CHAPTER 3

Affected Environment and Environmental Consequences

I. INTRODUCTION

This chapter presents both the existing environment of the *Moose Post-Fire Project* area and potential consequences to that environment by implementing any of the five alternatives presented in Chapter 2. Discussions of the current condition describe the physical, biological, social, and economic environment for each potentially affected resource. Discussions of environmental consequences form the scientific and analytic basis for comparing the alternatives. All direct, indirect, and cumulative effects are disclosed. The means by which potential adverse effects would be reduced or mitigated are also described (also see Chapter 2). Some resource conditions consider a larger area than the project area boundary if predicted effects extend beyond the project area. The project record contains information concerning the boundaries for each area analyzed.

The discussions of resources and potential effects take advantage of existing information included in the Forest Plan, other project documents, project-specific resource reports and related information, and other sources as indicated. Where applicable, such information is briefly summarized and referenced to minimize duplication. The project record for the Moose Post-Fire Project includes all project-specific information, including resource reports, the watershed analysis, and results of field investigations.

Changes between the DEIS and the FEIS

All resource sections were updated to include further analysis resulting from field verification, new information, or issues raised from comments on the draft EIS. Most resources have a specific section discussing the changes between the draft and final EIS in more detail.

Analyzing Effects

Direct, Indirect, and Cumulative Effects

Direct environmental effects are caused by the proposed project activities and occur at the same time and place (40 CFR 1508.8). Indirect effects are those that occur later or at a distance from the activity but may have significance to the action in the near future. Cumulative effects result from incremental consequences of actions when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over time.

Past, Present, and Reasonably Foreseeable Actions

Past, present, and reasonably foreseeable actions are activities have already occurred, are currently occurring, or are likely to occur in the vicinity of the project area and may contribute cumulative effects. The past and present activities and natural events have contributed to creating the existing condition, as described in the Affected Environment sections of Chapter 3. These activities, as well as reasonably foreseeable activities, may produce environmental effects on issues or resources relevant to the proposal. Therefore, the past, present, and reasonably foreseeable activities have been considered in the cumulative effects analysis for each resource area.

Not all past, present, or reasonably foreseeable actions affect resource areas (e.g. wildlife, recreation, etc.) the same. For instance, one reasonably foreseeable action may greatly affect a resource area while not affecting another. The cumulative effects analysis for each resource area considered those past, present, and reasonably foreseeable actions that would have relevant effects – reasons as to why past, present, and reasonably foreseeable actions had no effects are documented in the project record and are not elaborated further in this EIS.

Major Past Actions - Flathead National Forest System Lands

- Timber harvest has taken place in the Big Creek drainage since 1952, including precommercial thinning and reforestation. Approximately 26 percent of the drainage has been harvested (refer to the vegetation section in this chapter for further information on these past actions).
- Road construction/reconstruction/maintenance began in the 1950s. Approximately 165 miles of national forest system roads still exist within the Big Creek drainage
- Trail construction/reconstruction/maintenance
- Noxious weed treatments within the Big Creek Campground
- Construction/operation/maintenance of Big Creek Ranger Station (now known as Glacier Institute)
- Construction/operation/maintenance of Big Creek Campground
- Prescribed burning occurred in the Demers Ridge winter range area in the mid-1980s.
- Personal use firewood cutting, Christmas tree harvesting, post and poles, and bough collection
- Construction/operation/maintenance of Moose Lake Campground. The entire campground was reconstructed in 1997, making it handicapped-accessible. New trails to the campsites, a new toilet, new picnic tables, new fire rings, etc. were included. The trailhead to Moose Peak was also relocated a couple of years before.
- Hunting, fishing, snowmobiling and dispersed recreation
- Snowmobile trail grooming started in 1979 in the upper portion of the Big Creek drainage. A warming hut exists on the Lakalaho Road 1696, maintained by local snowmobile groups.
- Construction and operation of Big Mountain Ski Area; 7 downhill ski runs are located in the upper portions of Big Creek (the ski area was not affected by the fire).
- Between January 1985 and August 1997, there were approximately 1800 acres of land transferred from private to federal ownership in the headwaters of Big Creek. This area was extensively logged during the 1960s. The Flathead National Forest now manages the entire Big Creek basin.
- Road decommissioning. Approximately 23 miles of road in upper Big Creek and Skookoleel Creek have been decommissioned since we began decommissioning roads in 1995.
- Fire suppression since 1910 throughout the Big Creek basin.
- Wildfires: portions of the area experienced stand-replacing wildfires in 1910, 1919 and 1926. There have been very few wildfires since 1926, and none over 200 acres in size other than the Moose Fire.

- Moose fire suppression and rehabilitation: about 15 miles of fire line and three large safety zones were constructed and rehabilitated in the Big Creek watershed. Of the fireline construction, approximately 8 miles were hand line and 7 miles were constructed with mechanized equipment. Fire retardant was deployed with air tankers in the Big Creek watershed between mid-August and late September. Most area roads were cleared. Drain dips were installed during fall 2001 along approximately 5 miles of Elelehum Road 5272.

- Trees adjacent to roads within the Moose Fire area that were identified as a hazard to firefighters and the public were felled during fire suppression actions. Removal of these trees began in the winter following the fire and was completed August 19, 2002. Approximately 4500 tons of wood products were removed from the area.

- Moose Fire Burned Area Emergency Rehabilitation (BAER) projects: included replacement or removal of several culverts, installing drain dips; placing numerous straw wattles, fiber mats, and loose straw material; and aerial seeding grass to help trap sediment and reduce erosion in areas of high burn intensity (refer to the fisheries and hydrology sections in this chapter for further information on the BAER projects).

Past Actions - Coal Creek State Forest

- Timber sales and road construction

Current and Reasonably Foreseeable Actions - Flathead National Forest System Lands

- On April 1, 2002 temporary closure order resulting from the snowmobile agreement restricts snowmobiles to specific roads and areas in the North Fork. A programmatic amendment of the Forest Plan to address winter motorized access is ongoing. This amendment proposes changes to existing Forest Plan direction that may affect use and distribution of future snowmobile activity. It is expected to be completed in the late winter or early spring of 2003.

- Numerous activities to revegetate and reforest sites throughout the Moose Fire area including planting shrubs on about 200 acres in winter range areas (about 100 acres in MA 9 and 100 acres in MA 13. [See map in project record V-3.]). Shrub planting is expected to begin in the spring of 2003 and may take two years to complete.

- About 800 acres of conifers were planted within the burn in 2002. This activity was unrelated to the Moose Post-Fire Project. Approximately 1000 more acres are expected to be planted in 2003. All other post-harvest reforestation activities related to the *Moose Post-Fire Project* are addressed as proposed actions in this *FEIS*.

- Roads and culverts throughout the Big Creek and Coal Creek watersheds require improvements to meet best management practices (BMPs) and accommodate elevated levels of run-off anticipated from the fire. Activities began in the summer 2002 and will likely continue for the next 2-3 years. This road maintenance work, which includes roads planned for timber hauling associated with proposed harvest activities, is addressed in the *Moose Fire BMP Implementation Project*. This BMP project primarily includes installation of road drainage structures (e.g. stream culvert replacements, cross-drain culverts, drain-dips). This project involves the replacement of up to 77 culverts in the Big Creek drainage (8 culverts in the Coal Creek drainage) that currently do not meet INFISH and/or BMP size requirements or are otherwise deemed at high risk of failure. Seven of these culverts have been identified as barriers to fish passage and their replacement would provide fish access to several miles of habitat for the first time since the original road construction.

- Trail maintenance/reconstruction – The fire damaged several trails for a total of 21.2 miles. Of these, 10.6 miles need maintenance activities. These trails will receive clearing, hazard tree removal (on either side of the trail or over the trail where necessary), water bars, and retread. Work began in the summer of 2002, and some work may not be completed until 2004, depending on funding. Trails include:

- Du Hein (River) Trail 383 (completed in 2002)
- Demers Ridge Trail 266 (completed in 2002)
- Glacier View Mountain Trail 381
- Forks Patrol Trail 452 (partially completed in 2002)
- Elelehum Trail 255
- Deadhorse Trail 194 (completed in 2002)

Trail work on Forks Patrol and Elelehum will include total reconstruction on 10.6 miles of trail and would occur under a contract. See map in project record.

- Moose Peak burn – In 1998, a decision was authorized to use a series of prescribed burns to restore whitebark pine in the Moose Peak vicinity between Coal Creek and Mathias Creek to the north, and the Deadhorse and Hallowat drainages to the south and east. Approximately 2,000 acres were targeted for burning within the Moose Peak area. This area will be reevaluated to determine whether this project will occur. (Refer to map, Project Record V-4)

- Noxious weed monitoring and treatment – Monitoring and treatment of noxious weed infestations in the Moose fire areas began in 2002. The *2001 Forest-wide Noxious and Invasive Weed EA and Decision Notice* and BAER authorizes this work. Treatment areas include: open roads, gravel pits, Big Creek Campground, Glacier Institute, and planned roads for decommissioning. Project record O-20 shows areas treated in 2002. Weed inventories and treatments will continue in 2003 and may occur for several years beyond that.

- Commercial Mushroom Harvest – A signed decision authorized commercial and personal mushroom harvesting within the Moose Fire area. Mushroom harvest began in May 2002 and ended in August 2002. See decision and map in project record V-2.

- Two temporary area closures tied to the mushroom harvest began in May 2002. The closure order is expected to end in April 2003.

- A temporary road closure order (until April 2003) restricts the same open roads that are identified for closure in Alternative 2 of this FEIS.

- Routine road maintenance – Routine road maintenance occurred in the summer of 2002 and is likely to occur as needed on 25.5 miles of existing roads within the project area. These actions include road blading, done on an annual basis, and culvert cleaning when needed.

- Road decommissioning resulting from past planning decisions. Approximately six miles of road in the Werner Creek grizzly bear subunit and seven miles in the Lower Big Creek grizzly bear subunit still need some work to meet decommissioning needs. Work on all but three roads was completed in 2002. Completion of the remaining work is expected by 2005. Refer to fisheries and hydrology sections in this chapter for further information; also refer to Map 2-3 for the locations of these roads.

- A NEPA decision authorizing the expansion of the Big Mountain Ski Area was signed in 1995. Most management activities in the Big Creek drainage related to this decision have been completed, including the decommissioning of most of the roads. There are potentially nine new ski runs (Chair 8) planned and approved for construction under this decision affecting a total of 80 acres in the Big Creek watershed. A portion of these runs may be constructed in the next two years.

- Recreational public uses such as sightseeing, hiking, camping and snowmobiling are expected to continue. Public use is anticipated to increase over the next 10 years.

- Special forest product gathering for personal use is likely to occur, such as berry picking, firewood and Christmas tree cutting, evergreen bough and cone collection, particularly in those areas unaffected by the fire.
- The closure order for firewood cutting in the fire area currently in effect will be rescinded after harvest activities. Additional signs will be placed in riparian areas prohibiting firewood cutting in these areas (which are also specified in all firewood cutting permits) once the closure order is lifted.

- Improving road drainage on a small road used by Winter Sports Inc. to access Chair 7 (refer to hydrology section in this chapter for further information).

- During the summer of 2002, signs were located on bridges and other likely access points to encourage compliance with the Big Creek fishing closure.

- The U.S. Forest Service Cooperative Forestry and Forest Health Protection office in Missoula MT is proposing to conduct a 10-year study of the deterioration of fire-killed larch trees within 5 areas in the Moose Fire area (entirely on National Forest System lands). One area is about ½-mile from the junction of the Big Creek and Coal Creek Roads while the other four areas are located beyond Mud Lake near the Coal Creek Road. The intent of the proposed project is to: identify agents of change of fire-killed western larch in northwestern Montana; measure rates at which agents of change affect four different age/size classes of western larch; quantify merchantable volume reduction over the study period; and monitor conk development and snag fall during the study period and beyond. This study would start this year and evaluate 320 trees (240 dissected) in four distinct size classes (8-11" dbh, 12 to 15" dbh, 16 to 19" dbh, and 20+). Ten trees were randomly selected and will be cut down, with dissection parameters measured, in each size class during each dissection year. Dissection years would be 1, 2, 3, 5, 7, and 10 years after the fire. Non-dissected tree data would be taken on all trees every year, except trees cut in previous years, during the ten-year study. Twenty trees would be left uncut for each size class as "longevity snags" to continue monitoring for conk development and snag longevity. No study trees are located within any proposed salvage unit and would not be removed from the site.

- The fuel reduction zones created at the Big Creek campground, Glacier Institute site, and along the private land boundary in lower Coal Creek would be periodically treated by mechanical means (i.e. thinning) and/or prescribed burning (i.e. low intensity underburning), to maintain the desired condition of low fuel loadings and fire hazard. Treatments may occur every 10-20 years, depending upon stand conditions

- Road decommissioning authorized by previous decisions will continue.

Current and Reasonably Foreseeable Activities on Coal Creek State Forest

- *Coal Creek State Forest Moose Fire Salvage and Reforestation Project – Phase 1.* During the winter of 2001, the Department of Natural Resources and Conservation salvaged approximately 986 acres. They built approximately 0.5 miles of short, temporary jump-up and extension roads. These roads are planned for decommissioning. Western larch and rust-resistant western white pine were planted during the summer of 2002. Road maintenance activities occurred on Coal Creek Road 317, Road 909, spurs off of Road 909 on Coal Ridge, and Dead Horse Road 1693. During the spring of 2002, noxious weeds were monitored. Weeds were sprayed on Coal Creek Road in the summer of 2002.

- *Coal Creek State Forest Moose fire Salvage and Reforestation Project – Phase II.* The Department of Natural Resources and Conservation selected Alternative D (modified) for their Phase II project. It will log up to about 1202 acres, some of which is optional and helicopter logging only. No temporary roads will be built. Planting will follow. The sale was put up for bid in 2002 but did not sell. It was again offered for sale after a modification that made some units optional, rather than mandatory. The sale has since sold.

- Mushroom harvesting occurred during the summer of 2002 on State lands

II. VEGETATION

This section describes the existing situation of the area and the components of the vegetation resource affected by the proposed action and its alternatives. The alternatives would affect these components:

- Vegetative structure, composition and timber resource
- Spruce and Douglas-fir bark beetle populations and potential spread
- Sensitive plants
- Noxious weeds

Analysis area boundaries differ depending on the affected component, and are defined for each component.

A. Vegetative Structure, Composition and Timber Resource

1. Analysis Area

The analysis area used for the vegetation resource is displayed on Map 3-1, and incorporates all of Big Creek watershed, plus most of the Demers Ridge area, a total of approximately 58,500 acres. The portion of this area that burned in the Moose Fire is approximately 26,000 acres. This analysis area coincides with that used for the landscape analysis conducted just prior to the fire, the *Big Creek Ecosystem Analysis at the Watershed Scale* (Big Creek EAWS, project record V-8). This area includes all the proposed activities that have any measurable effects to vegetation structure, composition or pattern. The fire in 2001 did indeed burn across a larger area, including the Coal Creek drainage, but vegetative treatments are not proposed in those areas; therefore not all national forest system lands burned are included in the vegetation analysis area. The analysis area is hereafter referred to as the "Big Creek drainage" in this vegetation section.

This analysis area The Big Creek EAWS is a landscape level analysis of resource conditions and management opportunities, completed in 1999 (refer to Chapter 1 of this DEIS and the vegetation section in project record). Along with the document *Wildfires of 2001 Post-fire Assessment* (2001), the EAWS provided information used to characterize the affected environment for vegetation within the Moose Post-fire project. On-the-ground field visits were also conducted throughout the last year to gather data specific to resource issues, such as post-fire insect potential and activity, riparian boundaries, and vegetation conditions (project record O-1).

Changes to this section since the publication of the Draft EIS were primarily made in acres directly affected by the alternatives, as the area proposed for treatment has been reduced. Additional literature citations were added and clarifications/elaborations made in response to comments on the Draft EIS.

2. Affected Environment

Fire severities and interpretation related to vegetation

The Moose Fire of 2001 affected about one-third of the Big Creek drainage (see Map 3-1). The fire burned with varying intensity (BTUs) across the landscape, from creeping and smoldering to fast moving crown fires. Temperature, humidity, wind, topography, and fuel moistures can all influence how intensely a fire burns (DeBano *et al*. 1998). Satellite images of the area before and after the fire were compared and analyzed through a "change detection" process to determine "fire severity", or the extent to which vegetation was affected by the fire (this differs from effects to soils). Vegetation creates a reflectance value that corresponds to a spectral image. The fire altered the reflectance value to the point where the magnitude of change could be estimated. See project record O-2. Three broad categories were used to classify the effects of fire on the vegetation component of the landscape.

- Low fire severity results in only low to moderate duff reduction and patches of unburned or lightly burned understory vegetation and trees. Immediate mortality of the overstory tree canopy is less than 40 percent.

