of the alternatives without those effects diminishing to unnoticeable levels. The following descriptions identify the analysis areas for this project.

Spatial Bounds

The spatial boundary for this analysis is the Hemlock Elk Project Area, also referred to as the analysis area. This 36,653 acre area is large enough to capture trends and patterns of forest vegetation, but not too large to have the potential effects of the proposed actions associated with this project so small as to be negligible.

Temporal Bounds

The temporal bounds of this analysis are designed to capture the direct, indirect, and cumulative effects of the alternatives to forest vegetation within the analysis area(s). Activities are planned to begin in 2010 or 2011 and would likely take two to three seasons to accomplish. The effects of the proposed activities would likely last between 15 and 100+ years. Where intermediate silvicultural treatments are proposed, an effects time frame of 15 to 20 years is estimated. This length of time was determined by review of site index curves and forest succession data for Western Montana (Milner, 1992 and Arno et al. 1985, respectively), which describe height growth and stand development. After this length of time, it is believed that, in the absence of stand replacing disturbance or additional treatments, natural forest succession processes would result in residual stand conditions similar to pre-treatment conditions. This is due to accumulation of surface fuels, height growth of advanced regeneration, ingrowth of shade tolerant species, expansion of residual tree crowns, and individual tree mortality. The effects of regeneration treatments would last at least as long as it takes the stands to progress through successional stages from stand initiation to a mature stand condition (estimated 100 years) (Arno et al. 1985). Some effects, such as changes in species composition and large down woody material, could last even longer. The temporal bounds of past activities for the cumulative effects analysis is limited to the 1950s by the availability of accurate data relating to forest vegetation conditions. Due to planning timeframes, the temporal extent of future actions relating to forest vegetation is defined as 5 years.

Data Sources, Methods, and Assumptions Used

This section discusses the methodologies, data sources, and assumptions used to compile this report.

Data Sources

Landscape Level Analysis: A landscape analysis was completed in February 2004 for the Upper Swan Valley. The Upper Swan Valley Landscape Assessment (Project File Exhibit Q-4) was completed by the Swan Ecosystem Center in cooperation with the USFS and provides a broad view of existing and historic vegetation conditions. The Hemlock Elk Project falls within the area this assessment analyzed. This assessment and its conclusions are incorporated here by reference.

Additional data was used at a finer scale to characterize the landscape associated with this project. Forest Inventory and Analysis (FIA) plot data was summarized and used to describe existing forest vegetation conditions. Forest Inventory and Analysis plots are installed at random locations on all land ownerships across the country. These plots are monumented and re-measured over time. This provides the ability to make estimates of forest conditions over broad areas and at variable times.

Data related to historical forest vegetation conditions was derived from a variety of publications and will be referenced later in this report.

Insect and disease aerial detection surveys are conducted annually using fixed-wing aircraft and sketch mapping technology. Data associated with these surveys was incorporated.

In the summer of 2003, the Crazy Horse Fire burned approximately 8,000 acres within the analysis area. In September 2004, the Swan Lake Ranger District completed the Crazy Horse III Fire Salvage Project EA (Project File Exhibit Q-8). This document provides data relating to forest vegetation.

Stand Level Analysis: Individual stand inventory data was used in the stand level silvicultural diagnosis process to develop alternative treatments and in the analysis of the affected environment. Stand level data has been collected over time using Forest Service stand exam protocols. Stand exam data used in this project was collected between the years 1981 and 2007. This stand data is stored in the Timber Stand Management Records System (TSMRS) and the Field Sampled Vegetation (FSVeg) databases. As indicated above, the VMAP product was used to supplement stand exam data where stand data was not available or where stand exam data no longer represented the current conditions.

In addition to the stand exam data previously mentioned, each stand within the analysis area that provided an opportunity for management actions to meet the project objectives as described by the Forest Plan had a silvicultural walk through conducted in 2007 by the District Silvicultural Staff. During these walkthroughs, observations of forest vegetation conditions and the stand level diagnosis process were documented. This information is summarized in the Silvicultural Report (Project File Exhibit G-1). Stand-level data from these sources was complied into GIS layers and analyzed spatially using the methods described above.

Methods

Silvicultural Prescription and Diagnosis Process: The silvicultural prescription and diagnosis process provides information with which to move the forest vegetation toward a desired condition and meet management objectives. This systematic process integrates interdisciplinary resources goals and objectives and identifies silviculturally sound treatments to achieve those objectives. The process can be done at both the landscape and stand level. Forest Service Handbook 2409.17 provides national and regional direction for the prescription and diagnosis process.

- **Landscape-Level Process:** The landscape-level diagnosis process normally precedes the stand level process. This helps to place stand level analysis into context with the surrounding ecological conditions. The Flathead National Forest Guide for Watershed Analysis provides direction related to this process.

- **Stand-Level Process:** As mentioned above, this process commonly follows and closely parallels the landscape-level analysis, but at a more site-specific scale. The stand level process is used to systematically achieve desired stand and ultimately desired landscape conditions.

The Silvicultural Report (Project File Exhibit G-1) contains detailed information relative to the diagnosis for each area analyzed using this process for this project.

Spatial Analysis: Spatial analysis of the forest vegetation resource for this project was done using the ArcMap 9.2 software. Data from the Flathead National Forest Geographical Information System (GIS) Library was used as the basis for the analysis. A number of project specific GIS layers were created by Ranger District Resource Specialists.

Remote Sensing: The 2006 R1 VMAP product, developed by the Forest Service Region One Geospatial Services Group, was used to estimate stand conditions where existing inventory data was lacking or determined to no longer reflect current stand conditions. VMAP classifies vegetation into spatially distinct polygons with attributes related to life form, dominance type, size class, and canopy cover. VMAP data was incorporated into a GIS layer that identified forest vegetation attributes within the project area.

Forest Growth and Yield Modeling: The Forest Vegetation Simulator (FVS) was used to model the forest stand dynamics associated with alternative silvicultural treatments. Specifically, Version 2.02 of the Suppose interface and the Inland Empire variant were used. Due to limitations in data, only a sample of the stands were modeled and results were extrapolated to stands with similar conditions and proposed treatments.

Assumptions

When completing an analysis of a dynamic resource such as forest vegetation at this sale, some assumptions are necessary from an efficiency stand point. Assumptions were also made due to variation and interpretation of terminology and standards associated with silviculture and forest vegetation conditions. The following are some assumptions used in this analysis:

- Vegetation data used in this analysis is assumd to represent current on-the ground conditions. Efforts were made to ensure that this assumption is true including: field verification, new stand exam data collection, aerial photo interpretation, and incorporation of remote sensing technology. At the time this report was written, no large scale or catastrophic events were known to have occurred since the data for this project was compiled.
- GIS data used in this analysis is assumed to be accurate to within acceptable standards. This includes ownership boundaries, stand delineations, project and analysis area boundaries, etc.
- Modeling of forest stand dynamics using the methods described above gives a reasonable estimate to how stands will respond to treatment as to be able to compare alternative treatment options. Also outputs from growth and yield modeling can be applied to “un-modeled” stands with similar conditions, existing on similar sites, and within close proximity to the modeled stands.
- Definitions of terminology related to silviculture and forest vegetation for this analysis will come from *The Dictionary of Forestry* (Helms 1998) and/or the Forest Pland and associated amendments.
- Areas identified as “old growth” in this report are those areas that meet the specifications and descriptions in *Old-Growth Forest Types of the Northern Region* (Green et al. 2007) for the Western Montana Zone.

Measurement Indicators

Four measurement indicators were identified to evaluate the effects to forest vegetation. These were chosen because they are measurable (both qualitatively and quantitatively), are affected by silvicultural activities, and related to the project purpose and need.

1. Forest Structure: This indicator will discuss the horizontal (i.e. stand density) and vertical arrangement of forest vegetative attributes. Forest structure is relevant to tree vigor, fuel arrangement, and general forest resiliency.

2. Forest Seral Stage: This indicator includes age class distribution and has implications related to management objectives and vegetative fuel continuity.

3. Forest Composition: This indicator will discuss species composition within the analysis area. This is important given management direction and observed landscape trends. Species composition affects forest health and reslilience and susceptibility to disturbance.

4. Forest Insect and Disease Conditions: This indicator will measure how the alternatives affect the extent of known insect and disease agents in the analysis area. It will also report the risk of stands within the analysis area to potential insect and disease damage (including tree damage).

Affected Environment

This section explores and discusses the historic, existing, and desired conditions of general forest vegetation within the analysis area. This information is useful in placing the proposed actions into context.

Historic Conditions

Much work has been done related to the historic forest vegetation conditions of the Swan Valley and western Montana. While this work covered broad areas, they often included portions of (and can be applied to) the analysis area. The Upper Swan Valley Landscape Assessment (Project File Exhibit Q-4) includes a detailed historical analysis that is also applicable to the analysis area. Historical forest vegetation conditions provide us with an idea of what the area looked like at various points in time. However, it is important to remember they are limited by the availability and accuracy of historical information and do not necessarily identify ideal conditions.

Historic Disturbances: Disturbance relative to forest vegetation can be defined as a relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resource availability or the physical environment (Helms 1998). Observations and recent studies (Barrett 1998 and 2002; Ayers 1898; Arno et al. 1995; Freedman and Habeck 1985) indicate that fire has been the most influential natural disturbance factor following the retreat of the most recent glacial events in the Upper Swan Valley. Fire also provides us a record of its effects to forest vegetation, through fire scars and forest conditions, making it one of the most easily analyzed historic disturbances. Many other natural and human-induced disturbance factors have influenced the forest vegetation in and around the analysis area including insects, disease, wind, floods, invasive species, residential and commercial development, transportation systems, and timber harvest. Data were available from recent studies and historical accounts to determine some of the historic disturbances related to fire and insects and diseases. Most of the anthropogenic disturbances will be discussed later in the Ownership and Management Section.

Fire: Recent studies have looked closely at the fire history and fire regimes within 15 miles of the analysis area. These studies combined with fire history data from historical accounts provide a picture of how fire has been a dynamic agent of change in the region's forest vegetation.

Fires were frequent in the Upper Swan Valley until the early 1900's, with the earliest fire evidence dating from about 1241 A.D. On average, a fire occurred about every 8 years (range of 3 to 23 years) between 1586 and 1929 in the Upper Swan Valley, with the last major fire occurring in 1929 (Barrett 2002). Barrett (1998) reported that 1768, 1814, 1850, 1889, 1919, 1929 were important fire years in the area. A GIS dataset from the Flathead National Forest GIS library spatially displays the locations of some of the major fires in those years within the analysis area (Project File Exhibit G-1).

Fires were the result of natural causes, such as lightning and traditional burning by Indians (Barrett and Arno 1982; Ayers 1898; Arno et al. 1997; Barrett 2002 and 1998). Most Indian fires occurred in the valley grasslands and lower-elevation forests dominated by ponderosa pine, Douglas-fir, and western larch. These fires were likely ignited to improve big game browse, berry production, food gathering and hunting, improved travel, communication and horse grazing (Barrett 1981).