Many of the fire-killed trees still retain their small branches, twigs, and needles. Eventual mortality to thin-barked species such as spruce and subalpine fir can be expected, due to damage at their root collar.

- Moderate fire severity results in significant duff reduction, the majority of the understory vegetation is burned but not completely consumed, and 40 to 80 percent immediate mortality in the overstory trees. Many of these trees still retain their small branches.

- High fire severity results in complete consumption of the duff and understory vegetation. There is 80 to 100 percent mortality in the overstory canopy, often with total consumption of the tree crowns (needles, twigs, and small branches).

Map 3-1 displays the fire severities across the entire Moose Fire area. The Big Creek drainage (the area used for this vegetation analysis) is also shown on Map 3-1. Table 3-1 below displays the fire severities within the Big Creek drainage only.

Table 3-1: Moose fire severities within the burned portion of Big Creek Drainage

Fire severity	*Acres affected in Big Creek Drainage	% of Fire Area
High	11405	44%
Moderate	6119	24%
Low	5879	22%
Unburned	2503	10%
Total	**25,906**	**100%**

Numbers are approximate due to GIS/satellite data processing and interpretation, rounding, water and rock.

Satellite imagery, taken in late September 2001, indicated that about 2500 acres remain unburned within the portion of the Moose Fire that lies within the Big Creek watershed. However, some acres of *under*burning went undetected due to the remaining green canopy in the overstory. Field surveys were used to update the geographic information systems layer with verified data from ground-truthing. Additional mortality to trees, especially thin-barked species such as spruce, subalpine fir, and lodgepole pine, can be expected along the margins of areas characterized as *unburned* or of *low fire severity*.

Species Composition and Forest Structure

Tree species found in the Big Creek drainage include subalpine fir, Douglas-fir, lodgepole pine, ponderosa pine, western larch, Engelmann spruce, whitebark pine, and western white pine. Whitebark pine was historically a major species in most stands at the upper elevations in Big Creek, often mixed with significant amounts of spruce and subalpine fir. Widespread blister rust infection, in addition to the mountain pine beetle outbreaks of the last few decades, have taken a serious toll on whitebark pine. Ponderosa pine and western white pine were found in small, scattered amounts within the Big Creek drainage, probably because they are near the edge of their ecological range. White pine is also susceptible to blister-rust, but some resistance is evident. This watershed contains a minor amount of habitat suitable for the development of ponderosa pine and western white pine cover types. Common shrubs include Sitka alder, red osier dogwood and some devil's club.

The Big Creek EAWS found that the proportion of most forest cover types within the watershed is within the desirable range of historical conditions. An exception was the amount of subalpine fir/spruce cover types in the Upper Big and Hallowat Creek areas, which at about 80 percent of the land area is well above expected historical conditions. Correlated with this high proportion of climax species cover type is a low proportion of the seral species such as white pine, ponderosa pine, larch and lodgepole pine cover types and, to a lesser degree, Douglas-fir cover types. Factors contributing to this high amount of spruce/subalpine fir include the long period (at least 250 years) since the last large wildfire over much of the area within the Big Creek drainage, local climatic conditions which trend towards particularly high snowfall and associated shorter growing seasons, and the loss of most of the whitebark pine trees in the recent past to blister rust and mountain pine beetle. Cover groups affected by the Moose Fire are displayed in Table 3-2 (project record O-3).

Table 3-2: Cover groups affected by fire severity within the burned portion of Big Creek Drainage

	*Acres affected by Fire Severity			
Cover group	**High**	**Moderate**	**Low**	**Unburned**
Subalpine fir/Engelmann spruce	5371	3319	3263	1724
Douglas-fir	2358	1687	1560	372
Western larch	1786	500	310	103
Lodgepole pine	1608	233	467	180
Whitebark pine/alpine larch	60	91	80	38
Aspen/cottonwood	85	24	24	1
Shrubs	90	77	73	60
Grass/forbs	20	24	30	1

Numbers are approximate due to GIS/satellite data processing and interpretation, rounding, water and rock (non-forest).

Potential vegetation types (PVT) were mapped for the Moose Fire area and the Big Creek drainage. PVTs are areas of similar growth conditions described by moisture, temperature, and soils, which lead to similar “climax” forest conditions in the absence of disturbance (Christensen 1989). PVTs also help us define the fire regime for a forest. Based on vegetation and cover types, a majority of the area is in a lethal fire regime with an 80-240 year fire return interval. Cool, moist vegetation types support very high levels of biomass, forming a continuous fuel load (Fischer & Bradley 1987). Long intervals between fires allow large amounts of fuels to build up. Under a lethal fire regime, fires burn into tree canopies and can kill most of the overstory trees. Mortality can vary depending on time of day when the fire burned through an area, fuel conditions, fire intensities (how hot the fire is burning), terrain, and weather. This lethal fire regime is found throughout the Big Creek drainage primarily in the cool, moist habitat types. A smaller portion of the fire area is classified in a mixed-severity fire regime with an infrequent fire return interval. This regime is confined to the drier south and west aspects in the Douglas-fir cover types, such as in the Elelehum Creek area. There is no indication the Moose Fire is outside of this expected and historical range of fire severity, though it was approaching the upper limit in spruce-fir habitat types.

The dry PVTs only comprise about 644 acres within the fire. Generally, fires of low intensity and a frequency of 5 to 25 years would have occurred instead of stand-replacement fires. Fire exclusion has moved these communities toward a long-interval stand-replacement fire regime (Arno 2000). However, these small patches of dry PVT exist in a larger expanse of moist PVTs. A lethal fire occurring in the larger landscape would easily consume these patches as well. These are primarily Douglas-fir habitat types, so there is a high probability that ponderosa pine and western white pine would be lost as a component on these habitat types in the high and moderate burn areas due to a lack of natural seed sources.

Forest Structure within the Moose Fire

Disturbance processes alter the successional pathways of forest vegetation. A severe fire, with total consumption of all live vegetation, will set a forest habitat back to the grass/forb/seedling or stand initiation stage, while the vertical structure provided by snags would persist for some years. In the burned area, grasses and sedges were already resprouting in the autumn of 2001. Revegetation of shrubs can be expected in about six years (Stickney 1990).

Figures 3-1 and 3-2 display the forest structural stages within the Big Creek drainage and the burned portion of the drainage, before and after the fire. Some of the acreage within the Moose Fire had burned during previous wildfires, especially the 1910 Fire. Other recorded fires within the Big Creek watershed and Moose boundary occurred in 1919, 1926, and 1952 (see Map 3-14, Fire History and project record O-4).

MAP 3-1: Fire Severity Map and Vegetation analysis area – showing severities (effect on vegetation) in whole fire area.

Fire affects forest structure as a disturbance process. The range of severities experienced in the Moose Fire set back the successional and structural stages in many stands. The change in structure classification was a function of the fire severity and the cover type. Before the fire, 35 percent of the area was in a stem exclusion stage, mostly as a result of the 1910 fire (refer to Figure 3-1 and Map 3-14, Fire and Fuels section). Most of the area that burned in 1910 regenerated to highly dense stands of lodgepole pine, where growth had stagnated. High mortality from the Moose Fire returned these stands primarily to stand initiation (refer to Figure 3-2). Spruce/subalpine fir stands will experience nearly complete mortality with a low to moderate intensity fire, and return to stand initiation, whereas older western larch and Douglas-fir stands experiencing the same fire intensity may lose the understory but few or none of the overstory trees. These Douglas-fir and larch stands are now classed as understory reinitiation due to the new available growing space. See Figure 3-2 and project record O-5.

About 13,228 acres had burned within the last 100 years, and many of those acres regenerated to thick stands of lodgepole pine. By the year 2001, these 80- to 90-year-old trees were in the “stem exclusion” structural stage, occupied mostly by small trees, only 5-8” in diameter, due to competition for growing space. This stage is characterized as having trees of similar sizes occupying all of the growing space, allowing little or no light to the forest floor for new seedlings to become established (Oliver & Larson 1996). Most of these pole-sized stands were unmanaged at the time of the Moose Fire, and provided a continuous fuel matrix.

The understory reinitiation structural stage can develop over time as trees in the overstory begin to die, creating openings for sunlight to reach the forest floor, and making nutrients and water available to new vegetation. Seedlings then become established to create an understory layer *(ibid).* As the stand ages, this understory can eventually reach a height where, in conjunction with remaining overstory trees, a multi-storied stand dominated by larger, older trees in the upper canopy is created. This is referred to as a late seral, or old forest, stage. A young forest multi-storied structural stage represents stand development over time resulting from intermittent mortality to the overstory (i.e. fire, partial harvest, insect or disease). A forest dominated by trees of mixed sizes and canopy layers can result (Hessburg *et al.* 1999).

Forest Structure in Big Creek Drainage

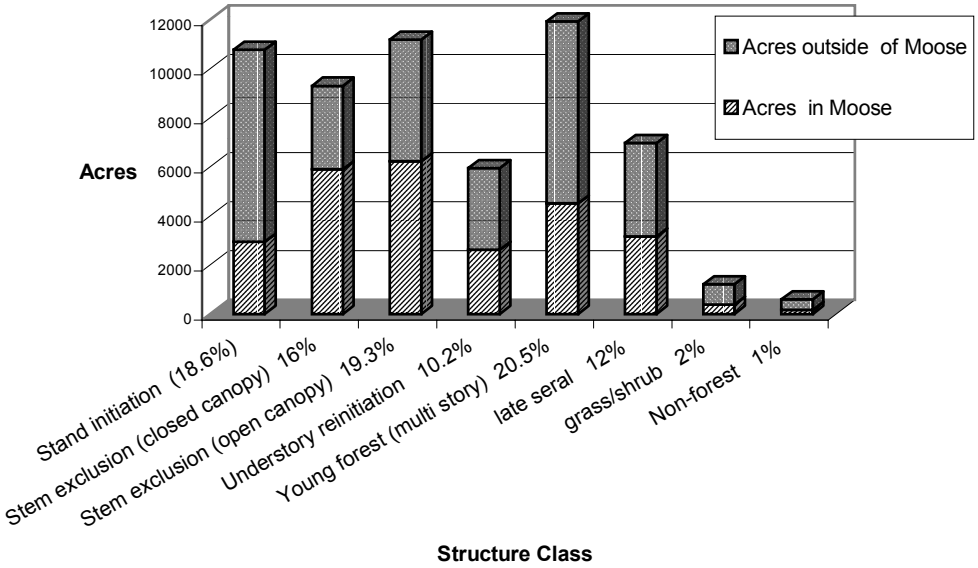
The Moose Fire, in conjunction with past harvest activities and natural disturbances, created a mosaic of new stand structures across the landscape. Acres harvested in the last four decades were in the stem exclusion (sapling), understory reinitiation (thinned sapling/pole), or the stand initiation (seedling) stage. About 14,785 acres of the area in Big Creek reverted back to a grass (stand initiation) stage, while keeping some vertical structure provided by the stems of burned trees (snags). The table below shows the amount of structure type affected by fire severity, within Big Creek. Structure type is based on Oliver and Larsen’s (1996) and Hessburg *et al.* (1999) stand development classification with local modifications that better define a late seral/old forest stage within Big Creek (Big Creek EAWS, 1999). Structure was altered substantially by the Moose Fire, as displayed in Figure 3-2. The structure most affected by the fire was stem exclusion, and it also had the most acres that burned at the highest severity.

Table 3-3: Acreage of structure class affected by fire severity level within the burned portion of Big Creek Drainage *

	* Acres Affected by Fire Severity			
Structure	**High**	**Moderate**	**Low**	**Unburned**
Grass/forb/shrub	111	101	103	61
Stand initiation (seedling)	768	1179	530	496
Stem exclusion	6542	2030	2330	1230
Understory reinitiation	1043	565	893	149
Young forest multi-story	1501	1450	1385	180
Late seral	1416	781	612	366

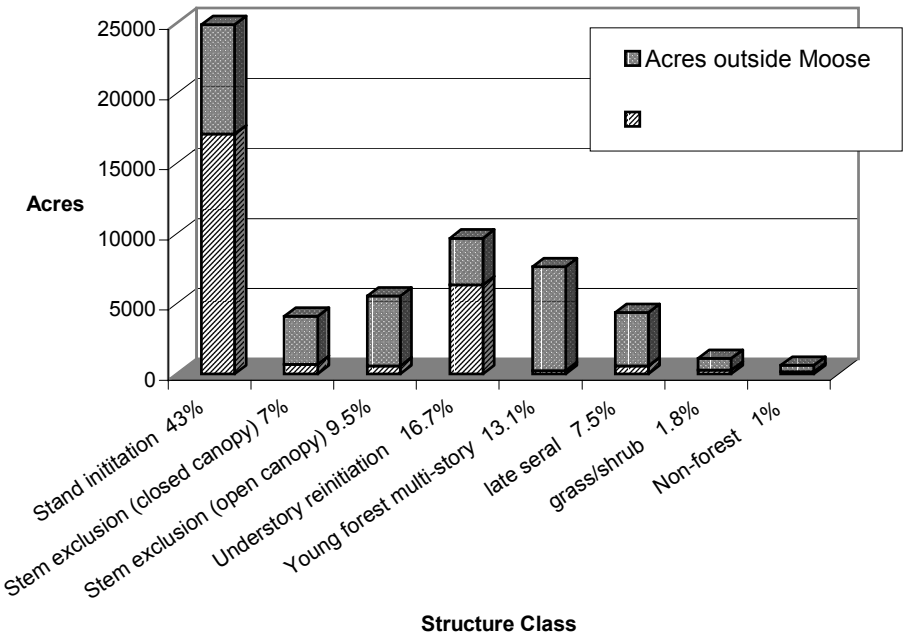
Numbers are approximate due to GIS/satellite data processing and interpretation, rounding, water and rock.

Figure 3-1: Prefire forest structure in Big Creek drainage



*Non-forest is rocks, cliffs, water, and roads.

Figure 3-2: Post-fire structure in Big Creek drainage



MAP 3-2: Post-fire forest structure within Big Creek

Late seral/Old forest

Prior to the fire, it was estimated that old forest structural stages occupied a little over 12 percent of the Big Creek drainage (Big Creek EAWS 1999). In the lower half of Big Creek, also about 12 percent (3233 acres) was estimated to be old forest stands in the area burned by the Moose Fire. Amount of late seral forest was greatly reduced by the fire. Overall, the current percentage of late seral stands in the Big Creek drainage is approximately 7.5 percent. Many stands burned with a moderate to high intensity, and reverted to stand initiation. Other stands were reclassified as understory reinitiation. The understory reinitiation stage is characterized as having an overstory of low to moderate density, where gaps have been created due to mortality and blowdown, allowing an understory to become established. Some late seral stands retained their character and function if they experienced a light ground-fire and were mainly comprised of fire-resistant species such as western larch. Other late seral stands of spruce were changed by low severity fire to understory reinitiation, due to spruce's susceptibility to girdling by fire. (project record O-5).

The range of natural variability in the amount of late seral/old forest within the watershed is wide, occupying from zero percent to nearly 38 percent of the land area (Big Creek EAWS, 1999). This is not surprising, considering the large, stand-replacing wildfires with long fire-free intervals (150+ years) that characterize the natural disturbance regime in these moist, cool forests (project record O-6). This disturbance pattern would result in large patches of burned forest, converting many if not most of the older forests in the watershed into a seedling/sapling stage of development. Over time, through natural succession, some of this would eventually develop into an old forest structure again, composed of larger-diameter trees and multi-storied canopies.

Windthrow

Blowdown of the standing dead trees is a natural consequence after fires. Fall down rates vary by species and diameter (Everett *et al.* 1999). Fall down rates are lowest for western larch and subalpine fir (DeNitto *et al.* 2000). Douglas-fir trees fall rates increase after five years, as the volume of decay increases in the lower stem. On the Sleeping Child burn in Montana, only 28 percent of lodgepole pine were still standing after ten years (Lyon 1977). Research (Harrington 1996) has shown that 75 to 80 percent of ponderosa pine trees that die in the first post-burn year will fall within ten years. The riparian areas of the Big Creek drainage have already experienced a great deal of blowdown, primarily among the mature spruce trees. Trees with extended use as snags will be those with moderate to low crown scorch that remain alive for at least two years after injury. Although a majority of trees will fall the first ten to 20 years, the trees that remain standing after that time may do so for a very long time (e.g. 50-70 years).