Areas of similar fire severity, frequency, size, and pattern have a similar fire regime (Brown 2000; Long 1998). The Upper Swan Landscape Assessment (Project File Exhibit Q-4) defines three identified regimes in the area:

1. Frequent, low intensity non-lethal severity fire regime with 1 to 25 year intervals.
2. Less frequent and more severe mixed severity fire regime with 25 to 75 year intervals resulting in scattered mortality.
3. Infrequent stand replacing lethal severity fire regime with intervals greater than 75 years.

Most fires burned with low to moderate severity with the occasional severe fire creating a diverse mosaic across the landscape of mature stands that burned repeatedly interspersed with younger fire regenerated age classes. During the pre-settlement era, valley bottom forests were dominated by mixed-severity fire regimes, low-severity fires were restricted to the driest terrain, and high severity fires were largely found on steep slopes at higher elevations and moist canyon bottoms (Barrett 2002). Barrett (1998) looked closely at the areas unique riparian "pothole" stands from a fire history stand point. He found that even in these areas frequent non-lethal and mixed-severity fires burned within a few feet of the shoreline at intervals similar to adjacent drier sites.

In the summer of 2003, the Crazy Horse Fire burned approximately 11,000 acres with approximately 8,000 acres occurring within the analysis area. The Holland Peak Fire burned roughly 1,600 acres on the east side of the Swan Valley, 9 miles from the Hemlock Elk Project Area in the summer of 2005. These fires are the largest and most recent fires in the Upper Swan Valley. Both fires burned mosaiclly with variable intensities.

Insects and Diseases: Numerous forest insects and diseases exist within the analysis area and larger Swan Valley at endemic levels. They have been interacting with and shaping the forest vegetation in the analysis area for some time. Those currently present and affecting forest vegetation will be discussed in the Existing Conditions Section of this report.

Historical accounts indicate that epidemic insect outbreaks have occurred in the area in the past. The most well-documented epidemic was an outbreak of spruce bark beetles in the Swan Valley following a large scale wind event in 1949 (Project File Exhibit Q-4).

It should be noted that two major diseases currently affecting forest trees are non-native and were not historically present within the analysis area. Larch casebearer was introduced from Europe and arrived in the Swan Valley in 1968. This defoliator's population peaked in the 1970s and is declining. White pine blister rust was introduced in 1910 and has since had a dramatic effect on the forest composition within the Swan Valley. Western white pine in the mid-lower elevations and whitebark pine in the upper elevations have been significantly affected by this disease.

Other Disturbances: Undoubtedly, other natural disturbances have occurred throughout history in the area. Most are not well documented except for the major wind event in 1949 mentioned above.

Historic Forest Vegetation Conditions

The forest vegetation conditions within the Swan Valley have been documented at various times throughout history starting at about the turn of the 20th century. These accounts have been at varying intensities and for diverse purposes. Most accounts were to inventory the area's timber resources. More recent efforts were conducted to explore the ecology and reconstruct the historical conditions associated with the area's forests.

Composition and Structure: H. B. Ayers recorded observations of the Swan Valley in 1899 during his mission to survey the timber of the then Lewis and Clark Forest Reserve. His journals describe large expanses of the Swan Valley dominated by large ponderosa pine, Douglas-fir, and western larch grown in an open canopy on the valley, benches, and foothills, and denser stands of shade tolerant species on the stream bottoms and high elevations.

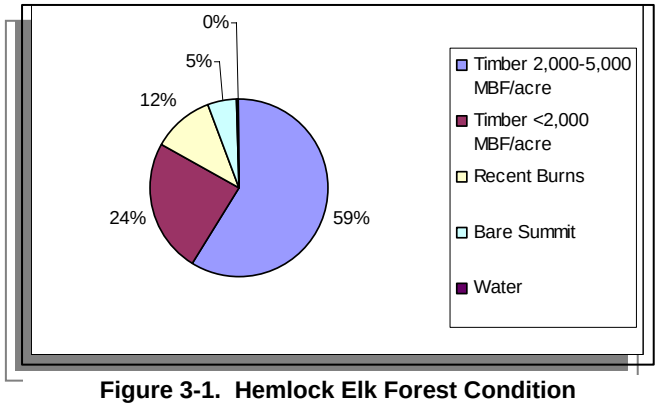
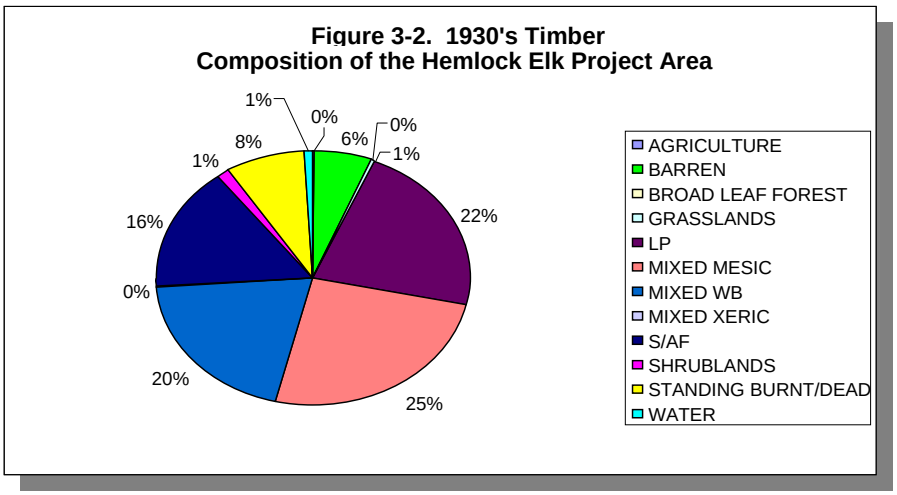


Figure 3-1. Hemlock Elk Forest Condition (Ayers 1898)

"The lands of the upper valley, where the rather scant covering of larch and lodgepole pine at first gives the impression of very poor soil, but upon close examination it is found that the sparseness of tree growth is largely do to frequently occurring fires which have thinned the forest." (Ayers 1898)

Figure 3-1 illustrates the forest conditions Ayers reported within the analysis area in 1898.



During the 1930s, a broad scale timber inventory was conducted, which identified cover, stocking, and estimated age. These data were collected over a large area and the resolution is not as fine as today's inventories. However, these data were confirmed to be reasonable and

valuable by Hart in 1989 and 1994. This inventory was digitized into a GIS shapefile which is available in the Flathead National Forest GIS Library. Figure 4 displays a summarization of what the composition of the analysis area was as a result of the 1930s Timber Inventory.

In 1998, the EIS for Forest Plan Amendment 21 analyzed the historical distribution of seral stages by forested terrestrial community for the Swan Sub-basin (USDA 1998). In addition to the timber inventories mentioned above, this analysis used data from aerial photo interpretations, computer modeling, fire history studies, and pollen and charcoal records. Again, this analysis was broad and looked at the entire Swan River Watershed. However, it can provide us with some insight into the historic distribution of terrestrial communities and the distribution of seral stages within the Hemlock Elk Analysis Area. The Amendment 21 analysis reported a historic range and 75 percent median of that range for each of three (early, mid, and late) seral stages in each of three terrestrial community groups (subalpine, montane, and lower montane) within the Swan Sub-basin. Table 3-9 displays the results of that analysis and is presented to provide a possible range of historic conditions (Project File Exhibit Q-13).

TABLE 3-9.
HISTORIC SERAL STAGES WITHIN THE SWAN SUB-BASIN

Seral Stage	Terrestrial Community Groups		
	Subalpine	Montane	Lower Montane
	Approximate Historic Range	Approximate Historic Range	Approximate Historic Range
Late Seral	8 - 10%	20 - 22%	2 -6%
Mid Seral	7 - 10%	31 - 37%	2-5%
Early Seral	2 - 3%	7 - 18%	0-1%

In addition to the results in Table 3-9 the EIS for Amendment 21 reported that the area historically had a relatively large representation of the lower montane group and a small representation of non-forest area. At the time of the analysis, the lower montane group had been substantially decreased. This is likely due to timber harvest (targeting of fire resistant species) and fire suppression allowing fire-intolerant species typical of the montane group to invade. One possible explanation for the increase in non-forested area is agricultural and residential development.

Again, it is important to note that the Amendment 21 analysis of a historical range of seral stages was done for the entire Swan Sub-basin. Given that the Hemlock Elk Analysis Area is a subset of that sub-basin and given the disturbance regime within the Hemlock Elk Analysis Area, the actual distribution of seral stages could be drastically different from the Amendment 21 analysis results at any given point in time.

Ownership and Management: The Swan Valley has diverse and interesting land ownership patterns. Though some similarities exist, most of the various owners have managed their lands with different objectives.

Most of the private lands were derived from the 1862 Homestead Act. Settlement of the area was relatively slow due to primitive and difficult access. Filing of homestead claims was most active between 1916 and 1920; and by 1919, 70 homesteads had been established in the Swan Valley (Project File Exhibit Q-4). Private non-industrial lands are residences, pastures, or small wood lots that are primarily located in close proximity to the Swan River and Montana State Highway 83.

In 1864, Congress granted lands to the Northern Pacific Railway Company as an incentive for building a transcontinental railroad. Sections of land in the Swan Valley were granted in lieu of sections already withdrawn along the planned railroad route. This action and later land exchanges resulted in the checkerboard ownership pattern that characterizes the Swan Valley (Project File Exhibit Q-4). These granted lands are now managed by PCTC, which owns approximately 64 percent

of the private land in the Swan Valley (Savage 2008). Forest management on PCTC lands has focused on productive, profitable, and sustainable forestry, which has evolved with the science of forestry over time. Harvest levels on PCTC lands have fluctuated over the years. The Past Harvest Section discusses activity on both PCTC and NFS lands.

Federal land in the Swan Valley was originally part of the Lewis and Clark Forest Reserve. In 1907, the Reserve was divided into the Flathead National Forest and Lewis and Clark National Forest. Surveys of the area were completed in the early 1900's. Early forest management consisted of small timber sales purchased primarily for fuel wood, house logs, and other homestead improvements.

Fire suppression started in the early 1930s and was effective. Current increased tree densities, changed forest composition, and longer fire intervals are evidence of the effectiveness of fire suppression (Barrett 1998).

Timber harvest on NFS lands in the Swan Valley has changed throughout time based on policy, objectives, and social values. In general, harvest activity peaked between the 1960s and 1980s (see Past Harvest Activity below). Following World War II, there was improved access and increased demand for timber to fuel an expanding nation. Regeneration cutting was the preferred silvicultural system of the era.

The NFMA looked closely at forest management practices across the country and set new policy direction. This direction led to smaller areas of regeneration harvest, increased artificial planting, and increased intermediate harvest treatments. By the 1990s, salvage logging of wind damaged and insect-or disease-related mortality was the dominant or only harvest activity on NFS lands.

A summarization of past harvest activities across all ownerships within the analysis area will be discussed in the Existing Conditions Section of this report. This is because existing forest conditions are influenced by past activities.

Existing Conditions

Using the methods described earlier, the existing condition of the forest vegetation within the analysis area was investigated at all scales from the landscape to individual trees. This section will discuss the existing site conditions, disturbance agents, and various attributes of the forest vegetation.