Deterioration of Fire-killed/Fire-damaged Timber

Relatively rapid deterioration of fire-killed or fire-damaged trees can be expected, causing a decline in its commercial value. Factors affecting the rate of deterioration are tree species, species characteristics, tree diameter, growth rate, age, site conditions, fire severity, and time of year. The agents affecting deterioration are insects, stand and decay fungi, and weather. Although the rates of staining and cracking (52% to 80% volume affected) are high the first five years, decay rates are much lower (USDA 2000). Cracking allows the sapwood to dry out, retarding or arresting decay. This is more common in thin-barked species such as Engelmann spruce, subalpine fir, and lodgepole pine. Field surveys conducted in the summer of 2002 indicate that cracking and checking has already resulted in 20% to 30% volume reduction, mostly in trees of smaller diameter.

Patch sizes

Immediately prior to the Moose Fire of 2001, the average size of a "patch" of forest of similar size and structure in the Big Creek drainage was 70 acres, ranging from nine acres to 1034 acres. The larger patch sizes were a result of the 1910 and 1926 fires. A "mid-scale assessment" by Hessburg *et al*. (1996) determined that patch sizes for Ecological Subregion 19 (which includes the Big Creek drainage) historically ranged from 60 to 2588 acres, with a median patch size for any given structural stage ranging from 149 to 252 acres.

The substantial amount of acreages affected by high intensity fire correspondingly reverted many acres back to a stand initiation stage. Based on GIS modeling, the largest patch size in the Big Creek drainage is now approximately

10,000 acres. The shape is highly irregular and contains a mosaic of islands of varying structure and fire severities (project record O-7).

Conifer Regeneration and Reforestation

Regeneration in previously managed stands

Since the 1950s, timber harvest has occurred on about 6224 acres, or about 24 percent of the 25,900 acre portion of the Moose Fire in the Big Creek drainage (Project Record O-8). Many regenerated harvest areas within the fire area were severely impacted by the fire. About 892 acres that had regeneration harvest in the last twenty years were moderately or severely burned. Another 2269 acres that were harvested between 1961 and 1980 were moderately or severely burned. Planting of seedlings on 850 of those acres is underway, and planned for 1026 acres in 2003 (project record O-9). If salvage is approved, planting of conifer seedlings will occur in units where natural regeneration will be hindered by a lack of seed source, or where species diversity is desirable. Reforestation in areas previously harvested and subsequently burned by the Moose Fire, is a high priority to meet the National Forest Management Act, and reforestation activities in these areas are already underway. Seedlings will be planted in the first two to three post-fire years before competition from pine grass, fireweed, and other early successional plants preclude successful establishment. White pine genetically resistant to blister rust had been planted in some harvested areas prior to the fire. White pine would be replanted in these same areas (Project Record O-14).

Regeneration in other areas

There is a large body of research on post-fire regeneration based on data gathered locally on the Flathead National Forest at Miller Creek (Project Record O-40). This body of knowledge from several studies, some with a longevity of 35 years, allows us to confidently predict what to expect in the Moose Fire area. The initial community establishing in the fire area is expected to be grasses and shrubs. Their source will be from one of three components: survivor, residual colonizer, and offsite colonizer (Stickney 1990). Trees may become established on a disturbed site in a number of ways, such as residual seed in the soil, from cones on trees that survived the fire, from seed that blows in from off-site, or from animal transport. Diverse natural conifer regeneration may be delayed or below desirable levels in some areas due to lack of seed source. It is likely that a majority of the fire area has surviving residual lodgepole pine seed in the soil, but other species, especially larch, will not become established unless a cone crop coincides with these first few years when the germination substrate is favorable (Shearer 1989). Some of these areas may occur in the center of larger burn areas with complete mortality, or at upper elevations and south facing aspects with thin soils.

The length of time for natural revegetation on dry potential vegetation types (PVTs) is expected to be slow and spatially discontinuous. Immediate post-fire species composition is largely dependent on seed from adjacent unburned areas, persisted through the fire, or repsrouted from plant parts surviving the fire (DeBano *et al.* 1998). Native grasses and shrubs will colonize the burned areas (Noste and Bushey 1987). Although the tree component will be influenced by competition, generally the community that was present before the fire is the community that will return successionally (Stickney 1986). For example, ceanothus was present in some stands before the fire, and is expected to return, especially on south-facing slopes. A medium to severe wildfire on a dry-type Douglas-fir/ninebark habitat type with evergreen ceanothus seed in the soil will result in an evergreen ceanothus community.

The *Northern Region Overview Summary* categorizes the forest and rangeland *species at risk* for the Northern Rockies Zone as western white pine, western larch, ponderosa pine, upland grasses/shrubs and whitebark pine. They are considered most at risk in this zone due to “past and potential future loss in the aerial extent of the cover type; significant changes in landscape level heterogeneity (fragmentation); significant changes in structure (both density and change in distribution of structural stages); and susceptibility to spread of identified exotic plants.”

There is a low probability for natural regeneration of ponderosa pine and western white pine due to the size of the burned area, the severity of the burn, lack of surviving seed source and the topography. Many areas have 90 percent mortality of the overstory, and very few cones of ponderosa pine and western white pine were observed during field reconnaissance. Ponderosa pine will be planted as stock becomes available at the regional nursery (project record O-15).

In some areas within the fire, there are good cone crops and survivors of western larch, Douglas-fir, Engelmann spruce, and lodgepole pine. Abundant seedlings were evident this summer in many, though not all, areas. A recently burned soil substrate is a very favorable condition for tree seedlings, especially western larch, to become established; however, an abundant cone crop must occur within two or three years of the fire for larch to gain a foothold on a site. Good larch cone crops are produced at about five year intervals. Larch is an early seral species, highly intolerant of shade, and if it gets a late start on a site, it is often out-competed and out-shaded by shrubs and other tree species (Schmidt *et al.*1976).

There are large areas of high severity burn where distance to the seed wall exceeds 3000 feet. These areas may have lodgepole pine in the soil seed bank or already regenerating from cones opened by the heat of the fire, but species diversity will be lacking as these patches regenerate without other seed sources. They are located primarily on Demers Ridge and in the Elelehum drainage. These areas were aerially seeded in February 2002 with a mixture of Douglas-fir and Englemann spruce. See map of seeding areas in the project record O-9.

The majority of the Moose Fire occurred on lands classified in the Forest Plan as Management Area 15, where cost-efficient production of timber is emphasized, while protecting the productive capacity of the land and timber resources. Planting may be necessary on some MA 15 lands to restore the productive capacity of the land in a timely manner. Vegetation treatments are appropriate and expected on MA 15 lands.

Forest Plan resource goals include designing treatments to encourage development of diverse vegetation native to the site. Larch was historically a dominant species in the south half of the fire area, and much of the original mature larch component was taken out with harvest in the 1960s, 1970s and 1980s (Bollenbacher, pers. comm.). Encouraging this species before lodgepole pine or other species get a chance to choke it out would contribute to restoring the Big Creek drainage to historical conditions.

Landscape level goals from the Forest Plan include protecting or restoring riparian vegetation to provide for shade, large woody debris, sediment filtration and normal hydrologic function, consistent with the site potential and natural disturbance process. Riparian areas, especially along Big Creek and Langford Creek, may need to be planted with shrubs or conifers to shorten the amount of time it takes for riparian vegetation to provide the benefits listed above.

Snags and Downed wood

The Moose Fire created an abundance of snags and downed wood in all areas that had not been previously harvested, approximately 19,600 acres in the Big Creek drainage. The size of the snags differs greatly though, between areas that have experienced one or more fires in the last 150 years (approx. 12,400 acres), and other areas in Big Creek that have not burned for 250 years or more (approx. 7,200 acres). Refer to the Snags and Downed Wood section in Chapter 3 for greater detail.

Inventoried Roadless Areas

There are 12,112 acres of inventoried roadless area (IRA) within the Moose Fire. The majority of this area burned at a moderate to high severity level. In the Big Creek drainage, Douglas-fir dominates the drier, more southerly aspects, and mixed stands of Douglas-fir, western larch, spruce and subalpine fir occur on the remaining more moist sites. There were small pockets of whitebark pine near ridgetops. Elevation ranges from 4500 feet to 6035 feet, the highest point at Deadhorse Ridge. Vegetative characteristics in the IRAs are similar to those in the rest of the Big Creek drainage.

3. Environmental Consequences

The analysis of direct, indirect and cumulative effects on vegetation is limited to the vegetation analysis area previously described (the Big Creek drainage). The potential effects described below represent the result of analysis based on research, experience, and monitoring to date and best professional judgment of the silviculturist, fuels

management specialist, wildlife biologist, regional entomologist, other interdisciplinary team members, and others in the professional community.

The direct, indirect, and cumulative effects of the proposed action or its alternatives would result mainly from the vegetation management activities described in Chapter 2. These activities primarily consist of salvage harvest of fire-affected trees and the regeneration of the harvest units to mixed conifer stands. The effects would vary among alternatives based on the acreage treated, as well as size and spatial distribution of the units. There were no significant issues related to vegetation (refer to Chapter 2). The following effects indicators were used to focus the vegetation analysis and disclose relevant environmental effects.

- Acres of salvage harvest
- Acres of reforestation
- Acres of natural successional development, especially in inventoried roadless areas and river corridor
- Change in access for future timber management
- Salvage harvest by structural stage (acres)
- Legacy areas remaining (acres)

Other impacts addressed in the vegetation effects analysis include: late seral forests, blowdown, conifer regeneration, and timber resource. The following effects indicators will be addressed in detail in separate subsections in this chapter.

- Potential for insect-caused mortality
- Sensitive Plants and Noxious weeds
- Fire and Fuels

Direct and Indirect Effects

Alternative 1 (No action)

Timber Resource

There would be no salvage or fuel reduction with the *no action* alternative. Deterioration of dead timber would be most noticeable within two years of the fire. Drying and splitting of the heartwood (checking) is a major cause of deterioration. Subjecting wood to rapid drying, which occurred in areas that burn at high intensities, causes checking. Checking will increase as a result of long periods of dry weather. Insect attack usually precedes fungal attack and provides the mechanism for introducing microorganisms that accelerate sapwood deterioration. Many variables influence deterioration, and volume and value lost vary by species (USDA 2000). Each stand is unique and each tree is unique. Blue stain will appear in the pines within the first year. By the second year, some of the sapwood will be decayed. After three years, the sapwood of most softwood species will have deteriorated beyond practical use. Fifty percent of the volume may be lost in Douglas-fir trees 11-20 inches dbh by year three (Lowell *et al.* 1992).

The decomposition rate is about half of that of production in western Montana. Based on principles of energy systems in the Northern Rocky Mountains, the timber resource is at risk if neither fuel management or fuel reduction activities are scheduled (Beaufait 1971).

Natural Successional Development

In this alternative, no vegetation management actions would be taken, but species and community biodiversity will return through succession, natural revegetation, and recolonization processes. These processes will be the same inside and outside the Inventoried Roadless Area or the Scenic River corridor. The early successional stage of vegetation (stand initiation) over most of the area will consist of shrubs, perennial herbs, and grasses that resprout. Germination can be expected from those plants, including conifers, whose seeds survived the fire or disseminated from offsite sources. On north facing slopes with limited conifer seed sources, shrubs may out-compete conifers if

no artificial regeneration occurs. On some south facing slopes, pinegrass will quickly become established and can also out compete seedlings. High-intensity fires in pure lodgepole pine stands usually result in a new stand of pure lodgepole pine. The high biotic potential in seed stored in serotinous cones is important in the establishment of extensive areas of pure, dense, lodgepole pine (Lotan, Brown & Neuenschwander 1984; Volland 1984). Without the artificial reintroduction of other species on these sites, overstocked stagnated stands of lodgepole is often the eventual result, as witnessed in areas unplanted after the 1988 Red Bench Fire in the North Fork of the Flathead River.

Establishing seral species of trees is important to maintain ecosystem stability and to prevent type conversion to noxious weeds, shrub fields, or climax species. As described under “Other Present Activities”, some aerial seeding of conifers was done in March 2002, but viability and success from this type of regeneration is inconsistent. Where needed, planting of seedlings in areas that had been harvested prior to the fire will occur regardless of this proposal or its alternatives.

In most of the fire area, tree species will return to the area through germination of seeds in the soil and/or from trees in unburned or adjacent areas, and some species will resprout. In general, conifers produce seed at irregular intervals which varies by species. The Moose Fire, in conjunction with past harvesting, left extensive areas without seed trees, and natural regeneration is expected to be a slow process. Regeneration is greatly increased in areas where dead trees are left standing to provide shade (Shearer 1976). The period of time required for the area to return to a forested ecosystem will depend on many factors including, but not limited to:

- Site conditions and productivity
- Burn severity of the Moose Fire
- Future fires and their extent and intensity
- Weather patterns
- Proximity of seed sources
- Seed dispersal events

Stands that experienced a high-severity fire, or even a moderate-severity fire, now provide growing space for plant life. Western larch favors a germination substrate where fire has reduced both the duff layer and sprouting potential of competing vegetation (Shearer 1975). However, in the first four or five years, shrubs and herbs will dominate the site. Common species include fireweed, spirea, beargrass, and grass species. Eventually, the growing space is completely occupied by plants. In about 15 to 25 years after the disturbance, the more competitive plants and tree species exclude others from colonizing and take over the growing space of the less competitive species. As development progresses, in 80 to 100 years, overstory trees may dominate the site completely (*stem exclusion*). Shrubs and trees that invade the understory grow very slowly in height for many years and form advanced regeneration (*understory reinitiation*).

The next successional stage may occur after about 150 years, provided it is not altered by another major disturbance. This stage (*understory reinitiation or young forest multi-story*), characterized by two or more layers of trees, but not dominated by large, old trees, may last many decades. Barring large partial or stand-replacement disturbances, the forest continues to grow until gradually some of the overstory trees begin to die. As they die, understory trees often grow to become the overstory. The result may be a stand structure with many layers of foliage, a diversity of tree sizes but dominated by large older trees, and large snags and downed woody material. As tree diameters increase and senescence begins, the stand evolves into what is known as late seral or “old growth”.

In light fire-severity stands, the fire directly killed a portion of the vegetation. Initially there is the appearance of greater survival, but due to the susceptibility of Engelmann spruce and subalpine fir (very thin bark) to heat, subsequent mortality is impending (Miller 2000). In the next year, crown canopy will decline and continue at a reduced rate for the next four or five years. This may be described as a partial disturbance. In this case, patches of growing space are available, and newly established species such as Douglas-fir, subalpine fir, spruce, and lesser amounts of shade-intolerant larch and lodgepole pine undergo similar changes to those described above for stands with complete disturbance. The invading individuals compete with other plants and trees that survived the fire. The species composition of conifers will be greatly influenced by site factors (Shearer 1986). The stands will progress in a manner similar to the slightly more open grown stands.

Snags and Downed Woody Material

Firewood cutting aside, which is not possible to quantify, all dead woody material will be left on site providing a high degree of ecological integrity by leaving the community of soil and decomposer microorganisms intact. The large number of snags and subsequent logs remaining after the fire will provide habitat and contribute to soil productivity (Harvey *et al.* 1987).

Blowdown can be anticipated over the course of time. In a study in similar upper montane subalpine forest types, 85 percent of the snags fell in the first 13 years, and 93 percent had fallen in 21 years (Lyon 1984). However, in this study, the majority of species were lodgepole pine. There are a variety of species in the Big Creek drainage, as described earlier in the affected environment section. The large woody debris recruitment for this process is important for stream health, wildlife habitat, and nutrient cycling. This topic is covered in depth in the snags and woody debris section of this EIS.

Forest Structure

The *no action* alternative will not change the amount of area in any of the structural classes in any burn intensity class as previously described in the vegetation *affected environment* section. As mentioned under the snag issue, blowdown is inevitable. In terms of standing dead trees, the vertical structure in high intensity burn classes would change dramatically over the next 10 to 20 years. In stands near ridgetops with predominantly subalpine fir, spruce, and lodgepole pine, and where the average diameter is less than 10” dbh, blowdown can be expected in closer to ten years than twenty. In low intensity burn classes, delayed mortality will allow these areas to stand longer; however, in twenty years the majority of dead trees will have blown down.

Fuel Reduction Treatments

No change in current conditions in the areas adjacent to private lands (near Coal Creek), the Glacier Institute site, and the Big Creek Campground would occur under Alternative 1. The Coal Creek and Glacier Institute sites are characterized by dense stands of mostly dead trees, from sapling size and poles (at Coal Creek) up to 12” and greater diameters (in portions of the Glacier Institute site). Natural succession will continue to occur at these sites, much as described above in other areas of the fire. Jack-strawed, heavy fuel loadings are likely to develop over the next 10 to 20 years (refer to Fire and Fuels section of this chapter). Lodgepole pine is likely to be the dominant conifer regenerating at these sites, with a few larch and Douglas-fir as well. Density of lodgepole would be very high in some areas, up to several thousand trees per acre.

The campground area is largely unburned, with dense patches of green Douglas-fir. Little light reaches the forest floor, which is characterized by sparse understory shrubs and small, stagnated Douglas-fir saplings and poles. This condition will continue under this alternative, with high densities inhibiting growth of the trees.

Alternatives 2 and 5

Timber Resource

Alternative 2, the proposed action, would salvage 2428 acres within the Moose Fire that contains fire-killed trees, and is physically and economically feasible to salvage. Most of the area is within the suitable timber base. Approximately 14.9 million board feet of timber volume would be harvested. Acreages within the fire not considered for salvage were primarily areas previously harvested, on unsuitable ground, small diameter unmerchantable timber, or areas too far from a road to make helicopter yarding possible or economically feasible (refer to the project record O-10 for more information). Chapters 1 and 2 of this EIS describe how the proposed action was developed and why certain areas were included for treatment. Alternative 5 includes the same vegetation treatments as Alternative 2, but considers different road management options.

The proposed action was designed to salvage fire-killed timber at risk or infested with bark beetles while leaving snags and woody debris sufficient to maintain ecological processes that protect ecosystem function.

Alternatives 2 and 5 would salvage harvest approximately 2428 acres within 71 distinct harvest units. Units vary in size from 2 to 166 acres. This alternative would salvage only dead trees and trees most likely to die because of severe fire injury or beetle-infestation (refer to Post-Fire Mortality Guidelines in Appendix B). In units requiring a skyline yarding system, some live trees may have to be cut to access portions of the unit. The intent of the project is to avoid removal of any trees likely to survive the effects of the fire, using the mortality guidelines described in Appendix B.). Further, timber salvage is appropriate in most of the management areas within the Moose Fire area within Big Creek.

Minimal post-salvage slash treatments are anticipated, though some fuel reduction may be necessary in units where accumulations of woody debris would inhibit regeneration and create a fuel hazard (refer to Appendix A for treatment descriptions). Jackpot burning would be preferred over grapple piling, to minimize impacts on the soil. The intent of salvage is to balance the objective of leaving remnants of the fire while reducing the hazard level if another fire should start.

Riparian habitat conservation (RHCA) guidelines described in Chapter 2 apply to this and all action alternatives. No salvage harvest would occur in these RHCAs.

Where seed sources are available, germination of lodgepole pine, larch, and Douglas-fir have a high potential for success if adequate cone crops exist due to the ash seedbed created by the fire (Schmidt *et al*. 1976; Miller 2000). Regeneration surveys would monitor this process. If natural regeneration is inadequate to meet stocking guidelines, planting would augment these areas. Conifer seedlings would be planted on approximately 1271 acres and natural regeneration is anticipated on 1182 acres of treated units. Regeneration surveys subsequent to salvage would be performed to determine the success of natural regeneration as well as the planting. A variety of conifer species would be planted to add to the diversity of the early successional vegetative community. Ponderosa pine would be planted where suitable growing conditions exist but where ponderosa pine is presently a minor component. Planting also ensures diversity in what otherwise might develop into an overstocked monoculture of lodgepole pine trees. Future generations may then have options and a useable resource for wood fiber if they so choose, as expressed in the National Forest Management Act (NFMA).

Regeneration success on the nearby Little Wolf Fire of 1994 has been very high. All harvest units (1175 acres) included in the fire salvage in Little Wolf have been certified as fully stocked (project record O-39). The spruce beetle control units (1213 acres) have also regenerated, with all but two being certified as fully stocked. The remaining two units are expected to be certified in autumn of 2002.

Natural Successional Development

Natural successional development (i.e., no planting after salvage) would occur on 24,713 acres (95.4%) of the approximately 25,900 acres of the Moose Fire within Big Creek. Even where seedlings are planted, growing space will still be available for herbs and grasses to become established. Long-term site productivity will not be adversely affected due to the abundance of coarse woody debris prescribed for all units. The removal of dead trees from salvage units would not keep natural successional development from occurring; however, summer logging of ground-based units would reduce the number of seedlings that may establish from the residual onsite seed source. There are 264 acres proposed for ground-based logging, and 177 acres of that would be planted with varying combinations of white pine, larch, Douglas-fir, or ponderosa pine. The 78 acres proposed for natural regeneration in ground-based units are adjacent to seed walls or would have islands of residual live trees left to provide a seed source for regeneration. If Alternative 2 or 5 were to be implemented, it is likely that some of the ground-based units would be harvested in winter, causing much less damage to new seedlings. Much less damage to new seedlings would also be expected with helicopter and cable yarding methods. The option of harvesting by ground in winter or by helicopter in summer would apply to 387 acres. In general, areas with bare soil and a nearby seed source can be expected to become overstocked anyway (Shearer 1989).

Inventoried Roadless Areas and Scenic River Corridor

Alternatives 2 and 5 would remove Douglas-fir and/or spruce in inventoried roadless areas if infested with bark beetles. It would directly treat 151 acres across 470 acres within inventoried roadless areas, with the remainder left

as leave tree groups. This 151 acres equates to 1.2 percent of the total roadless area acreage (refer to discussion under the Inventoried Roadless Area section of Chapter 3). Douglas-fir and spruce trees 14 inches and greater at dbh would be removed, and smaller trees and other species will be left on site. Units 72, 73 and 78 experienced high tree mortality from the fire and leave groups would mainly consist of snags of varying diameters. Units 70, 75, 76, and 77 would leave patches of mostly live trees, comprising 40 to 60 percent of the unit area. The logging system required on these units is yarding by helicopter. Trees would be felled by hand. No equipment would enter the roadless areas, and no roads would be constructed. These units are on the border of the roadless areas. There are no unique vegetative features present in the roadless areas to be affected by the alternatives. The only change that would be evident post-salvage is the existence of stumps across 151 acres where dead and dying Douglas-fir and/or spruce trees were removed. All other species would remain.

Removing dead trees from the units would not interfere with the natural successional path because no seed trees would be taken, and adequate amounts of woody debris for nutrient cycling and ecosystem function would remain. Nearly 12,000 acres in roadless designation within the Moose Fire area would remain unaltered for the monitoring of post-fire succession. Beschta *et al*. (1995) includes inventoried roadless areas in their list of sensitive areas. The roadless areas in Big Creek are political boundaries and are not inherently ecologically sensitive (see also the Special Designations section of this chapter, and Appendix D).

In the Scenic River corridor along the North Fork of the Flathead River, 16 acres are proposed for treatment across three units. Only beetle infested Douglas-fir trees would be removed, leaving most trees unsalvaged (estimated over 50% of the trees would remain). The anti-attractant pheromone MCH has been placed in portions of the Wild and Scenic River corridor on remaining live Douglas-fir to protect them from Douglas-fir beetle infestation. This should reduce the number of trees that would be salvaged in the river corridor. Natural regeneration is expected to occur in these units.

Snags and Downed Woody Material

In all units, larch > 18” diameter would be left; in some units additional larger snags of other species would also be left to serve a variety of ecological functions, including wildlife habitat, woody debris recruitment for nutrient cycling and long-term site productivity, and a degree of structural integrity. These will usually be the larger windfirm western larch or Douglas-fir. Unmerchantable trees with deep char or less than 8 inches dbh would be left. Some trees may be pushed over during harvest operations for logging access or safety reasons, or felled for helicopter operations safety. The remaining smaller-diameter leave trees will likely remain standing for five to ten years. Large diameter Douglas-fir and larch have the potential to remain standing for a considerably longer period of time, depending on the degree of stem char. Residual trees in tractor units will be distributed throughout the harvested units in clumps or as isolated trees. Chapter 2 alternative descriptions and Appendix A describes treatments by stand groups. Also see snag and downed woody habitat analysis under the wildlife section.

Access for future timber management

Implementation of Alternative 2 would require the removal of 57 miles of road from the forest system to meet grizzly bear security requirements. Reasonable and economical access to 4785 acres of forest for resource management would be lost with the implementation of the road decommissioning (project record O-12). Alternative 5 calls for decommissioning 56 miles of road, which could affect reasonable and economical access to about 4000 acres within the Big Creek drainage. Future timber harvest in areas where roads have been decommissioned would require logging systems that can economically operate farther away from existing roads, such as helicopter or forwarder, or reconstruction of decommissioned roads or construction of new roads. Logging systems such as helicopter or forwarder are more expensive than many other logging systems and could affect the financial viability of future sales. Reconstruction of decommissioned roads or new roads would also be an expense that would likely be borne by future timber sales, and could also affect financial viability.

Fuel Reduction Treatments

Alternatives 2 and 5 include three areas treated to reduce current fuel loadings and lower future fire risk and hazard adjacent to private property and administrative sites. The Coal Creek and Glacier Institute sites mostly burned at high severity, and treatment would “thin” the dead trees across about 189 acres, leaving an estimated 20 to 80 trees

per acre, blending into the unthinned burned forest. Slash would be either sold as a wood product, if feasible, or piled and burned. A maximum of 15 tons/acre dead and downed wood would be left across the units. Planting larch, Douglas-fir and/or ponderosa pine would occur across portions of these areas. These are all fire-tolerant species that are desirable in the future stand.

A thinning treatment would also be applied in portions of the Big Creek Campground, opening up the canopy around picnic areas and campsites, and removing dead trees that are safety hazards. Much of the campground was unburned, and thinning would remove live trees, leaving about 15-25 feet between the crowns of the trees in the campsite area. This would allow a greater amount of light to reach the forest floor, encouraging the development of shrubs, grasses and the establishment of a new generation of conifers on 19 acres. These are likely to be the more shade- tolerant species, such as subalpine fir and Douglas-fir. In localized spots, planting of ponderosa pine and larch would occur to introduce species diversity and more fire-tolerant species at the campground.

Refer to the Fire and Fuels section of this chapter for further detail.

Alternative 3

Alternative 3 was designed to respond to the issue of salvaging in roadless areas. No salvage harvest in inventoried roadless areas is included in this alternative or in Alternative 4. The same three fuel reduction treatment units are included as described under Alternatives 2 and 5. Effects from this alternative are essentially the same as those described for Alternatives 2 and 5, with the exception of effects to 151 acres in areas designated as roadless, and the addition of 14 acres to roadside harvest units. Standing snag structure on the 151 acres in roadless would not be altered, allowing for higher levels of natural downfall and buildup of coarse woody debris.

To respond to public comment regarding utilization and the abundance of snags in some areas, larch snags greater than 20” diameter at breast height would be designated to leave in seven units. This would allow the harvest of snags 18-20” dbh on 355 acres, unlike the other action alternatives. In all units that are adjacent to open roads, only snags that would provide high quality wildlife trees would be designated and marked as leave trees within 200’ of the road. In this area, all other snags that make a merchantable product would be removed during the salvage harvest.

Timber Resource

This alternative would recover 14.5 million board feet from 2,266 acres, 200 thousand board feet less than Alternatives 2 and 5. The prescriptions for treatment remain the same as Alternative 2, except for salvage in the inventoried roadless areas. Regeneration through planting would occur on 1086 acres, leaving 24,820 acres (95%) of the fire area within Big Creek to naturally regenerate. Although regeneration is greatly increased in areas where dead trees are left standing to provide shade, monitoring of reforestation in areas where salvage harvest occurred will ensure regeneration is adequate. Planting will be scheduled if stocking levels are below prescription by year three or five.

Access for timber management

This alternative would remove 56 miles of road from the forest system to meet grizzly bear security requirements. It has a slightly different combination of roads than Alternative 2. Reasonable and economical access to approximately 6400 acres of forest for resource management (planting, thinning, timber stand inventory, insect and disease monitoring, harvest, etc.) would be affected with the implementation of the road decommissioning (project record O-12), with effects essentially the same as those described for Alternative 2.

Alternative 4

Alternative 4 was designed to respond to the issues of harvest in roadless areas, the wild and scenic river corridor, winter disturbance to wildlife, buffering riparian habitat conservation areas, and greater wildlife security through increased road closures. In addition, higher levels of snags would be left in harvest units, and four units are excluded from salvage to leave higher levels of coarse woody debris and snags on those sites.

Timber Resource

This alternative would treat 1793 acres with a combination of helicopter, cable and ground logging systems. Approximately 11.9 million board feet of timber would be salvaged if implemented in a timely manner. No harvest would occur in winter. Ground yarding systems (208 acres) would employ rubber-tired skidders and/or forwarders, operating on a slash mat where soil conditions are a concern. This alternative calls for 1462 acres of helicopter yarding.

Three salvage units (25, 38, & 50) in areas that had been converted to shelterwood stands prior to the fire are eliminated from this alternative, to increase the potential amounts of coarse woody debris and snags on 129 acres. In order to increase the riparian habitat conservation area buffer to 300' on ephemeral streams, three more units (54, 55 & 64) are not included in Alternative 4. Additionally, 26 units have been reduced in size for RHCAs, eliminating treatment on a total of 215 acres. As in Alternative 3, no salvage would occur in inventoried roadless areas. Three units in the wild and scenic river corridor (67, 68 & 69) are not included in Alternative 4, dropping another 15 acres.

Interplanting of ponderosa pine for species diversity on 95 acres would not occur in this alternative because the units that have suitable habitat types for ponderosa pine are not included in this alternative.

Natural Successional Development

Natural successional development (i.e., no planting after salvage) would occur on 25,162 acres (97%) of the 25,900 acres of the Moose Fire within Big Creek. Even where seedlings are planted, growing space will still be available for herbs and grasses to become established. Long-term site productivity will not be adversely affected due to the abundance of coarse woody debris prescribed for all units. The removal of dead trees from salvage units would not keep natural successional development from occurring; however, summer logging of ground-based 208 acres proposed for ground-based logging, and 155 acres of that would be planted with varying combinations of white pine, western larch, Douglas-fir, or ponderosa pine. The 53 acres proposed for natural regeneration in ground-based units are adjacent to seed walls or would have islands of residual live trees to provide a seed source for regeneration. If Alternative 4 were to be implemented, none of the ground-based units would be harvested in winter, affording no protection to new seedlings. Less damage to new seedlings would be expected with helicopter and cable yarding methods, which account for 88 percent of the units.

Snags and downed woody material

In addition to larch snags, all 18"+ dbh severely burned Douglas-fir trees would be designated for leave. Within 200' of open roads, these snags would be signed or marked as wildlife trees in an effort to protect them from firewood cutting. These additional dead standing snags would be beneficial to the establishment of young seedlings by providing intermittent shade (Shearer 1976). See wildlife section for more complete analysis.

Access for timber management

Implementation of this alternative would decommission 87 miles of road in the Big Creek drainage, leaving eight miles of road open year-round and 23 miles open seasonally. This would eliminate reasonable and economical access to approximately 13,480 acres in the watershed for managing the vegetation resource (project record O-12). Planting, thinning, timber stand inventory, and /or timber harvest would all have substantially increased costs.

Fuel Reduction Treatments

Alternative 4 includes the fuel reduction treatment units adjacent to private lands near Coal Creek and at the Glacier Institute site. Refer to discussion under Alternatives 2 and 5. The treatment within the Big Creek campground is dropped from Alternative 4: therefore there would be no change to the current conditions in this area.

Direct and Indirect Effects of Action Alternatives on Succession, Structural Distribution, Fire severity class, and Blowdown

Stand level

Stand level effects are described in the stand group table in Appendix A. Table 3-4 displays the acreages of structure classes affected by Alternative across the landscape. It is important to note that the Moose Fire was the disturbance that initiated a new pioneer or early seral stage of succession. Some stands that had been functioning as late seral received enough mortality that they are now in early succession, or seedling, stage. The action alternatives affect succession to the extent that planting conifers in harvest areas hastens the revegetation process. Planting seedlings does not inhibit or prevent natural regeneration. Salvage treatments in the alternatives do not change the successional stage, because only dead and dying trees are proposed for harvest (as has been addressed in Appendix B Post-fire mortality guidelines, it is acknowledged that there may be some trees that are removed that would otherwise live, and some trees that are left that may die).

The potential for blowdown in harvest units is greater because the areas are more open and less trees and canopy are left for wind protection. The edge created by harvest will contribute to blowdown, but will be mitigated somewhat by residual standing snags and unmerchantable trees. Potential for blowdown is a function of species, diameter, landtypes/soils, elevation, and wind patterns. Deep-rooted species are western larch and Douglas-fir. Shallow – rooted species include spruce, subalpine fir and lodgepole pine. Dense stands of trees that have developed together over long periods of time mutually protect and support each other and do not have roots and boles to withstand exposure to wind if opened drastically. Residual live trees may develop windfirmness over time. Predicting when residual trees would blow down with or without harvest is difficult, but residual trees in harvest units can be expected to come down sooner than those in unmanaged stands because of increased exposure to wind. As stated earlier, research (Lyon 1977; Harrington 1996) has shown that most fire-killed trees are on the ground within ten to twenty years regardless of adjacency to salvaged trees, so blowdown patterns are not greatly influenced over the long term.