Site Conditions: A site can be defined as the environment where a tree or forest stand grows (Helms 1998). As far as tree growth is concerned, the site is controlled by the total physiologically available supply of solar energy, water, carbon dioxide, and various chemical nutrients (Smith et al. 1997). Individual sites are comprised of unique combinations of the physical environment including; landform (elevation, aspect, topography), climate, and geology. Generalizations of sites can be made to characterize the landscape. The following discussion describes some of the general site conditions found in the analysis area.

Landform: The elevation, topography, and aspects within the analysis area are widely varied. Elevation ranges from approximately 3,800 feet in the river bottom up to 8,600 feet in the Mission Mountains. The lower elevations are typified by undulating topography with small southwest-northeast ridges with slopes generally less than 25 percent. Higher on the slopes of the Mission Mountains, slopes generally range from 10 to 45 percent with some sheer cliffs. All directional aspects and slope shapes (concave and convex) are present (Project File Exhibit Q-4). In general, the highest elevations are steep east-facing slopes that transition into a broad expanse of relatively flat terrain dissected by numerous stream channels and small ridges.

Climate: The analysis area is at the eastern extent of the Pacific maritime climatic influence. Mean winter temperatures range from 15 to 25° F and summer temperatures average in the 80s with extreme temperatures reaching 100+° F. Higher elevations average 10 to 20 degrees cooler. Precipitation in the form of rain varies between an average of 30 inches on the valley floor and

over 100 inches at the highest elevations. The bulk of the precipitation usually comes from October to mid February and again from mid May to early July (Project File Exhibit Q-4).

Geology: Over time, the geology of the analysis area has been shaped by faulting and uplift followed by numerous glacial events. Geological processes have resulted in depositional, erosional, and breakland landforms. Soils are generally acidic and include fine silts, organic soils, lakebed deposits, and glacial tills derived from mostly shale and quartzite. Valley bottom soils are most productive, partially due to a 6- to 12-inch layer of ash deposited from the eruption of Mount Mazama (Project File Exhibit Q-4). The Soils Report for the Hemlock Elk Project EA contains detailed information related to soils.

The Flathead National Forest GIS Library contains a land type coverage that spatially defines areas based on soils, geology, slope, and potential vegetation. The Forest Plan has grouped the individual land types into 16 broad Land Type Groups.

Site Classifications: From a silvicultural perspective, it is useful to classify sites. Classification can provide information about a particular site related to susceptibility and vulnerability of trees to damaging agents, problems with competing vegetation, and responses to various silvicultural treatments (Smith et al. 1997). In forestry, sites are typically classified qualitatively by environment or vegetation or qualitatively by their potential for tree growth.

On the Flathead National Forest, the most common way of classifying sites is by habitat type. All land areas potentially capable of producing similar plant communities at climax may be described as the same habitat type. By focusing on climax plant communities, habitat types account for successional change overtime and, thus, provide a permanent and ecologically-based system of land stratification (Pfister et al. 1977). Pfister's *Forest Habitat Types of Montana* is the document used to systematically classify sites into habitat types, which are named for the climax vegetation community (dominant tree species followed by dominant undergrowth species, e.g., *Abies lasiocarpa/Clintonia uniflora*).

Appendix I of Amendment 21 has grouped similar habitat types into coarser potential vegetation groups. Table 3-10 provides a generalized description of the habitat types used to define the potential vegetation groups. Amendment 21, Appendix I (Project File Exhibit Q-13), includes the detailed list of habitat types by potential vegetation group. The Silvicultural Report (Project File Exhibit G-1) also contains detailed information related to individual stands associated with this project, including information related to habitat type.

TABLE 3-10.
HABITAT TYPES USED TO DEFINE POTENTIAL VEGETATION GROUPS

Amendment 21 Potential Vegetation Groups	General Description of Habitat Types
Warm Dry	Ponderosa Pine and Douglas-fir/grass types
	Most Douglas-fir types and dry grand fir types
	Douglas-fir/twinflower and most grand fir types
Warm Moist	Grand fir/queencup beadlily types
	Western redcedar and western hemlock/queencup beadlily types
Cool Moist	Subalpine fir/queencup beadlily and menziesia types
Cold Moist	Subalpine fir/beargrass and dwarf huckleberry types
Riparian	Western redcedar/devil's club types
	Subalpine fir/bluejoint types
Cold	Subalpine fie/ grouse whortleberry and woodrush types
	Whitebark pine and alpine larch types

Existing Forest Vegetation Conditions

As previously mentioned analysis of forest vegetation can be done at the landscape and stand level. Here we will discuss various aspects of the existing condition of forest vegetation within the analysis area at multiple scales.

Landscape: The Upper Swan Valley Landscape Assessment (Project File Exhibit Q-4) describes the general forest conditions at a landscape scale by grouping the analysis area into what was termed "Ecosystems." The assessment identified five "Ecosystems" in the Upper Swan Valley. Three of those forested "Ecosystems" are represented in the Hemlock Elk Project Area. The following summary descriptions of those "Ecosystems" was incorporated from the Cooney McKay Project Silvicultural Report (Higgins 2007) and will be described as they would be encountered traveling from east to west or upslope.

The warm-moist valley bottoms include the undulating flat lands of the valley floor with its many wetlands. This warm moist habitat is mostly forested with a large diversity of conifer and deciduous tree species. Openings in the forest are numerous, largely due to human settlement. These areas contain a mix of western larch, western white pine, lodgepole pine, Douglas-fir, ponderosa pine, Engelmann spruce, grand fir, and subalpine fir on the more well-drained sites. The neighboring riparian zones are bordered with cottonwood, birch, and aspen. Disturbances in this area included primarily low- and mixed-severity fire, and occasionally high-severity fire. High-intensity winds have also occurred at intervals and caused extensive blowdown.

The cool-moist midslopes include a transition between the warm-moist valley bottoms to the east and the cold-steep forested uplands to the west. Tree species in this area include Douglas-fir, lodgepole pine, western larch, western white pine, Engelmann spruce, grand fir, western red cedar, and subalpine fir. Disturbances in this area included a combination of low-, mixed-, and high-severity fires. High-severity winds causing blowdown have also occurred in the area causing increased insect problems.

The cold-steep uplands form a narrow band between the barren rocky ridges and peaks on the Mission Mountains and the more heavily forested areas on the lower slopes. Vegetation is scattered and clumped across the landscape. Trees and shrubs develop in areas where there is soil. Tree species include whitebark pine, Engelmann spruce, lodgepole pine, mountain hemlock, and subalpine fir. Disturbances in this area include a combination of mixed- and high-severity fires. Fires tended to be less frequent, usually occurred during dry periods, and were the result of lower elevation fires carrying into the higher elevations.

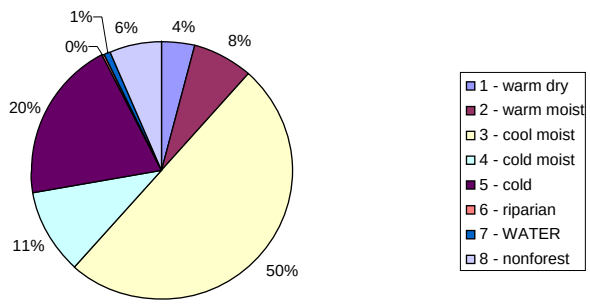
As referenced earlier, the EIS for Amendment 21 analyzed historical and current distribution of seral stages by forested terrestrial community for the Swan Sub-basin. Again, this analysis was done at a broad scale, but can provide us with some idea of the forested conditions in 1998. This also allows us to compare historical and 1998 conditions for the Swan Sub-basin. Table 3-11 displays the 1998 distribution of seral stages by terrestrial community group.

TABLE 3-11.
1998 DISTRIBUTION OF SERAL STAGES FOR THE SWAN SUB-BASIN

Seral Stage	Terrestrial Community Groups within Swan Sub-basin		
	Subalpine	Montane	Lower Montane
	Approximate 1998 Percent	Approximate 1998 Percent	Approximate 1998 Percent
Late Seral	2	10	1
Mid Seral	11	52	1
Early Seral	2	11	1

Stand: Analysis of stand-level existing forest vegetation conditions was accomplished by assessing individual stand conditions using the methods described earlier, and then compiling these data and summarizing them for the analysis area. Appendix A of the Silvicultural Report (Project File Exhibit G-1) has detailed information for individual stands used in this analysis. The stand-level analysis and diagnosis process that was discussed in the Methods Section primarily occurred on lands identified in the Forest Plan as suitable for timber harvest. Areas outside this land base (such as wilderness) have limited stand-level information. Information related to these areas was obtained using a combination of existing inventories, aerial photo interpretation, and incorporation of the R1 VMAP product.

Figure 3-3
Distribution of Potential Vegetation Groups within the Hemlock Elk Analysis Area



Summary information related to composition, seral stage distribution, and forest structure follows.

Composition: Composition refers to the proportion of various species within a stand or area. A variety of species exists within the Hemlock Elk Analysis Area. The spatial distribution and proportions of each species is directly related to site condition and inter-species competition. As previously mentioned, habitat types are commonly used to classify sites and also provide an indication of the potential and existing vegetation, both overstory and understory (Project File Exhibit G-1, Figure 6). Figure 3-3 displays the distribution of those groups as a percent of the analysis area.

Cover types are used to express the dominant species within an area based on plurality (also commonly referred to as forest type or existing vegetation). That is, the specie or species most abundant for a given area. Cover type information was summarized for the analysis area and illustrates species composition. Again, the current composition of the analysis area is the result of past disturbances, site conditions, and the competitive advantages of individual species. Project File Exhibit G-1, Appendix B, contains rule sets that were developed to consistently apply data to determine cover types. As Appendix B states, the non-forested area could include recently burned or regenerated areas if the canopy cover of tree species is less than 10 percent. Table 3-12 summarizes this information.

TABLE 3-12.
CURRENT COVER TYPE OF THE HEMLOCK ELK PROJECT AREA

Cover Type	Acres	Percent Analysis Area
Non Forested	7,403	20
Hardwood	95	0
Lodgepole	11,334	31
Douglas-fir	2,962	8
Western larch	3,089	8
Spruce/subalpine fir/mountain hemlock	11,264	31
Grand fir/western hemlock/western redcedar	506	1
Total	**36,653**	**100**

Seral Stage Distribution: Often forests are seen through our eyes as static entities. An example is a stand of trees we have visited many times but continues to appear unaltered. This concept could not be further from the truth. Change is constant in forest communities. Change occurs at all scales from a seedling sprouting to a wildfire consuming tens of thousands of acres of trees. This change is multi-dimensional and occurs at various time scales. Often the timescale of change within a forest is comparatively long, as some trees within the analysis area have existed at the same location and similar form for hundreds of years. At a stand and landscape level, this change is often associated with many of the disturbance factors previously discussed. These disturbances often result in the establishment of a new age class or cohort.