In stands with low to moderate fire severity, the distribution of mortality is highly variable. Consequently, harvest of dead trees would leave stands with irregular forest structures. Gaps or patches of openings would be interspersed with live green trees from sapling, pole, and mature size classes. A mixture of live green trees of all sizes, small-diameter dead trees, and large-diameter snags would represent the residual structure. Residual canopy cover would be greater than in stands with high fire severity.

Some green trees may be damaged (bark skinning) during harvest operations. Skid trails and skyline corridors would be located to minimize damage to green trees. Residual cone-bearing trees will provide a seed source for natural regeneration in these less intensely burned stands. Areas that experienced ground fire may provide site preparation and the germination substrate for natural regeneration.

The potential for blowdown within harvest units in less intensely burned stands is relatively less than in the more intensely burned stands. Stands will be opened up through the removal of dead trees, but green trees are more root-firm and likely to stand. This is not to say blowdown would not happen. As mentioned earlier, elevation, wind patterns, landtypes, and species contribute to the potential for windfall. In addition, open stands with mature trees with full crowns intercept wind better than burned crowns. In time, green trees would develop windfirmness, improving their ability to stand. Delayed mortality can be anticipated after harvest activities due to cumulative stress caused by the fire and climatic conditions. The trees affected by delayed mortality would contribute to future blowdown.

Landscape Level

Direct and indirect effects of the action alternatives on vegetation diversity and ecological processes will be evaluated through quantifying the amount of various communities and their characteristics (structure and fire severity classes) across the landscape. The analysis will focus on the condition of the forest communities, burned or unburned, that would result from the proposed activities and the effect they will have on future forests. It is important

to remember that remnants of the pre-fire condition are present in the vertical arrangement of the burned vegetation (structure).

The importance or relevance of examining structure, especially with regard to burned forest, lies in the precept that ecosystem function is a consequence of structure. If the Moose Fire landscape is to function to the extent that burned landscapes have in the past, then a substantial representation of the burn should remain undisturbed. The degree to which alternatives provide for a fully functioning ecosystem is a measure of how well overall ecological integrity might be maintained. The amount of structural class disturbed by the fire and left untreated are the *legacy* acres.

Although this post-fire harvest affects snag structure, it does not affect the *successional* structural class. The vegetative structure classes assigned are based on living trees, and the salvage is intended to remove only a portion of the dead and dying trees within the fire (as has been addressed in Appendix B Post-fire mortality guidelines, it is acknowledged that there may be some trees that are removed that would otherwise live, and some trees that are left that may die). Amounts of structural class affected by alternative are shown in the tables following (project record O-13a).

Table 3-4: Salvage harvest acres by structural stage for Alternatives 2 and 5.

Structural Class	Post-fire Structure acres	Harvest acres	Post-harvest acres	% of post-fire structure treated
Stand initiation	17763	1792	17763	10.0%
Stem exclusion	973	0	973	0%
Understory reinitiation	6339	1150	6339	17.8%
Young forest multi-story	89	0	89	0%
Late seral	387	0	387	0%

This table includes only national forest acres in the fire perimeter ***within Big Creek drainage.***

Table 3-5: Salvage harvest acres by structural stage for Alternative 3.

Structural Class	Post-fire Structure acres	Salvage acres	Post-salvage acres	% of post-fire structure treated
Stand initiation	17763	1587	17763	8.9%
Stem exclusion	973	0	973	0
Understory reinitiation	6339	867	6339	13.7%
Young forest multi-story	89	0	89	0
Late seral	387	0	387	0%

This table includes only national forest acres in the fire perimeter ***within Big Creek drainage***.

Table 3-6: Salvage harvest acres by structural stage for Alternative 4.

Structural Class	Post-fire Structure acres	Salvage acres	Post-salvage acres	% of post-fire structure treated
Stand initiation	17763	1281	17763	7.2%
Stem exclusion	973	0	973	0%
Understory reinitiation	6339	679	6339	10.7%
Young forest multi-story	89	0	89	0%
Late seral	387	0	387	0%

This table includes only national forest acres in the fire perimeter ***within Big Creek drainage***.

Varying amounts and distributions of structure are left as legacies across the landscape in each alternative. Smaller diameter trees and unmerchantable trees will leave some structure in harvested areas. All alternatives will meet Forest Plan requirements for snags and downed wood. By excluding salvage from 193 acres of previous shelterwood harvest, Alternative 4 would maintain a greater number of snags and legacy material.

Late Seral/Old Forest:

No areas mapped as late seral forest will be treated with this proposal. Ground-truthing in the unit included in the DEIS (unit 45) revealed mortality upwards of 80 percent in the mixed conifer stand, in addition to a large pocket of blowndown spruce trees. Fire severity in the majority of the stand altered the functioning structure of the stand from late seral to understory reinitiation. The portion of the stand with low severity fire and functioning late seral was not included in the unit boundary. The adjacent unit, unit 46, includes the acres from Unit 45 that experienced a moderate severity burn. Unit 46 is a helicopter unit, and western larch and Douglas-fir with relatively light or no fire damage will be left.

The late seral patch adjacent to Unit 66 was reduced to only a few functional acres by the Moose Fire (Project File Record O-1). Unit 66 is a cable unit with moderate fire severity in a western larch cover type. About 80 percent of the unit burned at moderate severity, with high tree mortality, and no longer functions as a late seral stand. The only portion being treated is the area that has changed to an understory reinitiation stage. As in all prescriptions for this project, western larch over 18” would be retained.

Fire Severity

Another component of the Moose Fire that provides a measure of the effects of action alternatives is the number of unharvested acres in each fire severity class, where no additional ground disturbance would occur from salvage activities. The following tables disclose the number of acres in each fire severity class where harvesting is proposed (project record O-13) and the percent of national forest system land left unharvested by alternative. At least 91 percent of the fire area in Big Creek drainage would be left as legacy (Perry and Amaranthus 1997) in all alternatives.

Table 3-7: Legacy area in Alternatives 2 and 5

Fire severity	Fire Acres in Big Creek Drainage	Salvage Harvest Acres	% of Big Cr. Fire Area unharvested
High	11405	1100	90%
Moderate	6119	695	89%
Low	5879	633	89%
Unburned	2502	0	100%
Total	**25,906**	**2403**	**91%**

Table 3-8: Legacy area in Alternative 3

Fire severity	Fire Acres in Big Creek Drainage	Salvage Harvest Acres	% of Big Cr. Fire Area unharvested
High	11405	1117	91%
Moderate	6119	648	90%
Low	5879	501	92%
Unburned	2502	0	100%
Total	**25,906**	**2266**	**92%**

Table 3-9: Legacy area in Alternative 4

Fire severity	Fire Acres in Big Creek Drainage	Salvage Harvest Acres	% of Big Cr. Fire Area unharvested
High	11405	920	92%
Moderate	6119	483	92%
Low	5879	390	94%
Unburned	2502	0	100%
Total	**25,906**	**1793**	**93%**

Harvest System

As shown in the following table, the majority of acres proposed for harvest in all alternatives would be salvaged using a helicopter system. Hand falling and helicopter yarding is the least impactive method of salvaging trees. No heavy equipment would be on the ground, nor would trees be dragged across the soil. However, more snags may need to be felled for safety.

Table 3-10: Harvest system by Alternative

Harvest system	Alts 2 & 5	Alt 3	Alt 4
Ground-based (skidder/tractor)	255	263	208
Skyline	266	266	123
Helicopter	1520	1344	1462
Winter Ground/or helicopter	387	393	0

Some post-salvage fuel treatments may be necessary in units where accumulations of woody debris inhibit reforestation efforts or pose fire hazards. These accumulations, or “jackpots”, would be burned under favorable burning conditions and in coordination with the state air quality requirements. Some spot grapple piling may occur. Unmerchantable material would be left standing where possible and practical, although harvest operations can be expected to push some smaller dead trees over.

Reforestation

Prompt reforestation would minimize the time that burned stands are unstocked and unproductive from a timber management standpoint. Skidding from the logging operations, jackpot burning or spot grapple piling would accomplish site preparation for reforestation. Regeneration activities are predicted to provide a fully stocked stand within five years. Regeneration indices for past harvest and planting in the Big Creek watershed show a high rate of success (project record O-36). Species diversity would be maintained or improved through reforestation. Natural regeneration would be monitored and augmented with planting in the event of poor cone crops. The following table displays the number of acres of planting and natural regeneration proposed by alternative.

Table 3-11: Reforestation by alternative

Reforestation Method	Alts 2 & 5	Alt 3	Alt 4
Acres to be Planted	1182	1086	738
Acres of Natural Regeneration	1246	1180	1055

Seedlings planted on national forest system lands almost always (the exception is rust-resistant whitepine) come from seed sources native to the site, and are native species found on the habitat types being planted (Beschta *et al.* 1994). This would be the case on the Moose project as well.

Road reclamation for grizzly bear security (Forest Plan requirements) would require planters and thinners to walk distances of .5 to 1.5 miles to access some units, increasing unit costs.

Harvest operations are anticipated to take two years. If harvest operations extend to the third year, significant loss of the value of timber products can be anticipated due to deterioration. Deterioration will be greatest in spruce, subalpine fir, and lodgepole pine trees less than 10" dbh. Should harvest extend into the third year, an estimated 30 to 60 percent of the volume not yet harvested would be affected by cracking. This varies greatly by species (USDA 2000).

Size of openings

The National Forest Management Act requires that openings created in the forest by even-aged silviculture shall be less than 40 acres except in areas harvested as a result of natural catastrophic conditions such as fire, insect and disease or windstorm (36 CFR 219.27,d,iii). The Moose Fire satisfies the "catastrophic" condition. Salvage units in high fire severity areas would result in even-aged stands because the fire caused 100 percent mortality and all new trees would be one age. Units in low severity fire areas would result in two age classes because residual green trees would provide one age class and newly regenerated trees would be a distinctly younger age. Moderate severity fire areas would result in a mixture of both, because delayed mortality to trees is expected in many areas that presently display green crowns but have fatal root and/or bole scorch. Refer also to description under Alternative 9, Alternatives Considered But Not Given Detailed Study, Chapter 2 of this EIS.

Cumulative effects

The cumulative effects analysis does not include actions in the Coal Creek State Forest affected by the Moose Fire because actions on the north side of the watershed divide will not affect the vegetation processes in the Big Creek drainage.

Past, present and reasonably foreseeable actions as described earlier in this chapter, are not expected to greatly influence the succession, structural distribution, or fire severity class for vegetation when combined with salvaging fire-killed trees. Rates of blowdown of fire-damaged or fire-killed trees may increase as a result of existing harvest openings.

Past, present, reasonably foreseeable, and similar actions considered for cumulative effects

Past Activities

Past harvest occurred on about 26 percent of lands within the Big Creek drainage. Much of this management occurred in the 1950s and 1960s in response to a spruce beetle outbreak. Within the portion of Big Creek drainage that lies within the Moose Fire, 24 percent of the area had been previously harvested. Harvested areas have been regenerated, either naturally or artificially, and were in various stages of growth at the time of the Moose Fire, as described earlier in the vegetation section. The introduction to Chapter 3 contains a complete list and description of past, present, and reasonably foreseeable activities.

Suppression tactics used to control the fire directly affected some vegetation resources in Big and Coal Creeks. Documented impacts to vegetation resulted from:

a) Construction of dozer lines along previously closed road systems and on previously undisturbed sites.
b) Creation of "safety zones", staging areas, and drop points within the fire perimeter.
c) Removal of aerial fuels and hazard trees during line construction activities.
d) Reduction of fuels and vegetation ahead of the fire-front by backfire operations.(Moose BAER report).

Rehabilitation of the above items was undertaken at the end of the fire. Waterbars and woody debris have been placed in dozer lines, and disturbed ground has been seeded with non-invasive grass seed.

Recent activities include aerial seeding, accomplished on 1357 acres in March 2002, using the seed available at that

time. Douglas-fir and Engelmann spruce seed was applied to four areas within the fire boundary (project record O-9). Other species that would have been desirable are western larch, western white pine, and ponderosa pine; however, no seed was available. It is recognized that mixed results are obtained from aerial seeding, but species diversity on these sites is desired, and without seeding or planting, a lodgepole pine monoculture can be expected, as occurred in many areas after the 1988 Red Bench Fire a few miles to the north of the subject area. Seeding can help stabilize areas on Demers Ridge where soil movement is a risk, and to establish tree species that will provide thermal cover on ungulate winter range.

Replanting of previously harvested units where regeneration was consumed by the fire was undertaken during the spring and early summer of 2002.

Removal of hazard trees (non-windfirm snags) along roads within the fire was completed in August of 2002. Adequate woody debris and residual snags remain for soil nutrient cycling.

Mushroom harvesting occurred during the summer of 2002 in the Moose Fire area, and although individual conifer germinants may have been affected, overall regeneration is expected to be abundant.

Noxious weed treatments have occurred in the Big Creek Campground, which is beneficial to native plants.

Big Mountain Ski and Summer Resort has converted vegetation from timber stands to brush and grass fields for seven ski runs, appropriate to the management area designation of those lands.

These past activities, taken in consideration with the proposed salvage of dead and dying trees, should not result in any long-term detrimental effects to the vegetation resource in the project area.

Present Activities

Special forest products gathering for personal use is likely to continue, such as berry picking, firewood and Christmas tree cutting, evergreen bough and cone collection, particularly in those areas unaffected by the fire. Christmas tree harvesting and bough collection affect a miniscule proportion of trees in the drainage, and can serve to prune and thin on a small scale.

Road and culvert improvements are continuing in the drainage, but do not effect the vegetation resource to any significant degree.

Reasonably Foreseeable Actions

A Decision Notice for a prescribed burn to restore whitebark pine on Moose Peak was approved prior to the Moose Fire, but it will not be implemented until the Moose Fire area has somewhat recovered, in about 3 to 5 years. Moose Peak is 2.5 miles from the boundary of the Moose Fire.

The network of roads in a forest facilitates economic management of forest resources. There are presently about 165 miles of road under Forest Service jurisdiction in the Big Creek drainage, with access ranging from open yearlong to those closed and allowed to naturally revegetate. However, Amendment 19 to the Forest Plan has yet to be fully implemented, and it likely will result in the reclamation of some roads in Big Creek to improve grizzly bear security.

Personal use firewood gathering, Christmas tree harvesting, and bough collection is likely to continue throughout the area of Big Creek unaffected by the Moose Fire, but these activities are not of the magnitude expected to influence the structure, composition or function of the vegetation resource. Post-and-pole sales usually occur in overstocked sapling/pole sized stands of lodgepole pine, where stand conversion is desirable.

The continuing expansion of Big Mountain's north slope, in the headwaters of the Big Creek drainage, is occurring on lands designated for recreational use. The effects of this expansion are documented in the Big Mountain EIS and Record of Decision. Activities at Big Mountain, though within the drainage, would not overlap in time and space with salvage activities within the Moose Fire perimeter.

Fuel reduction zones at Big Creek Campground, Glacier Institute, and on the boundary with private land in lower Coal Creek would be beneficial to the residual trees, allowing more growing space for sunlight, nutrients, and water, and improving the odds for their surviving a fire in the future if a crown fire is averted.

A study by the Forest Health Protection office to determine the deterioration rates of fire-killed larch has been proposed to the District Ranger. This is explained in detail at the beginning of Chapter 3.

Alternative 1

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. Although a list of all known activities, past, present, and future are listed earlier in this chapter, few of them have any direct, indirect, or cumulative impact to vegetation in conjunction with the *no action* alternative. Short of conversion to agricultural land or a paved road, forest vegetation will return to sites in the Big Creek drainage. Disturbances to vegetation, either naturally occurring, such as wind, fire, or flood, or through past harvest, are all short-term. Habitat types in northwestern Montana are generally highly productive for vegetative biomass, the climate provides adequate moisture, and seed dispersal from adjacent live trees, shrubs, grasses, bird and animal droppings, and residual seed in the soil will aid in renewal. The one percent of soils severely affected by fire intensity will be slower to recover, but will in time (see soils section in chapter 3). Disturbances caused by suppression activities on the Moose Fire have all undergone rehabilitation and no lasting effects to vegetation are expected.

The closure of some amount of road is a reasonably foreseeable action with the *no action* alternative because it is required under the amended Forest Plan. Former roadbed will slowly colonize and become vegetated. The Big Mountain Decision approved the revegetation of 27.4 miles of road that had historically been closed year-round to public access within the drainage. The effect is that access for vegetation inventory, monitoring, and management may be substantially diminished.

It is unlikely that mushroom harvesting would have affected the rate of regeneration within the burned area to any significant degree. Although substantial numbers of people were on nearly all 26,000 acres of the fire within the Big Creek drainage, and tender germinants undoubtedly were repeatedly stepped on, natural regeneration of lodgepole pine is so great, the fire area will probably only have isolated areas where regeneration is a problem.