A change in species dominance following disturbances is referred to as succession. Ecologists have recognized a number of successional patterns within forest communities based on site characteristics and the competitiveness of species (Oliver and Larson 1996). A seral stage is a temporal and intermediate stage in the process of succession (Helms 1998). Forest Plan Amendment 21 (Project File Exhibit Q-13) identified three seral stages. These three seral stages were defined by tree size. Tree size is a more commonly and easily measured attribute than tree age. It is believed, as in Amendment 21, that there is a correlation between tree size, successional development, and tree ages. Although this correlation does not fit well under certain circumstances, it is generally accepted given the disturbance regimes and patterns of forest communities in the Northern Rockies.

Three seral stages were identified in this analysis to illustrate distribution of succesional development and hence tree size and age. These seral stages are not associated with species composition. Appendix B of the Silvicultural Report (Project File Exhibit G-1) contains a rule set that was developed to consistently classify data into seral stages. The three seral stages used here are similar to Amendment 21 in name and how they relate to tree sizes, but differ in their classification. Of note is the fact that Amendment 21 uses the term “late seral” to describe old growth. However, here old growth is defined by meeting the criteria of Green et al. (2005) as mentioned previously. Therefore, late seral in this analysis would likely contain old growth areas, but it also contains those areas meeting the size descriptions given in the Silvicultural Report, Appendix B, but do not meet Green et al. (2005) old growth definitions. A more detailed discussion of old growth follows.

Tables 3-13 and 3-14 display the seral stage distribution by forested cover type within the analysis area.

TABLE 3-13.
CURRENT DISTRIBUTION OF SERAL STAGES WITHIN THE ANALYSIS AREA (ALL OWNERSHIPS)

Seral Stage	Description	Acres	Percent of Forested Area
Early Seral	Dominant Trees <5 inches DBH	2,378	8
Mid Seral	Dominant Trees 5-15 inches DBH	16,137	55
Late Seral	Dominant Trees >15 inches DBH	10,735	37

TABLE 3-14.
FORESTED COVER TYPE WITHIN THE HEMLOCK ELK ANALYSIS AREA (ALL OWNERSHIPS)

Cover Type	Early Seral Acres	Mid Seral Acres	Late Seral Acres	Total Acres	Percent of Forested Area
Hardwood	74	8	13	95	<1
Lodgepole	524	7,996	2,813	11,333	39
Douglas-fir	499	1,326	1,136	2,961	10
Western larch	361	1,466	1,262	3,089	11
Spruce/subalpine fir/mountain hemlock	767	5,114	5,386	11,267	39
Grand fir/western hemlock/western redcedar	151	230	124	505	1
Total	**2,376**	**16,140**	**10,734**	**29,250**	**100**

As Table 3-14 illustrates, the majority of early-seral areas are dominated by the spruce/subalpine fir/mountain hemlock cover type, the majority of mid-seral areas are dominated by the lodgepole cover type, and the majority of the late-seral areas are dominated again by the spruce/subalpine fir/mountain hemlock.

Old Growth: As mentioned earlier, old growth in this report is defined by Green et al. (2005) for the Western Montana Zone. The Silvicultural Report, Appendix C (Project File Exhibit H-1), includes the minimum and associate characteristics used to make old growth determinations. Stand inventories and subsequent review by the District Silviculturist and Wildlife Biologist were conducted to confirm that no actions associated with this project are proposed within stands that meet the Green et al. (2005) definition of old growth. The Wildlife Section of this EA discusses the amount, location, and spatial distribution of old growth habitat within the project area.

Statistical estimates of the amount of old growth can be confidently made at large scales. Forest Inventory and Analysis (FIA) data have been used to produce statistical estimates of old growth for the entire Flathead National Forest and each fifth code watershed unit. The estimate of old growth for the forest is 11.63 percent with a 90 percent confidence interval of 9.56 to 13.77 percent. These results, the process, and its appropriate application documented by Czaplewski 2004 are available on the USDA Forest Service Inventory and Analysis website at http://fsweb.r1.fs.fed.us/forest/inv/index.htm.

Forest Structure: Forest structure describes the vertical and horizontal distribution of components of a forest. Vertical structure describes the arrangement of trees and their crowns from the forest floor to the top of the forest canopy. This attribute can be classified as either single storied (tree crowns consisting of one main canopy layer), two storied (tree crowns forming two distinct canopy layers), or muilti storied or continuous (where tree canopies occupy three or more distinct canopy layers). Horizontal structure is often referred to in terms of density. In forestry, density can be measured in many ways, but is most commonly expressed in terms of basal area, trees per acre, or canopy cover.

Numerous combinations of forest structure exist within the analysis area and vary based on species composition, seral stage, and past disturbance. In terms of vertical structure, the following conditions exist. Most of the areas dominated by the lodgepole cover type and the early seral stages for all cover types are single storied. This is primarily due to stand dynamics in the early-seral stages, and the result of stand-replacing disturbances in the lodgepole cover type. Some of the more xeric (dry) areas dominated by the western larch and/or Douglas-fir

cover types also exhibit single storied canopies. Two-storied vertical structure exists in areas where remnant overstory trees exist above a smaller cohort. These cases are most commonly the result of mixed-severity fire regimes or past seed tree and/or shelterwood harvests. Some areas exhibit this structure due to historic non-lethal fire regimes that favored single-storied stands creating a single-dominant overstory, but where recent fire suppression has allowed a second canopy layer to develop in the absence of fire. Multi-storied stand structures exist in many of the mesic areas and high elevation areas dominated by shade-tolerant species. This structure appears to be increasing across the Swan Valley landscape due to the absence of fire and proliferation of shade tolerant understories (Barrett 2002 and 1998; Freedman and Habeck 1985; Arno et al. 1997).

Horizontal structure is also variable across the analysis area. Many of the early seral areas have extremely high tree densities over 1,000 trees per acre. Density is also high in many mid- and late-seral areas, also as a result of the absence of fire and subsequent shade tolerant ingrowth. One measure of density is canopy cover, which is proportion of the forest floor covered by the vertical projection of tree crowns (Berglund et al. 2008). This attribute of forest vegetation is readily measured using remote sensing technology. A summary of canopy cover for tree dominated areas (areas where tree canopies are greater than 10 percent of the area) within the analysis area using R1 VMAP data is displayed in the Silvicultural Report (Project File Exhibit G-1).

Existing Disturbance

Most, if not all, of the historical disturbance agents that affected the forest vegetation within the analysis area are still present today. The extent and effects of each of these agents varies through time. The following provides a snap shot in time of the existing disturbance agents observed within the analysis area. Again, Appendix A of the Hemlock Elk Project Silvicultural Report (Project File Exhibit G-1) contains information related to disturbance agents observed within individual stands.

Fire: The occurrence of fires within the analysis area is well documented. District Fire Management Staff log all confirmed fire starts on the District. They also keep records related to prescribed fire operations. See the Fire and Fuels Section of the Hemlock Elk Project EA for detailed information related to fires in the project area.

Of significance to the existing condition of forest vegetation was the 2003 Crazy Horse Fire. This fire burned approximately 8,000 acres within the analysis area, and its effects to vegetation are still ongoing. The Crazy Horse III Fire Salvage EA (Project File Exhibit Q-8) reported that the fire burned at three broad categories of fire severity. Sixty percent of the area burned under high fire severity (>80 percent immediate overstory tree mortality), 30 percent of the area burned with moderate severity (20 to 80 percent average - 50 percent immediate overstory tree mortality), and 8 percent burned as low-severity fire (<20 percent immediate tree mortality). In general, those trees that did survive are primarily thick barked, fire resistant western larch, ponderosa pine, and/or Douglas-fir (Project File Exhibit Q-8). In general, this fire created a mosaic of variable stocking, age classes, and species.

Reforestation surveys of areas experiencing high severity fire and/or identified as having reforestation needs (whether salvage logged or not) were conducted in 2006 and 2007. In the vast majority of these areas, reforestation surveys indicate that adequate natural regeneration of western larch, lodgepole, and lesser Douglas-fir and Engelmann spruce is established. In those areas where surveys indicate less than ideal regeneration at present, additional surveys or artificial reforestation are planned.

Insects and Diseases: Forest insects and diseases are major disturbance processes in the forests of the northern Rocky Mountains. Their effects can range from small-scale disturbances killing individual trees; to wide spread outbreaks causing extensive tree mortality. Native forest pests have been part of our forests for millennia and function as nutrient recyclers, agents of

disturbance, members of food chains, and regulators of productivity, diversity, and density (Black 2005). Aerial detection surveys, stand inventories, and silvicultural walk throughs have identified which species are currently present and affecting the forest vegetation. The following section identifies the species present and discusses some of the characteristics associated with them.

The most recent aerial detection survey was conducted by USDA Forest Health and Protection Staff and was completed in 2007. Project File Exhibit G-1, Figure 9, shows the digitized results of this survey within the analysis area. Aerial detection surveys are most useful in detecting insect and disease damage that can be easily identified from the air, such as mortality and defoliation. It is important to note that not all insect and disease agents have mortality signals that can be detected (FHMP 2005). Table 3-15 displays the major insect agents observed during this survey within the analysis area.

TABLE 3-15.
2007 AERIAL DETECTION SURVEY RESULTS - HEMLOCK ELK ANALYSIS AREA

Species	Acres Mapped	Number of Trees Affected	Occurrences
Mountain pine beetle	1184	1004	19
Western balsam bark beetle	105	19	5
Douglas-fir beetle	4	20	2

Review of the stand inventories and stand level diagnosis revealed a number of insect and disease agents present within the analysis area. The following paragraphs identify the major insects and diseases observed and provide a short discussion of their natural history. Miscellaneous insects and diseases observed, which are having a minimal effect on existing forest vegetation, are also mentioned. Here again, the Silvicultral Report, Appendix A (Project File Exhibit G-1) contains site-specific information related to these pests.

Mountain Pine Beetle: Mountain pine beetle (*Dendroctomus ponderosae*) is an aggressive bark beetle that feeds in the inner bark of host trees, often girdling and killing the tree. Hosts include most pine species with lodgepole pine, western white pine, and ponderosa pine being of concern within the analysis area. Infested trees fade within 1 year from yellow-green to red-brown. Large scale outbreaks are common, especially in lodgepole pine, when conditions are optimal and the beetles' food supply is abundant.

Amman and others (1977) developed a hazard rating system for lodgepole pine stands focusing on three stand characteristics. Stands with an average age greater than 80 years, which have an average DBH greater than 8 inches, and exist within suitable climate for beetle brood development (<6,000 feet based on latitude) can be considered highly susceptible.

Currently, Forest Service Entomologists use a more detailed hazard rating system developed by Shore and Safranyik (1992) which incorporates nearby beetle population data (Gibson 2004).

Mountain pine beetle was observed in numerous stands within the analysis area. Affects were primarily individual or small patches of lodgepole pine mortality. Most attacks appeared to be a few years old, but active populations were also noted. These occurrences, coupled with the aerial survey detection of mountain pine beetle in and around the analysis area, suggest that given optimal conditions, mountain pine beetle populations have the potential to increase. The stand conditions identified earlier as high hazard occur in a few areas and are not currently wide spread within the analysis area. This is primarily due to age and average tree DBH. Most of the associated elements contributing to high hazard (density, percent lodgepole pine, and adequate environmental conditions) are present. It is

logical to conclude that as stands age and grow larger in diameter over time, susceptibility to mountain pine beetle infestations will increase.

White Pine Blister Rust: White pine blister rust (*Cronartium ribicola)* is an introduced pathogen that affects five–needled pines. Since its introduction in 1910, it has spread throughout most of the range of its North American pine hosts. The fungus causes branch and stem cankers that eventually lead to top kill or death of most infected trees (Hagle et al. 2003). Resistance to blister rust occurs naturally in some white pine. Silvicultural walk throughs revealed that most if not all western white pine larger than sapling size were infected with blister rust. Effects ranged from mortality to dead branches.

Larch Dwarf Mistletoe: Larch dwarf mistletoe (*Arceuthobium laricis*) is a small parasitic plant whose principle host species is western larch. Lodgepole pine, mountain hemlock, and other conifer species are secondary or rare hosts. Dwarf mistletoes are obligate parasites depending on their host to survive, and are the most widely dispersed pathogen in the western United States. Effects include, witches brooms, top kill, reduced height and diameter growth, and occasionally mortality. Mistletoe inflicted mortality usually does not occur until trees are mature and begin to decrease in vigor. Spread and intensification is usually slow (FHP and SFO 2004). Hawksworth (1977) developed a 6-class dwarf mistletoe rating (DMR) system to quantify mistletoe infestations.

Larch dwarf mistletoe within the analysis area was identified in numerous stands (Project File Exhibit G-1). Although not evaluated for each tree or stand, observations indicate Hawksworth ratings ranged from 1 to 6. Some mortality was observed in overmature western larch trees. Infestation of advanced western larch regeneration growing under infested overstory western larch trees was also observed.

Root Disease: Root diseases are the most damaging group of tree diseases. In Montana, they are most common in Douglas-fir, grand fir, and subalpine fir. Once established, they become a disease of the site and can continue for decades in roots, stumps, and killed trees. Damage can range from diffuse mortality to large and/or small root disease “pockets.” Tree species vary in their resistance to root diseases (Hagel 2004).

Root disease was observed within the analysis area. Honey mushroom (*Armillaria ostoyae*) is likely the most common species present. Douglas-fir and true firs are the most susceptible to this species with larch and then pines being least susceptible. Mortality within the project area included both mature and immature trees and was confined to small pockets and individual trees.

Miscellaneous Insects and Diseases: A number of additional forest insects and diseases were identified in the analysis area. They are listed here as miscellaneous because either they were observed very infrequently or their effects to forest vegetation were insignificant. Undoubtedly, the following additional forest insects and disease occur in the project area.

- Spruce beetle (*Dendroctinus rufipennis*)
- Indian paint fungus (*Echinodontium tinctorium*)
- Western gull rust (*Endocronartium harknessii*)
- Lodgepole pine dwarf mistletoe (*Arceuthobium americanum)*
- Douglas-fir dwarf mistletoe (*Arceuthobium douglasii)*
- Pini (*Phellinus pini*)

Region One Forest Health and Protection Staff has developed a system to assess hazard ratings for important forest insects using the FVS growth and yield model. These systems evaluate stand conditions and assign hazard ratings at various points in time (Pederson

2006). This system was applied to some areas proposed for treatment where adequate input data exists. The results will be discussed in the Environmental Consequences Section of this report.

Wind: Although the effects of wind to forest vegetation are constant, no evidence of recent large scale wind events was observed. Due to observations of individual tree and small patches of blowdown, it is obvious that wind has been a disturbance factor within the analysis area. Stand inventories and silvicultural walk throughs identified two areas recently affected by blowdown to a level that warrants noting. Proposed treatment Unit 2 experienced a blowdown of lodgepole pine during the winter 2006/2007. Additionally, in Unit 27, it appears that the majority of the lodgepole pine in this stand suffered wind damage following regeneration harvest on adjacent PCTC lands. This harvest created an abrupt straight edge, and Unit 27 is positioned along the leeward boundary in a corner that likely funneled wind.

Forest Management: National Forest System and PCTC lands total 32,904 acres within the analysis area (26,915 and 5,989, respectively). The Forest Service keeps records of past timber harvest activity, going back to around the 1950s. Plum Creek past harvests were determined through analyzing recent satellite imagery and past harvest GIS layers (on file at the Flathead National Forest). Table 3-16 displays the timber harvest activity by decade for these landowners. In addition to the past timber harvest activities, a variety of forest management practices have affected the existing vegetation within the analysis area. These activities include, artificial regeneration (planting), timber stand improvement (pre-commercial thinning, etc.), site preparation, and fuels treatments (prescribed burning, slashing, piling, etc). Records of these activities are only available for NFS lands and are reported in Table 3-16.

TABLE 3- 16.
PAST FOREST MANAGEMENT ACTIVITIES

Regeneration Harvest	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**Grand Total**
Forest Service Acres	171	966	187	462	0	203	1989
Plum Creek Acres	0	0	1272	1848	2037	1184	6341
Total Acres Treated	**171**	**966**	**1459**	**2310**	**2037**	**1387**	**8330**
Intermediate Harvest							
Forest Service Acres	0	93	94	295	0	257	739
Plum Creek Acres	0	0	0	0	0	0	0
Total Acres Treated	**0**	**93**	**94**	**295**	**0**	**257**	**739**
Timber Stand Improvement Treatments (Pre-commercial Thinning and Individual Tree Release)							
Forest Service Acres	0	115	258	412	252	0	1037
Reforestation							
Forest Service Acres of Restoration	20	283	258	237	153	38	989
Site Preparation							
Forest Service Acres of Site Preparation	0	512	308	923	50	0	1793
Fuels Treatments							
Forest Service Acres of Fuels Treatments	0	749	305	973	193	321	2541
Total Acres Treated	**20**	**1659**	**1129**	**2545**	**648**	**359**	**6360**
Grand Total (All Activities and Ownership	**191**	**2718**	**2682**	**5150**	**2685**	**2003**	**15,429**

Areas that were regenerated in the 1950s and 1970s are typically fully-stocked poletimber stands ranging from approximately 300 to 1900 trees per acre and averaging between 20 and 70 feet tall. Regeneration harvest that took place in the 1980s and 1990s have resulted in

areas of primarily sapling-sized trees with average heights of 10 to 20 feet and again range in density from approximately 300 to 2000 trees per acre. Regeneration harvests that occurred since 2000 are comprised of seedlings generally less than 5 feet tall. Intermediate harvest treatments retain the existing stand in a modified condition. These harvested areas typically have lower densities, with more growing space available for residual trees.

Ownership and Development: Development of forested land has been ongoing in the Swan Valley since roughly the turn of the century. Although still a rural area, an increasing amount of land is being developed primarily for residential purposes. Often this development results in areas converted into a non-forested condition. This is typically done for house lots, transportation systems, out buildings, and pastures. In 2002, it was estimated that 900 people lived in the Upper Swan Valley (Project File Exhibit Q-4). In 2000, PCTC announced that it was going to divest 20,000 acres in the Swan Valley for real estate development (Savage 2008). The Lands Section in the Hemlock Elk Project EA discusses the ownership and development within the analysis area in detail. More recently, the Montana Legacy Project was announced under which much of the current ownership of Plum Creek land in the Swan Valley could be purchased under a still evolving land acquisition agreement involving Plum Creek, the Nature Conservancy, and Trust for Public lands. The recipient of the bulk of the lands in the Swan Valley appear at this time likely to be the State and Forest Service where they are the dominant surrounding land owners.

Some former industrial forest land within the analysis area has recently been acquired by local conservation organizations in partnership with the Confederation of Salish and Kootenai Tribes. This land is to be managed as a community forest.

Environmental Consequences

This section describes the direct, indirect, and cumulative effects of the No Action Alternative and the proposed actions to forest vegetation.

Alternative A - No Action
Direct and Indirect Effects

The direct and indirect effects discussed in this section pertain primarily to effects that occur as direct or indirect (in time and space) results of the alternative. These may include immediate or longer-term effects.

No actions would occur under this alternative, allowing the processes of vegetation succession to continue in a similar fashion as they currently are. Some roadside firewood gathering, Christmas tree cutting, and continued wildfire suppression consistent with Forest Plan direction is expected. The direct and indirect effects of the No Action Alternative to forest composition, forest structure, seral stage distribution, and forest insect and disease conditions are discussed below.

Forest Composition

Forest composition would continue to reflect the existing condition with the lodgepole pine and spruce/subalpinefir/mountain hemlock cover types dominating the analysis area at a combined 62 percent. Areas dominated by western larch would remain at current levels, comprising only 8 percent of the analysis area.

Regeneration of western larch and other intolerant species would remain low and inhibited by lack of disturbance and increased shade. Schmidt et al. 1976 and Shearer 1971 report that western larch is a pioneer species whose seedlings are adapted to disturbed conditions, such as those found on bare mineral soil or following severe burns, and seedling survival is poor on undisturbed litter, humus, or

sod of the mature forest. Ingrowth and advanced regeneration of shade-tolerant species such as subalpine fir, Engelmann spruce, grand fir, and Douglas-fir would continue. These species have the ability to become established and successfully compete for growing space in a shaded understory environment (Pfister et al. 1977). The effects to species composition based on this alternative include decreased proportions of long-lived, fire-tolerant, shade-intolerant species over time.

Areas recently burned and regenerated by the Crazy Horse Fire, some of which are now considered non-forested due tree canopy covers being less than 10 percent, would increase the percentage of western larch and lodgepole pine as they mature, as these species were the most prevalent in recent regeneration surveys. This would also be the case under the action alternatives and will not be discussed further.

Additionally, the amount of western white pine and western larch would continue to decline because of forest pathogens, since whitepine blister rust and western larch dwarf mistletoe continue to affect these species respectively.

Forest Structure

Both horizontal and vertical structure would continue to reflect existing conditions under the No Action Alternative with some incremental changes expected. Stand densities would remain high as only individual tree or small patches of mortality are expected. The exception is the potential for larger scale lodgepole pine mortality from mountain pine beetle. As mentioned earlier some non-forested areas would likely increase in density as forests become established and grow in size. Density would also continue to slowly increase in all seral stages as trees grow larger, tree crowns expand, and shade tolerant species become established in the understories. Trees experiencing high levels of density-related competition would be less vigorous and less resilient to disturbances, especially in drought conditions (Barnes et al. 1998).

Similarly, it is expected that vertical structure would remain near existing conditions. It is likely that shade tolerant ingrowth would continue to occupy lower, middle, and upper canopy layers as these species establish and grow.

These effects to horizontal and vertical structure would impact the fuel arrangements and potential fire behavior, resulting in more ladder fuels and, subsequently, higher crown fire initiation probabilities, and increased crown fire spread rates.

Seral Stage Distribution

The distribution of seral stages in the analysis area is not expected to change in the short term under this alternative. A major natural disturbance could create increased early seral conditions and related decreases in mid- and late-seral stages, but it impossible to predict these disturbances. As trees grow, they would eventually shift into different seral stages, but this process often takes considerable time.