The Moose Peak prescribed burn is being delayed to allow vegetation and wildlife recovery in Big Creek before applying fire to the landscape again. The purpose of the prescribed burn is to promote the regeneration of whitebark pine, a fire-dependent species.

Areas affected by suppression efforts were seeded with non-invasive grass species, mainly annual rye, which should not persist past next growing season, allowing native species to become established.

The bottom line for cumulative effects to vegetation is that, as mentioned above, short of paving, vegetation is irrepressible. Even where soils have been compacted such as roadbeds, experience shows that grasses, alder, and conifers can all become established. Conifer productivity is known to decline on abandoned roadbeds where soil is compacted.

Action Alternatives 2, 3, 4 and 5

The removal of dead trees, in conjunction with the past, present and reasonably foreseeable activities cited in Chapter 3 and reiterated earlier in this section, should not have a substantial impact on the vegetation resource in terms of structure, function, or composition. The Moose Fire was the significant disturbance, any salvage activity of dead and imminently dead trees is not going to affect the ability of vegetation to continue to function as it has since the glaciers receded. Artificial regeneration would introduce biological diversity in areas that would otherwise be expected to develop into a lodgepole pine monoculture. Disturbances caused by suppression activities on the Moose Fire have all undergone rehabilitation, including revegetation with annual rye (a short-lived annual) and native species; no lasting effects to vegetation are expected.

It is unlikely that mushroom harvesting during the spring and summer of 2002 affected the rate of regeneration with the burned area. Large numbers of people combed nearly all 26,000 acres of the fire within the Big Creek drainage, and tender emerging seedlings were undoubtedly stepped on. It is not possible to determine the percent survival of seedlings under these conditions. A very minor amount of mushroom harvesting activity can be expected in future years as green plants become established and conditions for the flush of fungi are no longer present.

The larch deterioration study would fell 240 snags over a ten-year period. The downed snags would be left on site to provide woody debris and nutrient cycling for soils, as well as wildlife habitat. The vegetation resource would not be affected by this study.

Road closures and decommissioning have been occurring in the Big Creek drainage for many years and will continue to occur. The cumulative effect of this is a continuous reduction in access for both the public and for management activities. Costs for monitoring and managing the vegetation resource can be expected to increase, though the exact amount is hard to determine.

According to Perry and Amaranthus (1997), management systems can be devised that sustain productivity and biological diversity. Design criteria for this project includes consideration for soils, woody debris for nutrient cycling, and conifer regeneration, which would ensure that implementing any of the action alternatives would not destroy indigenous biological diversity or soil integrity on this landscape. The action alternatives contain plans for the future through regeneration of the forest with a diversity of species, and at a landscape scale. Future generations may then have options for forest management.

3. Regulatory Framework and Consistency

The National Forest Management Act (NFMA) (16 USC 1604) requires that Forest plans “reserve and enhance the diversity of plant and animal communities… so that it is at least as great as that which can be expected in the natural forest” (36 CFR 219.27). Additional direction states that “management prescriptions, where appropriate and the extent practicable, shall preserve and enhance the diversity of plant and animal communities, including endemic and desirable naturalized plant and animal species, so that it is as least great as that which could be expected in a natural forest and the diversity of tree species is similar to that existing in the planning area.”

Vegetation

Flathead National Forest Plan (LRMP) goals include maintaining a diversity of vegetation and habitats across the forest to meet the needs of a variety of wildlife species, and to provide for a sustained yield of timber products (LRMP, original, II-5). NFMA implementing regulations also require that management consider the existing diversity of plant and animal communities. The LRMP further defines timber management goals of providing a sustained yield of timber products that is cost-effective, responsive to the needs of the local economy, and is consistent with other Forest Management goals (LRMP II-5). These goals are discussed in Forest-wide timber management objectives described on pages II-7 to II-9 of the LRMP.

The NFMA requires that “timber will be harvested from national forest system lands only where there is assurance that such lands can be restocked within five years of harvest.” Determination of adequate stocking would be based on regeneration surveys conducted one, three, and five years following tree planting or site preparation for natural regeneration. Numbers of trees per acre and stocking percentages would be calculated from these surveys, and compared to the minimum and desired stocking levels identified in the harvest prescription for each particular stand.

Management Area 9 contains a wildlife and fish standard that states, *“Regeneration of each managed habitat unit will include diverse tree species but will feature Douglas-fir (40% of trees by numbers) if the site is capable of growing Douglas-fir.”* Any silvicultural treatments in MA 9 are designed to achieve at least 40 percent Douglas-fir to provide thermal cover over time. In salvage areas, this may have to be achieved by planting Douglas-fir.

The LRMP provides goals, objectives and standards for protection and improvement of the timber resource and other vegetation (LRMP pgs II 5-8 and II 38-40). In accordance with this direction, the area has been analyzed and

determined that all alternatives are within the standards set in the Forest Plan. Therefore, all alternatives are consistent with LRMP direction and its amendments concerning vegetation.

Old Growth Habitat (Late Seral)

Amendment 21 to the Flathead Forest Plan (management direction related to old growth forests) was signed in January 1999. It has a goal to "maintain and recruit old growth forests to an amount and distribution that is within the 75 percent range around the median of the historical range of variability. Where current conditions are below this amount, actively manage to recruit additional old growth." Another goal is to "ensure that Forest Service actions do not contribute to the loss of viability of native species". For species associated with old growth forests, there are objectives to "maintain ecological processes and provide for natural patch size distribution" and to "manage landscape patterns to develop larger old growth patch sizes where needed to satisfy wildlife habitat requirements." Across the landscape, "sufficient retention of forest structure (large-diameter live trees, snags, and coarse woody debris)" should be left to provide for future wildlife movement through the matrix surrounding old growth forests. At the landscape level, there is also a standard that states that "treatments within existing old growth may be appropriate where current insect and disease conditions pose a major and immediate threat to other stands." Another standard states that vegetation treatments should be modified "as needed to meet habitat needs of old growth associated species." If needed to "satisfy wildlife habitat requirements, limit associated human disturbance, or reduce excessive mortality risk", the timing, extent and intensity of vegetation treatments should be modified.

As described earlier in this chapter, no salvage harvest would occur in late seral habitat. Also see "Snag and Downed Woody Habitat" for further discussion of regulatory consistency in regards to snags and old growth.

B. Spruce and Douglas-Fir Bark Beetles

Changes between the DEIS and FEIS

The major change is the incorporation throughout the effects analysis in Section 3, *Environmental Consequences*, of updated information on spruce and Douglas-fir bark beetle infestation levels and locations, resulting from beetle population surveys conducted in July and August of 2002. Some change was made to Section 2, *Affected Environment*, to recognize the results of the monitoring. Most of the information under *Affected Environment* remains the same, providing a description of the spruce and Douglas-fir bark beetle life cycles, host interactions, past beetle activity in the area, and the condition of the vegetation on lands within and outside the fire area related to its susceptibility to continuing bark beetle infestation. Maps 3-3 and 3-4 display the areas that were considered at risk to beetle infestation immediately after the fire. These were the primary areas surveyed for beetle populations. Map 3-5 is a new map that displays the results of the beetle surveys.

1. Analysis Area

The area affected directly by spruce and Douglas-fir bark beetles is defined as the National Forest System Lands within the Moose Fire perimeter (refer to Map 1-2, project area map). For evaluating indirect and cumulative impacts of bark beetles, the area affected is expanded to include all lands within a 5-mile radius of the Moose Fire perimeter (refer to Map 3-3 and 3-4). This distance is based on our knowledge that bark beetles will only fly as far as necessary to find a suitable host, but will fly as far as 30 miles if necessary (Schmid and Frye 1977). Flight tests indicate few beetles can fly more than 7 miles nonstop (Chansler 1960, in Schmid and Frye 1977). Therefore, it is reasonable to assume the generations of beetles produced in the fire area might fly up to five miles from whence they were bred. In subsequent years, given a continuation of favorable beetle breeding conditions and high beetle populations, their influence could extend beyond this zone. Thus, for analysis of potential cumulative effects of beetle population growth in the fire area, the analysis area was expanded to include lands within 10 miles of the project area (refer to Map 3-5).

2. Affected Environment

Introduction

There are many insects and pathogens that may capitalize on the changed forest condition in the Moose Fire; however, only the Douglas-fir and spruce bark beetle are of concern to land managers because of their potential to develop large populations within the fire area, spread into live trees within and outside the fire area, with possible effects to other resource values. This concern is one of the stated needs for action in Chapter 1, and a major driving force behind the design of the proposed action.

Disturbances such as insects, disease, and fire, are all a natural part of the ecosystem, with the wildlife, vegetation, and other components of the ecosystem evolving and responding to the influence of these processes for many thousands of years. Most commonly, bark beetle populations are “endemic” in the forest, with relatively low annual tree mortality. However, periods of high beetle population levels occur periodically, typically in response to disturbances that stress and weaken the host trees (such as drought, fire, blowdown). These insects have evolved to fully capitalize on just such a disturbance as the Moose Fire, where many thousands of fire-killed and stressed trees present the perfect breeding ground for the bark beetles. A bark beetle outbreak in and around the fire area would be normal and natural from an ecological context; however, high tree mortality in much of this area (both on national forest and other ownerships, such as state and private lands) may conflict with landowner’s management objectives and create undesirable consequences.

As noted following the 2000 fire season, bark beetle outbreaks following fires are not a foregone conclusion, but they certainly are not unprecedented (FHP 2000b). Each situation is unique, with widely ranging fire severity, vegetation and site conditions, beetle population levels, and other influencing factors. Several conditions must exist for bark beetles to take advantage of fire-damaged hosts (*ibid*). These include the following:

First, the fire area must have sufficient numbers of host tree species, and the host trees must have an adequate supply of undamaged inner bark (phloem). Beetles feed and lay eggs in this phloem. Hot, stand-replacing types of fires, or fires in thin-barked tree species, may render the inner bark dry and unusable to the beetles. However, documentation following the 2000 fire season recorded numerous examples of beetle infestation and potential outbreaks where Douglas-fir trees burned in hot, stand replacing fires (Gibson 2001, Project Record J-27). High existing Douglas-fir beetle populations in the vicinity probably are contributing to this situation. Within the Moose Fire, many of the older and larger diameter (>16”) Douglas-fir in the areas that burned at high severity were found to still have viable, moist inner bark, protected by the thick, fire-resistant bark of this species. They are still capable of attracting and supporting bark beetles, at least in the larger trees and for up to one year, before the inner bark dries out. But fewer beetles would probably be produced in these than if they were alive or less charred.

Second, fires must occur at a time when beetles are able to capitalize on the new feeding and breeding habitat. Fires in late summer or early fall may occur after adult beetles have flown, and a burned tree’s inner bark may become too dry, or in some cases “sour”, before the next years flight season. The Moose Fire occurred after the height of the beetle flight season in 2001. The fire killed many Douglas-fir trees, though the inner bark on many trees is still moist and able to support a new generation of beetles (project record J-29). Many other Douglas-fir trees not directly killed by the fire have experienced severe crown scorch and are highly stressed. These trees are the most at risk to beetle infestation, and the most able to support and produce high numbers of new adult beetles in subsequent years.

Third, there must be a population of beetles within a reasonable distance to take advantage of weakened trees that become available. High Douglas-fir beetle populations currently exist throughout northwestern Montana, including the Flathead National Forest in the vicinity of the fire. This is likely to continue for at least 2-3 more years (Gibson 2001, Project Record J-27). Spruce beetles are currently at endemic population levels in Northwest Montana, not in excessively high numbers, but expected to be fully capable of exploiting the new, highly desirable feeding and breeding sites in the Moose Fire area. Monitoring in the summer of 2002 has found Douglas-fir and spruce bark beetle activity across an estimated 7000 acres (project record J-32). Monitoring results are summarized in a later section of this chapter.

Historically, there have been, and continue to be, bark beetle outbreaks on the Flathead National Forest. Within the past 20 years there have been significant outbreaks of mountain pine beetle in lodgepole pine stands (McGregor *et al*. 1983) and spruce beetle outbreaks in stands of Engelmann spruce (Gibson 1984). Currently an epidemic exists in Douglas-fir stands in parts of the Big Creek and Coal Creek drainages, as well as in Logan and Good Creek on the Tally Lake District, and surrounding lands (Gibson 2002a, Project Record J-28). Certainly, the precedent exists for outbreaks in this area of the Flathead National Forest. In addition, past bark beetle outbreaks in the Northern Region precipitated by fire-damaged stands are well documented (Amman & Ryan 1991; FHP 1999b; Gibson & Oakes 1993, 1994).

Predicting bark beetle infestations is not an exact science. "Impact" models are useful in predicting beetle-caused mortality in stands of certain characteristics (Cole and McGregor 1983; Negron *et al*. 1999). Our best efforts are directed towards risk management – recognizing when "outbreak conditions" are present, considering potential effects on various resources should an outbreak be realized, and implementing strategies to prevent or lessen the effects of an outbreak if management objectives deem that a prudent course of action. Such is the strategy of this analysis and development of the Moose Post Fire proposed action and its alternatives.

The greatest benefits in dealing with actual or potential Douglas-fir or spruce beetle infestations are derived from efforts aimed at preventing outbreaks rather than suppressing them (Schmitz and Gibson, 1996). This involves modifying live susceptible stands to the extent possible to make them less vulnerable prior to some type of stand disturbance, which may trigger an outbreak. Actions may include altering tree densities and species compositions. Once disturbances occur (common ones being blowdown, fire and drought), removal of bark beetle susceptible trees before they are infested is the most effective course of action to prevent an outbreak or influence beetle populations. Risk of large-scale bark beetle infestation can also be effectively reduced by removing as many infested trees as feasible before the adult beetles emerge and spread to live trees in the vicinity (USDA 1995,1999d, Gibson 2001, Project Record J-27, J-34). Alternatives include use of pheromones both to trap or repel beetles, burning/peeling infested logs to destroy brood, treating infested trees with chemicals, and using trap trees to attract beetles and then removing these trees. All these methods have utility and are applicable in under certain conditions and in specific situations (Project Record J-23). The Moose action alternatives employ a variety of methods to deal with a potential bark beetle outbreak. Refer to Chapter 2 discussions under Alternatives 2 through 5 and Alternatives 6 and 7 (alternatives considered but not in detail) for a more full discussion on treatments proposed and why.

Spruce Beetle

Description, Life History and Host Interactions

The spruce beetle (*Dendroctonus rufipennis* [Kirby]) is the major natural mortality agent of mature spruce in this area. At low, endemic population levels, spruce beetles usually live in wind thrown trees and scattered individuals and groups of trees. Outbreaks normally occur after a stand disturbance event, such as a windstorm, that result in an abundance of feeding and breeding habitat for the beetle. Beetle populations can increase dramatically in these situations and spread into susceptible, larger diameter standing live spruce in surrounding regions, causing extensive mortality of these trees. Outbreaks this last decade in Alaska and Utah spread over more than 2.3 million acres and 122,000 acres respectively, killing tens of millions of trees (FHP 1999a).

The spruce beetle normally has a 2-year life cycle, with adult beetles flying and attacking host material mostly in early summer. The female finds a suitable breeding site, emits a pheromone (or chemical substance) that attracts male as well as other female beetles and initiates a mass attack on the tree. Several thousand beetles can infest a tree and in turn produce two to five times the number of beetles in the next generation. Once mated, the female constructs an egg gallery in the inner bark of the tree and lays her eggs. Eggs hatch that summer, and larvae bore outward from the egg gallery and feed, killing the tree by girdling.

Most of the time spruce beetle overwinter as larvae and pupate in early summer. These new adults will overwinter again in the same tree. Some stay in their original pupae chamber, but the majority will emerge from their original pupae sites, move to the base of the same tree, and bore back into the bark near the litter line. This may be an adaptation to reduce predation by woodpeckers and reduce winter mortality from extreme cold. The spring and

summer of their second year, the adult beetles will emerge from the tree to seek out mates and new breeding sites, beginning the life cycle again.

Spruce beetles are able to fly several miles in search of suitable breeding sites, and being non-aggressive in nature will favor wind thrown, weakened trees to attack. If these trees are not available, they will attack live, healthier trees, though they may or may not be successful. Larger-diameter trees (>18" dbh) are usually attacked first, but with high and persisting populations, the smaller diameter trees are likely to be attacked as well.

Natural enemies of the beetle include birds, insect predators and parasites. When beetles are at lower populations, these organisms can effectively keep population levels in check. During outbreaks, their influence is much lower.