Insect and Disease Conditions

Here again, insect and disease conditions would remain similar to current conditions as a result of this alternative. Trees and stands would continue to experience the effects of the major insects and diseases previously discussed, including mountain pine beetle, white pine blister rust, western larch dwarf mistletoe, and root disease.

The continued effects of mountain pine beetle include individual and group tree mortality. This would decrease the proportion of primarily lodgepole pine and increase surface and standing dead fuel loadings. As stand conditions change over time, it is believed that the risk of larger-scale mountain pine beetle activity would increase.

The FVS was used to model and assess the hazard rating and potential for damage to forest stands from forest insects including mountain pine beetle. The areas modeled were chosen because they include proposed treatment areas, which allow for comparisons with the action alternatives. These areas were modeled for a 50-year period starting in 2008 and had no treatments simulated. This essentially created a condition similar to the No Action Alternative. The results of this hazard rating and simulation contained a mix of no risk, low risk, moderate risk, and high risk, based on the area assessed. The results of this simulation showed that the hazard associated with mountain pine beetle in white pine and lodgepole pine increased as time went on in many areas. It also showed that the hazard rating for no area decreased as time progressed. The detailed result of this simulation is included in the Project File (Exhibit G-3).

White pine blister rust would also continue to significantly affect the forest vegetation under this alternative. Most of the white pine trees within the analysis area are infected with blister rust. As the disease progresses, tree girdling and subsequent mortality increases. White pine seedlings, which would become established near overstory white pine trees, are likely to become infected as well, given the proximity to the disease and their likely non-resistant genotype. The effects would ultimately be a continued decrease in the proportion of western white pine within the analysis area.

The spread and impact of larch dwarf mistletoe is predictable. The trees currently infected within the analysis area would continue to experience decreased growth and potential mortality. It has been reported that dwarf mistletoe-related mortality usually takes 10+ years to occur once it has spread through the entire tree crown and the spread of dwarf mistletoe within a stand is approximately 1 to 2 feet per year, being highest in multi-storied stands (FHP and SFO 2004).

Root disease would continue to affect areas where it is present, as it can persist on site for decades. Susceptible tree species would continue to be stressed and/or killed where affected by root disease. It has been reported that the area occupied by root disease in a stand can double every 10 years (Hagel 2004). Some lands could become essentially non-forested when susceptible species are the only species present and regenerating in a root disease area.

Tree damage such as windthrow, stem abrasion, and branch breakage, etc., is expected to remain at current natural levels.

Alternative A – No Action
Cumulative Effects

Past, current, and reasonably foreseeable actions on all lands within the analysis area were evaluated when considering the cumulative effects to forest vegetation associated with the No Action Alternative. Past actions, which have affected the vegetation resource, include forest management and other activities within the analysis area. These activities are discussed in the Existing Conditions Section of this report and provide the baseline vegetation conditions. Given that, the following discussion will focus on the current and reasonably foreseeable activities on all lands in combination with the effects of the No Action Alternative on NFS lands. See the Cumulative Effects Worksheet for additional cumulative effects information (Project File Exhibit G-2).

Forest Composition

Cumulatively, the effects to forest composition would continue to reflect the existing condition, where lodgepole pine and spruce/subalpinefir/mountain hemlock cover types dominate. Western larch and western white pine would continue to remain subordinate and the potential for further reduced representation remains from disease issues. This is based on no current or reasonably foreseeable activities (such as regeneration harvest) that would create conditions favorable for western larch regeneration and no activities designed to introduce rust resistant western white pine. In addition, it is assumed that fire suppression activities would continue.

Some cumulative effects to forest composition can be expected from future intermediate harvest on private lands, and reforestation activities, not associated with this project, planned on NFS lands. Approximately 800 acres of intermediate harvest are planned on private lands through the Grizzly Meadow and Stoner Lake Projects. It is difficult to predict the effects of this treatment to forest composition because prescriptive parameters are unknown. It is possible that this treatment could increase representation of a single species or group of species by favoring them for removal or retention. Again, however, this is unknown at this time.

Forest Structure

The cumulative effects to forest structure are similar to the direct and indirect effects of the No Action Alternative where existing conditions would be reflected immediately, followed by increased stand density, continued multi-layer vertical structure, and accumulating fuels. This is primarily due to continued fire suppression and relatively low levels of current or foreseeable disturbance.

The exception to this is that 800 acres of intermediate harvests are planned on private lands. These harvests would likely decrease stand densities, modify average stand diameters, modify vertical structure, and alter fuel arrangements. Prescriptive specifics are not known, so it is difficult to predict effects more precisely.

Land development, although not a significant level of current or reasonably foreseeable development is expected, could affect forest structure by converting forested areas to non-forests.

Seral Stage Distribution

Given little current or reasonably foreseeable regeneration (either natural or human-caused), the cumulative effects to seral stage distribution are primarily a continued slow shift of seral stages as trees grow. National Forest System land acquisitions of previously regenerated lands would increase the amount of early seral stage NFS land.

Insect and Disease Conditions

Here again, the cumulative effects to forest insect and disease conditions are similar to direct and indirect effects of the No Action Alternative when considering other current and reasonably foreseeable activities. Since current and reasonably foreseeable activities that would affect insect and disease conditions are limited, the effects discussed above may be compounded or increased, as existing conditions across all ownerships remain unfavorable over time (e.g., mountain pine beetle loss hazards continue to increase with changing stand conditions).

There are possibly some expectations to this. Depending on stand and insect and disease conditions, the 800 acres of intermediate harvest could have either positive or negative effects. A possible positive effect would be creating conditions that are not favorable for mountain pine beetle population growth. Potential negative effects would be increased risk of windthrow, increased residual tree damage, and increased mortality from root rot diseases. This is hard to assess not knowing these conditions or the management emphasis of theses treatments.

Alternatives B, C, and D
Direct and Indirect Effects

This section discusses the effects to forest vegetation from implementation of the three action alternatives. Since the proposed actions are similar between alternatives, varying primarily by the number of acres treated, the effects discussion will be combined. It should be noted that one minor variation between alternatives will also be discussed. That is, Alternative C has winter logging requirements on 281 acres. Where possible, the effects will be quantified for each alternative to allow

for comparison. Descriptions of each treatment type are found in Chapter 2 and in Appendix C of this document.

The direct and indirect effects to forest vegetation will be discussed relative to the measurement indicators.

Forest Composition

The proposed timber harvests and reforestation activities would result in effects to forest composition within the analysis area. Both intermediate harvest and regeneration harvest areas would have altered species composition following treatment.

As previously stated, management direction includes emphasis on long-lived, fire-tolerant, and shade-intolerant species, where appropriate. The presence of these species suggests that site capabilities are adequate, and they are appropriate areas to apply this direction. These species primarily include; western larch, western white pine, and ponderosa pine. Therefore, these species would be preferred and favored for retention. Due to the relatively short longevity and fire intolerance of lodgepole pine, this species would be favored for removal in most situations. In all harvest treatments, species that are relatively rare within the analysis area and surrounding landscape would be favored for retention either selectively or by exclusion. These include broadleaf species such as aspen, cottonwood, and birch, western red cedar, and western and mountain hemlock.

Where intermediate harvest is proposed, the species composition would be altered through the selection of tree species to be retained and removed. The intermediate treatments proposed are mostly Thinning From Below. Thinning From Below implies that trees in the suppressed and intermediate crown classes would be removed first, while most of the co-dominant and nearly all dominant crown class trees would be retained. Due to the differentiation in shade tolerance among species, these treatments would primarily remove shade tolerant species such as grand fir, subapline fir, Engelmann spruce, and Douglas-fir, which currently occupy the suppressed and intermediate crown positions. Conversely, the shade intolerant species mentioned are currently occupying the dominant and codominant crown positions and, hence, would be favored. There are areas where shade intolerant species occupy the majority of the stocking. In these areas, shade intolerant tree species would be removed to reach the target residual density. However, this removal would not affect the species proportions in these situations.

Other intermediate treatments besides thinning are also proposed and include Sanitation and Salvage treatments. Where Sanitation treatments are proposed, larch dwarf mistletoe infected western larch would be targeted for removal. Although this would alter the species composition of the overstory by decreasing the proportion of western larch, removal of infected overstory trees has been shown to have positive long-term effects to western larch growth and removing infections, which easily spread to understory trees (i.e., western larch regeneration). The benefits of removing infected overstory trees are most pronounced where understory trees are also thinned (as is proposed here to address fuels concerns) (Jackson et al. 2006). Salvage treatments would focus on the removal of dead, dying, and damaged trees and mostly remove lodgepole pine. Since these trees are either already dead or dying, species composition would not be effected measurably.

Table 3-17 shows the number of acres proposed for intermediate treatments under each alternative. Although the actual species composition in these areas is not measurable until after treatment, this table provides an opportunity to compare how many acres associated with each alternative would have species composition altered according to the effects discussed above.

TABLE 3-17.
ACRES OF INTERMEDIATE TREATMENTS BY ALTERNATIVE

Intermediate Treatment	Alternative B	Alternative C	Alternative D
Thinning(s)	475	475	582
Sanitation	51	51	51
Salvage	10	10	30
Total	**536**	**536**	**663**

Regeneration harvests are likely to have a greater effect on species composition than intermediate harvests. This is due to the establishment of a new age class of trees where control of species composition is possible at establishment. This is possible through manipulation of seed source and artificial regeneration. Regeneration harvests associated with the action alternatives include Seedtree with Reserves and Clearcut with Reserve treatments. These treatments are designed to facilitate regeneration of the desired species discussed earlier (western larch, western white pine, and ponderosa pine). “With reserves” indicates that certain trees would be retained indefinitely to provide species and structural diversity. In both treatments, the reserves would be comprised of western larch, ponderosa pine, and western white pine species. This does not mean that all trees of these species would be reserved in these areas.

Artificial regeneration would focus on hand planting of western larch and blister rust resistant western white pine. Planting of ponderosa pine would be limited to those sites where it is believed ponderosa pine would be able to successfully compete with other species. This would likely be limited to more xeric (dry) areas.

Where adequate site preparation is achieved, natural regeneration is expected to supplement planted seedlings. A variety of species would likely become naturally established. It is also likely that these species would primarily be shade-intolerant pioneer species such as lodgepole pine and western larch. Some shade-tolerant species may become established on sites where moisture and seed sources are adequate (e.g., Engelmann spruce).

As discussed, winter logging is planned for 281 acres under Alternative C. This would have a negative effect on natural regeneration of western larch, for reasons previously referenced by Scmidt and Shearer (1976). However, this would have a negligible effect of species composition because artificial regeneration of western larch is planned.

Due to variations in seed source and to periodicity and unpredictability of adequate seed crops (Burns and Honkala 1990), artificial regeneration is planned for all regeneration areas. The number of acres planned for regeneration treatments by alternative are displayed in Table 3-18. Of the 203 acres proposed for regeneration, species composition would be converted on 170 acres. That is, the current cover type would not be representative of the species composition following treatment. This is primarily the result of converting lodgepole pine dominated and shade-tolerant species dominated areas to areas where primarily western larch would be the dominant species. Table 3-18 displays the number of acres where species conversion of this nature would occur.