Past and present spruce beetle activity in and around the project area

As stated in the Big Creek EAWS (USDA 1999), spruce is and has historically been a very common species throughout the Big Creek drainage, particularly in the upper half of the watershed, where very moist and cool conditions predominate, and fire intervals are long. Spruce beetle activity undoubtedly fluctuated through time and was probably always a common cause of mortality in the larger diameter spruce. Periodic epidemics occurred in response to events such as fire or windstorms, depending upon the condition of the stands.

As described in the Big Creek EAWS, a major spruce beetle epidemic occurred in northwest Montana and northern Idaho following a severe windstorm of hurricane force winds in 1949. Hundreds of thousands of acres of blowdown resulted, many thousands of these acres in drainages of the North Fork Flathead River, including Big Creek and Coal Creek. This was followed by millions of spruce trees infested and killed by spruce beetles through the 1950s. The earliest harvesting within Big Creek (in the 1950s and 60s) was conducted to slow down the epidemic and salvage the value of the many dead and high-risk spruce trees. This blowdown event and subsequent salvage effort converted many of these stands to an early seral seedling and sapling forest. As a result, the vulnerability of the Big Creek landscape to spruce beetle was and is considerably reduced from the pre-1950 condition.

Spruce beetle activity has been at low, endemic levels in and around the project area for the past 40 years, causing scattered, limited mortality nearly every year. Aerial surveys have detected scattered spruce beetle-caused mortality across a total of about 3400 acres within the Moose project area since 1968 (the first year of aerial surveys), an average of about 100 acres affected per year. The highest activity levels occurred in the early 1980s (Project Record J-21).

Current spruce beetle conditions within the fire perimeter

National Forest System Lands:

Shortly after the Moose Fire, all stands on National Forest System Lands within the fire area (about 35,750 acres) were evaluated for risk of spruce beetle infestation, as disclosed in the Moose Post-Fire Project Draft EIS, published June of 2002. Risk ratings were determined using a well-established rating system developed over 20 years ago (Schmid & Frye 1976). Criteria used were average diameter of spruce over 10" dbh; proportion of spruce in the canopy; basal area (density) of the stand; and physiographic location (i.e. creek bottoms vs. lower productivity sites). This rating was then integrated with the fire severity and its effect on the susceptible spruce trees. Refer also to Section J in the project record for data and maps related to spruce beetle risk and hazard (J-1, J-8, J-9 through J-12).

Over 900 acres were identified at some level of spruce beetle risk, with about 382 of these acres at med-high to high risk – the acres that were considered most likely to be infested with spruce bark beetles in 2002. Most of these acres are in moist, productive riparian zones, where the fire stayed on the ground and burned through the vegetation on the forest floor, damaging the spruce trees in the process. These sites have the highest number of larger diameter fire-affected spruce, many over 20" DBH, and many already wind thrown, creating even more desirable beetle habitat.

Unlike Douglas-fir, spruce has thin bark, and a moderate or high severity fire that chars the bole along most of its length kills the inner bark, rendering the trees useless to spruce beetles. Low severity underburn fires char only the lowest part of the bole or the root crowns and the foliage is usually still green, creating perfect beetle habitat and conditions of high beetle risk. The inner bark has been damaged in the charred regions of the bole, highly stressing the trees. In most cases, these high beetle risk trees have been killed by the girdling effect of the fire itself (they are "dead but don't know it yet"). They still contain abundant moist inner bark in which the beetles may successfully breed.

Field surveys were conducted in August 2002 to determine the extent, location and level of spruce beetle infestation. About 570 acres were surveyed, including nearly all of the medium-high to high risk stands. High levels of spruce beetle infestation were found across about 67 percent of the total surveyed area, or an estimated 385 total acres. Most acres are in the riparian area of Big Creek and its tributaries. Copies of the actual field surveys are found in the Moose Project Record, J-31. A summary of the results of the monitoring is disclosed in this chapter at the beginning of Section 3, *Environmental Consequences,* with the full *Summary Report* found in the Moose project record, J-32.

State Forest Lands:

The Moose Fire burned across approximately 6867 acres on the Coal Creek State Forest, or about 45 percent of the total 15,094 forested acres on the Coal Creek State Forest. An analysis of beetle risk within this area was documented in Appendix E (Vegetation) and Chapters II and III of the *Moose Fire Salvage and Reforestation Project Phase II Environmental Impact Statement* (Montana Department of Natural Resources and Conservation, 2002) (Project Record J-14, J-15). These documents disclose that most of what burned (67%) was in the 40-99-year-old age classes (originating from the 1910 Fire), and most of this (35%, or 2429 acres of the total burn area) was of the lodgepole pine cover type. These stands pose no risk of Douglas-fir or spruce bark beetle infestation. The analysis also determined that areas that burned at high severity (about ½ the area, or 3700 acres) pose greatly decreased or no risk of infestation due to the degraded tree conditions.

The analysis stated that before the fire, mortality had been occurring in both spruce and Douglas-fir over the past few years due to bark beetles in and adjacent to the State Forest. They recognized substantial bark beetle risk across much of the burned area, specifically in the mixed severity burn areas (about 3000 acres). Most of the risk is probably to Douglas-fir beetle rather than spruce beetle. Field observations indicate that the riparian area along Coal Creek contains some underburned, fire-damaged spruce trees that are prime hosts for spruce beetle. Though no surveys are known to have been completed to ascertain the actual infestation level of spruce beetle, it could be assumed (based on survey results on National Forest System Lands) that spruce beetle has infested at least some portion of the underburned, fire injured spruce trees. Exact numbers are not known.

Glacier National Park:

The Moose Fire burned across approximately 26,955 acres in Glacier National Park. Approximately 900 acres within the park are estimated to contain spruce trees of larger diameter that could be at risk of spruce beetle infestation (refer to Map 3-3 and Project Record J-13). This was determined from pre and post aerial photo interpretation and fire severity maps. Nearly 70 percent of these acres (610 acres) are considered to be at low risk, with many if not most of the spruce on these acres burned too severely to pose any beetle risk. About 290 acres are considered to be at medium or high risk. Based on results from surveys on national forest lands, it is likely that some of these acres are infested with spruce beetles, though exact numbers and extent is not known.

Private Lands:

About 953 acres of the Moose Fire burned on private lands in the North Fork Flathead River valley. Most of these lands are dominated by small seedling, sapling and pole-sized trees. As such, these acres pose very little risk in regard to spruce beetle infestation. There are a few spruce scattered along the North Fork River and in moist riparian areas that were affected by the fire and may have attracted a few spruce beetles.

Current spruce beetle habitat conditions outside the fire perimeter

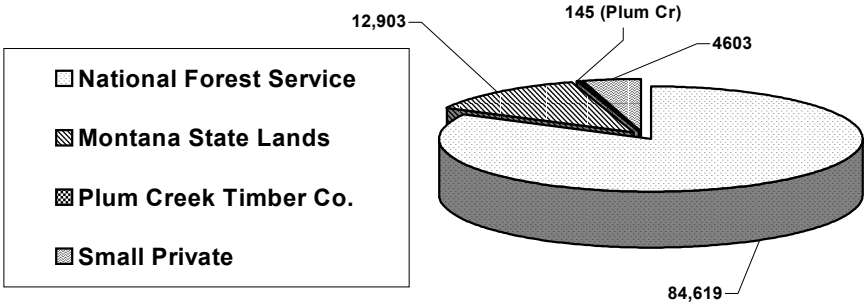
Using information from a variety of sources (past field inventories, photo interpretation, satellite imagery, field knowledge, communications with private individuals and State Forest managers), spruce beetle stand hazard ratings were determined for the forest lands outside the Moose Fire perimeter, within a region five miles from the boundary (as described above under *Analysis Area and Information Sources).* Criteria used to determine hazard include tree size, proportion of spruce, stand density and physiographic location (Schmid & Frye 1976). Refer to Project Record J-8 and J-29 for description of the hazard rating analysis.

The hazard rating measures a stand's ability to support a population of beetles. Hazard ratings do not predict when or if the beetle will be active or cause mortality in a certain stand nor do they predict actual stand losses from beetles. What they are able to do is identify stands with conditions that would support a beetle outbreak, and stands that could experience considerable mortality once an outbreak occurs.

High hazard stands are those in which large amounts of beetle mortality might be expected once a disturbance (such as fire) occurs, allowing a buildup of beetle populations. Moderate and low hazard stands may experience less beetle-caused mortality, but large, old trees might still be killed in these stands (Randall and Tensmeyer 1999). In addition, low hazard stands become more at risk when high hazard stands nearby are infested.

Figure 3-3 below displays the different land ownerships and acreages within the 5-mile zone that may be directly or indirectly affected by bark beetle activity. Most of this area (83%) is National Forest System Lands. Glacier National Park lands are not evaluated in the effects analysis. This is because potential bark beetle activity and tree mortality is not a management concern to park managers, in light of the land management philosophy and legal mandates that guide national park management.

Figure 3-3: Acres by land ownership within five miles of fire
Total: 102,270 acs.



National Forest System Lands:

Table 3-12 and Map 3-3 display the estimated acres of spruce stands on National Forest System Lands outside the fire area and their hazard ratings for spruce beetle (Project Record J-9 through J-12). The estimates in Table 3-12 use data only from stands that have had past field exams, and therefore may underestimate the extent of spruce stands. However, they are believed to have captured the majority (at least 80%) of acres containing spruce at risk of beetle infestation.

Table 3-12: Estimated Acres and spruce beetle hazard rating for stands on Flathead National Forest System Lands within five miles of Moose Fire

Spruce Beetle Hazard Rating	Acres	% of Total Acres at risk
Low	0	0
Low-Medium	344	3%
Medium	10404	85%
Medium-High	1032	8%
High	444	5%
TOTAL =	**12,224 acres** **14% of total National Forest System Lands**	

Relatively few stands fall in a low hazard category. Low hazard stands are typically those where larger (>16" dbh) spruce may be present, but at low numbers. Individual trees may be infested and killed by spruce beetle, but the stand as a whole does not provide abundant beetle habitat.

The overwhelming proportion (over 95%) of the susceptible spruce stands within five miles of the fire boundary is rated medium to high hazard to spruce beetle infestation. This is not surprising considering the cool, moist habitats and lack of stand replacing fire for over 200 years in the upper reaches of both Big Creek and Coal Creek, where most of the lands within this area are located. Shade tolerant, climax forests of spruce and subalpine fir are the dominant forest cover in these areas.

Medium risk stands are typically well-stocked stands on productive sites, composed of spruce of large average diameter (>16"), but where spruce comprise less than 50 percent of the overstory stand stocking. In most of these stands, <20 trees per acre of spruce occur, but it can be up to about 30 trees per acre (tpa). Spruce beetle has the capability of causing high mortality to the larger diameter (>16" dbh) trees in these medium hazard stands, but net losses would be lower than the high hazard stands, because there are fewer of these susceptible trees present.

The med/high to high-risk stands generally are of similar character as medium hazard, but have higher proportions of spruce in the canopy, often over 65 percent of the stocking. They may have upwards of 50 trees per acre of spruce, but are mostly in the range of 20-30 trees per acre. Given high beetle populations, these stands would experience the greatest net losses and would be able to support and contribute substantially to high beetle population buildup.

State Forest Lands:

Table 3-13 below displays the estimated acres at some level of hazard to spruce beetle on State Forest lands within 5 miles of Moose fire (Project Record J-16). Though most of these acres are outside the fire perimeter, some small, unburned inclusions within the fire may be included.

Table 3-13: Estimated Acres and spruce beetle hazard rating for stands on State Forest lands within five miles of Moose Fire

Spruce Beetle Hazard	Coal Creek State Forest (15,094 acres total) 8227 unburned acres within 5 miles of Moose Fire	Stillwater State Forest 4676 acres within 5 miles of Moose Fire
Medium	1237 acs (10% of total unburned area)	36 acs (<1% of total acs)
High	247 acs (3% of total unburned area)	0
TOTAL =	**1484 acs (18% of total unburned area)**	

Private Forest Lands:

Nearly all of the 4603 acres of private lands in the 5-mile zone outside the fire area are small private holdings in the North Fork River valley, north of the Moose Fire. The majority of these lands are cleared forest/pasture and seedling and sapling stands, in addition to many acres of pole-sized forests of lodgepole pine originating from the 1910 fire. There are no large areas of spruce dominated forest, though small patches of susceptible spruce trees may exist, primarily along the North Fork Flathead River and along streams. It is not known exactly what hazard level these stands may be, and it would depend on how many larger diameter (>16” DBH) spruce trees exist. Based on conditions seen in other similar riparian areas, large spruce are likely to be a component in the these stands, and these trees would be vulnerable to spruce beetle infestation and mortality if epidemic conditions occur because of beetle infestation in Moose Fire stands.

MAP 3-3: : Spruce Beetle Hazard/Risk Within Moose Fire and Within 5 Miles of Fire Boundary, National Forest Lands.

Douglas-fir Bark Beetle

Description, Life History and Host Interactions

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

The Douglas-fir beetle has a one-year life cycle. In this area, adult beetle flight season lasts from mid-April through July. Adult beetles are strong fliers, capable of flying for several miles in search of mates and breeding sites. Once the female beetle finds a suitable host tree, she emits a pheromone that attracts the male beetles as well as more female beetles. Thousands of beetles can be attracted to one tree, initiating a mass attack. Once mated, the females bore into the moist inner bark layer and lay eggs. The larvae that hatch bore outward from the egg galleries, feasting on the inner bark, and kill the tree by girdling. Later in the year, the larvae pupate and develop into adults, which then overwinter in the tree. The following spring, this new generation of adults emerges to begin the cycle again.

Beetles will usually only attack trees over about 8” in diameter, because of the need for sufficient thickness of the inner bark to support the brood. They preferentially attack stressed and weakened trees, such as those recently damaged or killed by fire, drought, other insects or diseases. If dead or stressed trees are not available, they will attack live, more healthy trees, even stands normally considered to be low risk (such as those with trees of smaller diameter or low numbers of larger diameter Douglas-fir). Beetle brood success in these types of stands will depend on individual tree vigor and number of attacking beetles.

As many as 3000 male and female beetles may attack a typical 20” diameter tree and produce 7-15,000 beetles in the first generation, assuming a conservative 5 percent brood survival rate. Generally, at high population levels, one infested tree can produce enough beetles to kill an additional 5-10 trees (Gibson 2002c).

Natural enemies of the beetle include a whole array of bird species (woodpeckers and other insect-eating birds), insect predator beetles, and parasites. These organisms can have an impact on beetle populations and brood success when beetles are at lower population levels. During outbreak conditions, their effect is much reduced, simply because of the very large numbers of beetles.

Past and present Douglas-fir beetle activity in and around the project area

Historically, Douglas-fir dominated forests were probably never very widespread within the cool, moist Big Creek watershed, and were mainly limited to the drier south and westerly aspects in the lower half of the drainage (USDA 1999). Douglas-fir beetles would have had periodic influence on these Douglas-fir forests, particularly after a triggering event such as blowdown or fire, with effects ranging from small to large, depending upon stand conditions at the time.

Douglas-fir beetle activity has occurred nearly every year in this watershed since at least 1968 (the first year of aerial surveys), affecting an overall area of about 1200 acres, though no single large outbreak took place during this time (USDA 1999). Douglas-fir beetle and associated agents (mainly root disease and drought) have had particularly strong influence on the condition of the older, “old growth” Douglas-fir stands that dominated the drier aspects in lower Big Creek (the area that burned in Moose Fire). Continuing, yearly mortality of the older, larger overstory trees in these areas has occurred steadily over decades, with many stands progressing into what was referred to as a “post-old growth” stage in the Big Creek Ecosystem Analysis (Project Record O-28). In these stands, little to no replacement of the lost overstory trees with younger trees was occurring because root disease was (and is) so prevalent on some sites that the younger understory trees were dying before they had a chance to develop into larger diameter age classes.

Western Montana is currently experiencing a Douglas-fir beetle outbreak. In 2001, aerial surveys showed more than 200,500 acres infested with Douglas-fir beetle across the Northern Region (Montana, North Idaho). Compared to the year 2000, the infested area in western Montana increased to 82,300 acres, while the area affected by Douglas-fir beetle in northern Idaho declined to just under 115,000 (Gibson 2002d, Project Record J-35). Acres infested has been steadily increasing since the late 1990s, linked to unusually high amounts of wind-thrown and winter damaged trees, and exacerbated by drought conditions. It is the highest level of tree mortality caused by Douglas-fir beetles seen in the region since the early 1950s (FHP 2000a). Outbreaks are usually short-lived, lasting anywhere from 2-6 years, depending on the weather. Continuing drought and mild winters, combined with an abundance of host material, has favored the beetle and prolonged the outbreak.