TABLE 3-18.
ACRES OF REGENERATION TREATMENTS BY ALTERNATIVE

Regeneration Treatment	Alternative B	Alternative C	Alternative D
Clearcut with Reserves	74	74	0
Seedtree with Reserves	129	129	0
Total	**203**	**203**	**0**

TABLE 3-19.
ACRES REGENERATED BY COVER TYPE

Current Cover Type	Alt. B	Alt. C	Alt. D
Lodgepole Acres Regenerated	93	93	0
Douglas-fir Acres Regenerated	15	15	0
Western larch Acres Regenerated	33	33	0
Spruce/subalpine fir/mountain hemlock Acres Regenerated	62	62	0

Regeneration surveys would be conducted post treatment to assess regeneration success and species composition.

Forest Structure

Forest structure would be affected by the proposed intermediate harvests, regeneration harvest, and associated fuels treatments. Both the effects to horizontal and vertical structure will be discussed.

Intermediate harvests would modify existing forest structure primarily through density reduction. The treatment descriptions displayed in Chapter 2 provide a generalized description of the target residual stand density following treatment. Essentially, the number of trees that are currently growing within an area proposed for intermediate treatment would be reduced. By reducing the number of trees on a given area, the spacing between tree stems and crowns would be increased. Vertical structure would be affected through the selective removal of crown classes. As discussed, Thinning From Below would target lower crown classes first. This would feature in a more pronounced and defined single-storied canopy comprised of dominant and codominant trees. Due to the increases in multi-storied vertical structure previously cited by Barrett, Freedman and Habeck, and Arno, an increased representation of single-storied structures would add diversity to the landscape.

Intermediate treatments would also result in larger average stand diameters. Average diameters are calculated by summing the diameters for all trees within an area and then dividing the product by the number of trees within the area. Typically, the suppressed and intermediate trees have smaller diameters than the dominant and codominant trees. By removing the smaller diameter trees, average stand diameters would increase. The exception to this would be in areas proposed for Sanitation and Salvage treatments. This is because trees targeted for removal are not necessarily associated with any particular size or crown position.

By removing a portion of the density, growing space would be made available to the remaining trees. Increased growing space and decreased competitive stress for nutrients, water, and sunlight would result in improved, growth, vigor, and resiliency to disturbance (Smith et al. 1997; Oliver and Larson 1996). Much research has been conducted to explore this belief, while looking at variables such as species composition, age, and geographic location. When looking at the response of trees to partial cutting in western Montana, Schwalm and Milner (2002) found that height and diameter growth increased in residual trees of ponderosa pine, Douglas –fir, western larch, and lodgepole pine. Filip et al. (1989) observed increases in growth and vigor following thinning of western larch for trees both with and without larch dwarf mistletoe infection. Although sometimes small and negated by increased mortality following harvest, Dahms (1971) saw positive growth responses in older lodgepole pine. At a site on the Lolo National Forest south of the analysis area, research indicated improved physiological performance of 300+ year old ponderosa pine and western larch following restoration cutting and burning treatments (Fiedler 2004; Harrington 2004; Sala and Callaway 2004).

Regeneration treatments would replace the existing forest structure as opposed to intermediate modifications. Clearcut with Reserves and Seedtree with Reserves Treatments are proposed in some of the action alternatives. These treatments would have a variable effect on the short and long term

effects to forest structure. Although the number of reserve trees would vary by treatment (with Seed Tree areas having more overstory reserves), initially both treatments would result in a scattered single-storied structure. The reserve trees would exist above small seedlings and other vegetation. Over time, the seedlings would grow into saplings, then poles, then larger trees. As this occurs, a two-storied stand structure would become apparent. This effect would be less pronounced and consistent in the Clearcut with Reserve Treatments, due to the number of reserve trees on site.

Forest structure is directly related to wildland fuels and potential fire behavior. Recent emphasis on fuels management has led to studies focusing on the effects of manipulating forest vegetation and fire hazard and behavior. It has been found that reduced stand densities, retaining larger diameter fire resistant species, managing surface fuels, and increasing height to live crowns has had positive effects on tree and stand survivability, decreased crown fire activity, decreased surface fire potential, and decreased fire severity (USDA 2003; Skinner et al. 2002; Omi et al. 2002; Graham et al. 1999; Agee and Skinner 2005). The Fire and Fuels Section of this EA contains more detail related to forest structure and fire behavior.

Standing dead trees (snags) and down woody material are significant components of the overall forest structure. These elements are specifically important to wildlife habitat and nutrient cycling. Forest Plan Amendment 21 (Project File Exhibit Q-13) includes standards for retention of these elements. The standards include numbers of snags and amounts of down woody material by potential vegetation group. All proposed treatments would be designed to meet these standards. Amounts of down woody material may be expressed as tons per acre. Tons per acre are a commonly and easily measurable specification. Existing snag densities and down woody amounts may be less than Amendment 21 standards due to stand conditions. Where feasible and needed to comply with Forest Plan standards, live trees would be left for snag recruitment and activity generated slash would be used to supplement existing down woody material. Some snags may be felled to mitigate safety hazards. Please refer to Table 2-15 in Chapter 2 which displays Design Criteria for snags and down woody material that would be left on site following treatments.

Understory trees also appreciably add to the forest structure. In most situations, these trees would be cut to achieve fuel management and site preparation objectives. This treatment is referred to as slashing. Often, smaller understory trees act as ladder fuels providing an opportunity for fire to move from the forest floor to the tree crowns. One of the primary benefits these trees provide is to serve as hiding cover for various wildlife species. Where not acting as ladder fuels or where the distribution of groups of regeneration is such that overall fuels objectives can be met in the stand as a whole, understory trees may be left over a portion of treatment areas to provide hiding cover and structural diversity.

Eventually, the effects to forest structure from all treatments would diminish. Because trees grow over time, stand densities would increase, tree crowns would expand, advanced regeneration would become established and continue to grow taller, fuels would accumulate, and crowns would become stratified through stand dynamics. Refer to the Vegetation Temporal Bounds Section of the EA for estimates on how long these effects may last.

Seral Stage Distribution

Regeneration treatments would affect seral stage distribution more so than intermediate treatments. Note that seral stages for this analysis were defined by size classes outlined in Appendix B of the Silviculturist's Report (Project File Exhibit G-1).

Intermediate harvest treatments would have no effect on the age class distribution within the treatment areas. However, as has been previously discussed, these treatments would have effects on the average residual stand diameters and on residual stand radial growth. It is impossible to measure these increases until after harvest, but the following can be expected. It is unlikely that immediate changes in average stand diameters would increase significantly enough to alter an area's classification into a particular seral stage. It is likely that increases in average stand diameters

coupled with expected increases in radial growth following treatment would accelerate the time required for an area to shift from early-seral to mid-seral or from mid-seral to late-seral stages.

Regeneration harvest would immediately affect an area's classification into seral stages. This is because existing mid-seral and late-seral areas would be converted to early-seral stages. Table 3-20 quantifies the number of acres in where this conversion would occur by alternative.

TABLE 3-20.
ACRES CONVERTED TO EARLY SERAL STAGE (REGENERATION HARVESTS)

Existing Seral Stage	Alternative B	Alternative C	Alternative D
Mid Seral	118	118	0
Late Seral	85	85	0
Total	**203**	**203**	**0**

Insect and Disease Conditions

The effects to forest insect and disease conditions associated with action alternatives will be discussed relative to the major insect and diseases observed within the analysis area. Tree damage (including windthrow) associated with the proposed activities will also be discussed as it can affect the insect and disease conditions.

In general, proposed activities could have both positive and negative effects relative to forest insect and disease conditions. Decay associated with tree damage and increases in bark beetle populations associated with windthrow are two potential negative effects, while increased resilience to insect and disease agents would be a potential positive effect.

Damage to trees because of logging is more common in intermediate harvest than regeneration harvest due to higher residual stand densities. This damage typically includes stem abrasion from skidding and yarding equipment, crown damaged because of adjacent tree felling, and root damage from logging equipment. These wounds create ideal entrances for decay organisms (Hunt and Krueger 1962). Hunt and Krueger (1962) also cite references to logging damage increasing tree susceptibility to insects and disease. Design Criteria are proposed to address tree damage from logging during implementation (See Table 2-15).

Prescribed burning, including pile burning, associated with site preparation and fuels treatments could affect insect and disease conditions. Where residual trees exist and are exposed to fire, there is the potential for tree damage and mortality (primarily in fire-intolerant species such as lodgepole pine) as a result of burning. If trees are damaged and stressed, they can become more susceptible to successful attacks from insects. This is commonly observed where Douglas-fir bark beetles and stressed residual Douglas-fir trees exist. This situation is expected to be rare within the Hemlock Elk Project Area based on residual species composition and planned treatment.

When stand density is reduced, residual trees can become more susceptible to windthrow. These effects can vary by tree species, tree size and age, residual stand density, and site. Some generalities can be made regarding the risk of damage associated with windthrow.

Of the tree species likely to be reserved, western larch and ponderosa pine are considered more windfirm than Douglas-fir or lodgepole pine, primarily due to rooting habits (Burns and Honkala 1990). Where high water tables or rocky soils exist, windthrow is more likely due to shallow rooting depths (Koch 1996). Younger trees grown in dense stands are susceptible to windthrow when densities are reduced. Larger trees grown under low densities or where their crowns have been exposed to winds are relatively windfirm. The highest probability for windthrow associated with the action alternatives would be with intermediate harvesting of lodgepole pine dominated stands and where regeneration

harvests would create leeward edges where lodgepole pine dominates (Koch 1996). Alternatives B and C contain 141 acres and 71 acres of these situations, respectively; Alternative D contains 218 acres of lodgepole pine dominated intermediate harvests and no regeneration. Suggestions to mitigate windthrow associated with lodgepole pine have been suggested by Koch (1996), Schmidt and Barger (1986), and Alexander (1975). This information would be considered and incorporated where feasible during implementation of this project.

Where windthrow does occur, increases in bark beetle populations are possible. Primarily Douglas-fir beetle, spruce beetle, *Ips* spp. and western balsam bark beetle are attracted to these conditions. Wide-spread windthrow is not expected, and none of these beetle species are present in significant numbers within the analysis area.

A positive general effect from the proposed treatments is related to the previous discussions regarding increased growth and vigor of residual trees following harvest and subsequent resiliency to insect and diseases. Black (2005) and Dix et al. (2006) acknowledge studies where thinning has increased vigor and, in turn, made trees less susceptible to insect attack.

Mountain Pine Beetle: The forest management actions proposed in the action alternatives would have an effect on the risk associated with mountain pine beetle damage. This is primarily limited to areas dominated by lodgepole pine and would be seen in both intermediate and regeneration harvest. Many studies have been conducted to assess the effects of timber harvest to control mountain pine beetle. It should be noted that Black (2005) claims that there is little evidence to support that timber harvests can control bark beetles once an outbreak starts. This does not apply here because no wide-scale mountain pine beetle outbreak is underway and mountain pine beetle exists only at endemic levels in and around the analysis area.

Intermediate harvests can be designed to alter stand conditions making them less attractive to the beetles (stand conditions, temperature, air movement, pheromone transport, etc.) (Amman et al. 1977; Dix et al. 2006; Koch 1996; Fettig et al. 2007; Gibson 2004). Ideal stand conditions for mountain pine beetle population growth include:

- Larger average lodgepole pine diameters;
- High stand density (both basal area and trees per acre);
- Proportion of density that is lodgepole pine;
- Stand age; and
- Elevation (Pederson 2006 and Amman et al. 1977).

Regeneration harvests in lodgepole pine dominated areas would not exhibit these conditions for many years, even if lodgepole pine was the primary species regenerated. Regenerated areas create a mosaic of age classes on the landscape, which also disrupts the continuity of bark beetle food supply.

It has been seen that mountain pine beetle prefer larger trees; however, increased tree vigor, reduced stand density, and decreased proportions of lodgepole pine counter balance the effect of increased residual tree growth and stand average diameters in intermediate harvest areas.

Similar to the effects analysis for Alternative A, FVS simulations were run for some of the lodgepole pine dominated areas. In these simulations, both regeneration and intermediate harvests were simulated (Thinning From Below used for all intermediate treatments) in 2010 and then the stands were modeled for 50 years. Intermediate simulations included stands where both commercial and non-commercial treatments are proposed. The results of modeling the intermediate treatments showed that:

- 43 percent of the stands modeled had a reduction in hazard rating from high to moderate;

- 43 percent showed no change in hazard rating; and
- 1 area had a hazard rating change from moderate to high which accounted for 14 percent.

The area that increased in hazard was a non-commercial unit where Thinning From Below resulted in increased average stand diameters, which likely led to the increased hazard rating. When Seedtree treatments were modeled, 75 percent of areas modeled had changes in hazard rating from high to low and 25 percent had changes from moderate to low. Where Clearcut treatments were modeled, 50 percent of the areas showed a decrease in hazard rating from high to low and 50 percent a decrease from moderate to low. Eventually, all areas modeled increased in hazard as time went on, regardless of treatment. Detailed information associated with this modeling is available in the project file (Exhibit G-3).

White Pine Blister Rust: The effects to white pine blister rust from the action alternatives would primarily be limited to regeneration and introduction of genetically rust-resistant trees through planting. Some severely infected trees could be removed through intermediate and regeneration harvests. Alternatives B and C include regeneration of 203 acres where artificial regeneration is planned. White pine blister rust resistant western white pine seedlings would be included in the seedlings planted. It is hoped that over time resistance is maintained in the gene pool.

Larch Dwarf Mistletoe: The proposed actions would affect the spread and intensification of larch dwarf mistletoe in both intermediate and regeneration harvests. The impacts of larch dwarf mistletoe can be effectively reduced through silvicultural treatments emphasizing the removal or killing of infected branches or trees (FHP 2004). Larch dwarf mistletoe is an obligate parasite, and once host trees are killed (through cutting) the mistletoe dies. Several factors influence the spread of larch dwarf mistletoe including vertical structure and infestation levels. Intermediate harvests (including sanitation) would prioritize the removal of infested western larch and promote single-storied structures that would reduce spread compared to multi-storied stands with no treatment (Beatty et al. 1997). However, Jackson et al. (2006) found that overstory removal and thinning of infected western larch led to improved residual tree growth; these actions negatively affected the spread and intensification among thinned trees.

Root Disease: As discussed, root disease is a disease of the site that can persist for many years and has no cure. Forest management actions proposed in the Hemlock Elk Project can have both positive and negative effects to root disease. Regenerating affected sites with susceptible species and partial harvests that leave susceptible species could intensify root disease by providing additional food bases for the disease to colonize. Managing for root disease tolerant species is one of the most effective and cost efficient means of addressing root disease (Hagel 2004). In all alternatives, disease tolerant western larch and pine species would be favored in both intermediate and regeneration harvest. Despite this focus, some susceptible species may be retained in intermediate harvests and naturally regenerate in regenerated areas.

Alternatives B, C, and D
Cumulative Effects

Past, present, and reasonably foreseeable actions on all lands within the analysis area were evaluated when considering the cumulative effects to forest vegetation associated with the action alternatives. Past actions affecting the vegetation resource include forest management and other activities within the analysis area. These activities are discussed in the Vegetation Existing Conditions Section of this EA and provide the baseline vegetation conditions.

As with the cumulative effects discussion for the No Action Alternative, when considering the cumulative effects of the action alternatives, the direct and indirect effects previously discussed will apply, in combination with present and reasonably foreseeable activities. The activities discernibly

affecting forest vegetation are identified in the Cumulative Effects Worksheet (Project File Exhibit G-2).

Forest Composition

The cumulative effects to forest composition from the action alternatives, present and reasonably foreseeable intermediate harvest, and continued fire suppression would only differ in scale from the effects described in the direct and indirect effect discussion.

Some cumulative effects to forest composition can be expected from future intermediate harvest on private lands. Approximately 800 acres of intermediate harvest are planned on private lands. It is difficult to predict the effects of this treatment to forest composition because prescriptive parameters are unknown. It is possible that this treatment could increase representation of a single species or group of species by favoring them for removal or retention. Again, however, this is unknown at this time.

Table 3-21 includes these intermediate harvests with the action alternatives.

TABLE 3-21.
CUMULATIVE ACRES OF INTERMEDIATE TREATMENTS BY ALTERNATIVE

Intermediate Treatment	Alternative B	Alternative C	Alternative D
Thinning(s)	475	475	582
Sanitation	51	51	51
Salvage	10	10	30
Current and Foreseeable Intermediate Harvests	800	800	800
Cumulative Total	**1336**	**1336**	**1463**

Forest Structure

The cumulative effects to forest structure are similar to the direct and indirect effects of the action alternatives. Continued fire suppression, relatively low levels of current or foreseeable forest management, and land development are the only activities that could cumulatively affect forest structure.

The exception to this is that 800 acres of intermediate harvests are planned on private lands. These harvests would likely decrease stand densities, modify average stand diameters, modify vertical structure, and alter fuel arrangements. Prescriptive specifics are not known, so it is difficult to predict effects more precisely.

Land development, although not a significant level of current or reasonably foreseeable development is expected, could affect forest structure by converting forested areas to non-forests.

Seral Stage Distribution

Aside from the proposed actions, little current or reasonably foreseeable regeneration (either natural- or human-caused) is expected. Beyond the direct and indirect effects discussed, NFS land acquisitions of previously regenerated lands would increase the amount of early seral stage NFS land.

Insect and Disease Conditions

Here again, the cumulative effects to forest insect and disease conditions are similar to direct and indirect effects of the action alternatives when considering other current and reasonably foreseeable activities. Since current and reasonably foreseeable activities that would affect insect and disease conditions are limited, the effects discussed above may be compounded or increased, as existing conditions across all ownerships remain unfavorable over time (e.g., mountain pine beetle loss hazards would continue to increase with changing stand conditions).

There are possibly some exceptions to this. Depending on stand and insect and disease conditions, the 800 acres of intermediate harvest could have either positive or negative effects. A possible positive effect is creating conditions that are not favorable for mountain pine beetle population growth. Potential negative effects are increased risk of windthrow, increased residual tree damage, and increased mortality from root rot diseases. This is hard to assess not knowing the specific prescriptions for the treatments which are proposed on other ownerships.

Regulatory Framework and Consistency

National Forest Management Act (NFMA)

The NFMA and accompanying regulations require that several specific findings be documented at the project level and include the following:

Suitability for Timber Production: The NFMA requires that no timber harvesting shall occur on areas classified as not suited for timber production, except salvage sales, sales necessary to protect other multiple-use values, or activities that meet other objectives on such lands, if the Forest Plan established that such actions are appropriate.

The silvicultural diagnosis process and the Forest Plan were used to determine that all areas associated with this project are suitable for timber harvest using the following criteria:

- Meet the definition of forestland;
- Technological feasibility exists to protect soil productivity and watershed protection. Forest Plan standards, project Design Criteria, and applicable BMPs would be used to protect these resource values.
- There is reasonable assurance that lands can be restocked within 5 years of final harvest.
- None of the areas considered for harvest have been withdrawn from timber production.
- As stated earlier, all areas proposed for treatment are with in MAs where timber harvest is allowed per Forest Plan direction. Treatment units in MA 12 address fuel reduction objectives, which are compatible with protection of the riparian resource.

Maintenance of the Diversity of Plant and Animal Communities: Forest Plan (including Amendment 21) goals, objectives, standards, and guidelines address maintaining a diversity of vegetation and habitats across the Flathead National Forest to meet a variety of wildlife species needs and to provide for sustained yield of timber products. In addition to applying this Forest Plan direction, project designs prescribed by the Project Wildlife Biologist and Botanist also address plant and animal community needs.

Appropriateness of Even-Aged Management and Optimality of Clearcutting: The NFMA directs that clearcutting be used only where “it is determined to be the optimum method.” Other even-aged methods can be used where “determined to be appropriate.” As stated in the treatment description section of this report, the silvicultural diagnosis process was used to

evaluate and determine that clearcutting is the optimal treatment to meet management objectives where proposed. Other even-aged methods are proposed, as they are most compatible with the disturbance regimes found in the analysis area and the adapted silvics of desired shade intolerant species.

National Forest Management Act Findings for Vegetation Manipulation: All proposals involving vegetation manipulation of tree cover for any purpose must comply with the following requirements.

- Best suited to the multiple-use goals stated in the Forest Plan for the area with impact. All proposed treatments are consistent with multiple-use Forest Plan direction and address the project Purpose and Need.
- Assure that the lands can be adequately restocked within 5 years. Previous regeneration harvests in the analysis area have been successfully stocked within 5 years. Regional reforestation indices also support that reforestation techniques have been successful.
- Not chosen because they will give the greatest dollar return. Although timber harvest associated with this project will generate revenue, all treatments have been designed to meet project objectives, not revenue generation.
- Be chosen after considering the effects on residual trees and adjacent stands. The effects to residual trees and adjacent stands were considered in the interdisciplinary development of this project. Residual tree protection measures are included in the design criteria section of this report.
- Be selected to avoid permanent impairment of site productivity and to ensure conservation of soil and water resources. The Soil and Water Resources Sections of the Hemlock Elk Fuels Reduction and Forest Health EA include protection and enhancement designs sufficient to ensure conservation of the resources.
- Be selected to provide beneficial effects to water quality and quantity, wildlife and fish habitat, regeneration of desired tree species, forage production, recreation uses, aesthetic values, and other resource yields. Following Forest Plan and MA direction, an ID Team considered all of these resources in the context of the surrounding landscape and this project as documented in the EA.
- Be practical in terms of transportation and harvesting requirements and total costs of preparation, logging, and administration. Standard ground-based logging systems and log hauling is prescribed for this project and has been determined to be practical for this project.

Flathead National Forest Plan Direction

As discussed in the Desired Conditions Section of this report, all planned activities are consistent with Forest-wide and MA direction.

Forest Service Manual and Handbook

The FSH 2409.17 Silvicultural Practices direction was referenced and applied to the development of this project.

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