Aerial insect and disease surveys over the Flathead National Forest show that Douglas-fir beetle populations have been steadily building over the past 3-4 years, with especially high populations in the western portion of the forest, where epidemic conditions currently exist in and around the Good Creek and Logan Creek region of the Tally Lake Ranger district (FHP 1999b, Project Record J-21). Within ten miles of the Moose Fire, area infested by Douglas-fir beetle have doubled every year since 1998, with almost 1000 acres infested in 2001, prior to the Moose Fire event. Within the fire area, Douglas-fir beetles, in combination with root disease, caused mortality over about 500 acres in 2001, before the Moose Fire began (Project Record J-21).

Current Douglas-fir bark beetle conditions within the fire perimeter

National Forest System Lands

The Moose Fire affected about 35,750 acres of National Forest System Lands. Shortly after the fire, stand risk ratings for Douglas-fir beetle were determined for all these acres, primarily using field surveys (pre and post-fire) and photo interpretation. This analysis was disclosed in the Moose Post-Fire Project Draft EIS, published in June of 2002. About 7180 total acres on National Forest System Lands within the Moose fire were identified at some level of risk to Douglas-fir bark beetle. About 754 acres (11%) were at Mod high to High risk; 2431 acres (34%) at Moderate risk; and 3995 acres (55%) were at low risk.

Criteria for the rating include stand density and the size, age, and proportion of Douglas-fir in the stand (Wheatherby & Thier 1993; Negron *et al*. 1999; Randall & Tensmeyer 1999). This rating was integrated with the fire severity and its effects on the larger diameter (14”+) Douglas-fir trees within the stand. Douglas-fir trees severely affected by the fire, but perhaps not directly killed (i.e. scorched crowns of varying degrees, charred boles, charred root crowns or large, surface roots) were rated higher risk, and considered more vulnerable to beetle attack and mortality than they were before the fire. Stands where average tree size was smaller, where Douglas-fir was a more minor stand component, and/or fire severity was particularly high, damaging the cambium layers of the tree, were rated lower risk. The Moose project record (J-29) contains a full discussion of beetle risk determination and potential for population buildup. Maps of beetle risk areas are found in the Project Record J-1.

Surveys to monitor Douglas-fir beetle populations were completed in July and August of 2002. Over 3700 acres were surveyed, and beetle activity was found over all acres. An additional 3500 acres at risk to Douglas-fir beetle were not surveyed. Based on observations of surveyed areas, it is highly likely that most of these acres also contain Douglas-fir beetle activity. Overall, average infestation levels across the surveyed acres were low. Copies of the actual field surveys for Douglas-fir beetle are found in the Moose project record, J-31. A more detailed summary of the results of the monitoring is disclosed in this chapter at the beginning of Section 3, *Environmental Consequences,* with the full Summary Report found in the Moose Project Record, J-32.

State Forest Lands

The beetle risk analysis for the state lands affected by the Moose Fire is documented in the *Moose Fire Salvage and Reforestation Project Phase II Environmental Impact Statement* (Montana Department of Natural Resources and Conservation 2002). As stated above under the section on spruce beetle, much of the 6867 acres that burned on the 15,094 acre Coal Creek State Forest is at little risk of bark beetle infestation due to the age/size classes, species, and fire severity. The areas that burned at mixed severity (about 3000 acres) pose the greatest risk to Douglas-fir

beetle, with two areas (totaling about 340 acres) of particular concern. These are located in South Coal and Winona Ridge (MT DNRC Phase II EIS Appendix E, page E-5), and were rated highly susceptible to Douglas-fir bark beetle, due to the lower fire severity, larger diameter older tree component, and the high beetle populations in these stands and adjacent stands prior to the fire. Refer to Project Record J-14 and J-15. Though no known surveys have been done, it is probable that these acres contain some level of Douglas-fir beetle infestation, probably at low tree densities, based on survey results on national forest lands.

Glacier National Park

Approximately 2800 acres of the total 26,955 acres that burned within national park lands are estimated to be a risk of Douglas-fir beetle infestation, as interpreted from pre and post-fire aerial photo interpretation and fire severity maps (Map 3-4 and Project Record J-13). All these acres are believed to be at low risk, primarily because larch is the more dominant overstory species in the stand and beetle susceptible Douglas-fir is in most cases a relatively minor component. Based on survey results on National Forest System Lands, it is likely that a low level of Douglas-fir beetle infestation has occurred across some of these acres; exact number is not known.

Private Lands

As stated under the spruce beetle, the 953 acres that burned on small private landholdings in the North Fork Valley have mostly small diameter trees, which pose very little risk to bark beetle infestation. Isolated trees and small groups of beetle-infested Douglas-fir may exist across this area.

Current Douglas-fir bark beetle habitat conditions outside the fire perimeter

Using the same information sources as described earlier under the spruce beetle, Douglas-fir bark beetle hazard was determined for the forested lands within five miles of the Moose Fire perimeter. Refer to Figure 3-3 for display of land ownership in this zone. Criteria used to determine Douglas-fir beetle hazard include tree size, age, stand density and proportion of Douglas-fir in the stand (Randall & Tensmeyer 1999; Weatherby & Thier 1993; Steele *et al*. 1996). Refer to J-29 in the project record for discussion of the hazard rating analysis. As explained under the spruce beetle section, the hazard rating identifies stands with conditions that would support a population of beetles, and the level of beetle-caused mortality that may be experienced.

National Forest System Lands

Table 3-14 and Map 3-4 display the acres at risk to Douglas-fir beetle on National Forest System Lands outside the fire area. The acres are a conservative estimate and may underestimate the occurrence of at risk Douglas-fir stands, since only data from areas that have had past field inventories was used. Though additional acres susceptible to Douglas-fir beetle may exist, review of the data suggest that it most likely captured over 90 percent of the area at some level of risk to Douglas-fir beetle. Refer also to Project Record J-2 through J-6.

Table 3-14: Estimated acres and Douglas-fir beetle hazard rating for stands on Flathead National Forest System Lands within five miles of Moose Fire

Douglas-fir Beetle Hazard Rating	Acres	% of Total Acs at risk
1 - 2 = Very low	8013	67%
3 – 4 = Low	473	4%
5 = Low/Moderate	2351	20%
6 – 8 = Moderate	499	4%
9 –10 = High	532	5%
11 = Very high	29	<1%
TOTAL =	**11,898 acres** **12% of total National Forest System Lands**	

Although nearly 12,000 acres are susceptible to Douglas-fir beetle, the majority (91%) of stands are rated as very low to low/moderate hazard. This is in large part due to the low proportion of larger, older Douglas-fir within these stands. Most of these stands are mixed species, where Douglas-fir comprises a relatively small proportion of the total overstory stocking. In other low hazard stands, Douglas-fir may be a dominant species, but the stand is relatively young and not yet at the size and age that makes it highly susceptible to Douglas-fir beetle. However, even these stands may experience beetle mortality during an epidemic situation.

Nearly 1100 acres within the 5-mile zone are considered moderate to high hazard to Douglas-fir beetle. These are stands where larger diameter, older Douglas-fir comprise a large portion of the stand stocking, providing beetles with more abundant breeding material given a disturbance such as fire and subsequent beetle population buildup.

State Forest Lands

Table 3-15 below displays the estimated acres susceptible to Douglas-fir beetle on the Coal Creek state forest lands outside the fire area (Project Record J-16) and Stillwater State Forest (from stand data provided by forest managers) (Project Record J-17, J-18). Most of these acres represent mixed species stands, and though susceptible Douglas-fir is known to be present, precise estimates of beetle hazard could not be determined. It is assumed that most are low to moderate hazard (based on similarities to adjacent National Forest System Lands), with variable amounts of larger, older Douglas-fir, but usually not greater than 50 percent of the stocking (which would probably make them high hazard). These stands would be vulnerable to various degrees of mortality of the larger diameter Douglas-fir, depending upon individual stand conditions.

Table 3-15: Acres and Douglas-fir beetle hazard rating on State Forest lands within 5 miles of Moose Fire

Douglas-fir Beetle Hazard	Coal Creek State Forest (15,094 acres total) 8227 unburned acres within 5 miles of Fire	Stillwater State Forest 4676 acres within 5 miles of Fire
Low to Moderate	815 acs (10% of total unburned area)	700 acs (15% of total acs)

Private Forest Lands

Within five miles of the Moose Fire perimeter are about 4600 acres of small private lands in the North Fork Valley, north of the Moose Fire. As stated under the section on spruce beetle, most of this is small-diameter seedlings, saplings and pole-sized trees at no risk of bark beetle infestation. There are probably some undetected small groups and individual susceptible Douglas-fir trees on some of these lands that would be vulnerable to beetle-caused mortality.

MAP 3-4: Douglas-fir Beetle Hazard/Risk Within Moose Fire and Within 5 Miles of Fire Boundary, National Forest Lands

3. Environmental Consequences

As previously stated, bark beetle activity in forest stands and its resulting consequences are a normal and natural part of the ecosystem, a process that has been occurring for many thousands of years. Beetle outbreaks after disturbance events, such as fire, are not a certainty, but neither are they unheard of. As described under *Affected Environment,* there may be situations where the consequences of beetle activity may conflict with management objectives for a variety of resources, potentially affecting wildlife habitat and old forest, riparian and stream stability, timber productivity, private property or other values. The purpose of this section of the EIS, and associated discussions under other resource areas, is to disclose the risk of and possible effects from a beetle outbreak on these resource values. This information allows the decision maker to make a fully informed decision, integrating the beetle risk assessment with the other multiple considerations and purposes of the proposed activities.

Current and potential beetle activity and the possible course of an outbreak will be described in this analysis in both a quantitative and qualitative manner. Numeric predictions are best used as a relative comparison of potential risks and effects between alternatives.

No significant issues related to spruce and Douglas-fir beetles were identified (refer to Chapter 2). The following Effects Indicators were used to focus the beetle analysis and disclose relevant environmental effects:

- Beetle funnel trap treatments and salvage treatments in areas infested with spruce beetle (acres)
- Salvage treatments and other non-salvage methods in areas of Douglas-fir beetle infestation (acres)

Results of Spruce and Douglas-fir Bark Beetle Population Monitoring, July/August 2002

Surveys to monitor Douglas-fir and spruce bark beetle populations on the National Forest System Lands within the Moose Fire were completed in July and August 2002. Survey areas consisted of the proposed salvage and pheromone trap treatment areas as displayed in Alternative 2 (the proposed action) in the Draft EIS. Approximately 3700 acres were surveyed for Douglas-fir beetle and 570 acres surveyed for spruce bark beetle. The objective of this monitoring was to determine the level of beetle infestation within the fire area, and the location and pattern of infested trees.

Methods

Surveys consisted of walking through all units on a grid pattern, with surveys typically covering from 80-95 percent of the unit area. All trees that had current (2002) successful spruce or Douglas-fir bark beetle hits were noted, as well as the condition of the tree attacked (dead blackened, dead red crown, live green crown, and whether down or standing), and the infestation level (number of successful beetle attacks per tree). Level of infestation was defined as follows:

Very Low = < 6 attacks, all below 4.5 feet high (DBH)
Low = < 12 attacks, all below 6 feet high
Medium = > 12 attacks, extending above 12 feet high
High = tree has dozens of attacks surrounding the bole and extending higher than 6 feet

After trees were evaluated and recorded, infested trees per acre were calculated and in some cases, areas of beetle concentrations were mapped. Infested trees per acre were calculated by dividing the total number of trees infested in a unit by the total number of acres in the unit.

Following is a general summary of the results of these surveys for spruce and Douglas-fir bark beetles. Map 3-5 displays the results of the surveys. Moose Project Record J-31 contains the actual surveys and J-32 the survey reports, including tables listing individual unit conditions and survey results.

Survey Results

Spruce bark beetle:

As compared to pre-fire conditions, spruce beetle populations are dramatically elevated within the Moose Fire area, and the area is currently experiencing outbreak conditions. Infested trees were found throughout the survey areas, covering about 380 acres. Across most of these acres, infestation levels are high, with a large proportion of the spruce infested, and trees with medium or high levels of infestation (number of attacks per tree). Sizes of trees ranged from about 11" DBH to over 30" DBH, with most trees in the 16-25" DBH range. A large number of the spruce were windthrown, and these were generally where the spruce beetle infestation levels were highest (dozens of attacks per tree). However, many standing, underburned spruce were attacked as well. As was expected, most attacked trees still had green crowns, though they were severely injured or killed by the fire at ground level, with charring of the lower boles and root crowns.

A total of 604 spruce trees infested with bark beetle were tallied, but the actual number is believed to be closer to 1000 trees, due to the noted inability to evaluate many of the spruce in the areas of heavy downfall. On average over all units surveyed, the number of spruce infested with beetles was just over one tree per acre. With the elimination of areas with no or inconsequential amounts of infested spruce, the average was about 1.7 infested trees per acre or more, considering additional infested but not accessible trees. The range among all units was from zero to 11 trees per acre. Generally speaking, entomologists consider infestation levels of greater than 1 tree per acre per year to represent outbreak beetle populations levels.

Some additional areas within the Moose fire at risk to spruce beetle infestation were not surveyed in 2002, mainly because of time limitations, poor access and their lower risk rating. These areas include acres in more remote regions of the Inventoried Roadless Areas, as well as narrow stringers along some of the streams within the Big Creek drainage, and may cover up to 300 or 400 acres. Based on the original spruce beetle risk determinations, these areas are all either medium or low risk to spruce beetle infestation, due to burn severity or probable scarcity of larger diameter spruce trees. Though we do not know for sure, based on their risk and the pattern of infestation that was observed in the surveyed areas, it is not believed they contain substantial numbers of beetle infested trees, though undoubtedly there are some infested spruce across these acres.

Table 3-16 provides a summary of the spruce bark beetle survey results. Map 3-5 displays the survey areas. Most of the area surveyed was proposed for treatment with pheromone baited beetle funnel traps, but five proposed salvage units were also surveyed and found to have spruce beetle infestation. An additional 34 acres within Big Creek riparian area (in 13 small areas) originally proposed in the DEIS for beetle funnel trap treatments were surveyed and found to have no infested trees, or inconsequential numbers of trees, and thus have been dropped from the FEIS.

MAP 3-5: Beetle Monitoring Results

Table 3-16: Spruce beetle survey results

Areas not within proposed salvage units (proposed funnel trap treatments)			
Survey Area	**Acres infested**	**Level of infestation**	**Comments**
Big Creek and tributaries	262	0.5 to 11.0 trees per acre infested	High numbers of attacks per tree in most cases. Heavy downfall in many areas, and beetles show preference for these trees. Well over 600 trees estimated to be infested.
Dead Horse Creek	25	1.2 trees per acre infested	Only one area at risk to beetle within Dead Horse Creek. Estimate over 30 trees infested, dozens of hits per tree.
TOTAL	**287**		
Areas within proposed salvage units (Alternative 2 of the FEIS): not within riparian areas			
Proposed Salvage Units (Alt. 2) 44, 55, 57, 76	94	0.2 to 2.0 trees per acre infested	Infestations tend to be concentrated in portions of the unit rather than scattered trees, with estimated 94 acres out of actual unit total of about 182 acres. Estimated >130 trees infested. Both down and standing trees. Unit 76 is in inventoried roadless area, estimated 30 acres infested, 45+ total trees.
TOTAL	**94**		

Douglas-fir bark beetle:

Notably elevated Douglas-fir beetle populations exist within the fire area, considering the number of infested acres and the density and intensity of infestation across most of these acres. Douglas-fir beetle infested trees were found in every stand surveyed, extending across 3700 acres. About 2800 infested trees were actually tallied, but total number of trees infested across the survey area is estimated to be at least 3500, based on the average density of infested trees and the percent of the total area covered in the surveys. The widespread presence of Douglas-fir bark beetle is not surprising considering the widespread availability of susceptible trees, and particularly the easily attacked, “defenseless” fire killed Douglas-fir trees. However, the number of attacks per tree and density of infested trees was lower than anticipated. This is most likely due to the cool, wet spring conditions experienced in the area in 2002. We also anticipated the beetles would focus more on the severely injured but live trees, rather than almost exclusively the fire-killed, severely charred trees.

Size of attacked trees ranged widely, from around 10” up to 30+ inches DBH. Very few of the trees that still had green crowns have been attacked, even though they may have been underburned or partially scorched and stressed by the fire. Nearly all trees attacked were fire-killed, most often with completely blackened boles and crowns consumed, or with 100 percent scorch (red needles). These are the trees least able to resist beetle attack, and thus were most attractive to the relatively non-aggressive Douglas-fir beetle. The cambium layer in these trees is still moist, even in late September, and most are expected to retain enough moisture to support full development of the beetles through next spring.

Infestation pattern is most often as scattered individuals, sometimes in small clumps of 3 or more, sometimes grouped in larger patches. There doesn’t appear to be a discernable logic to why one tree was attacked and not another. Often, a tree that in our understanding appears to be far more attractive to a beetle (i.e. large diameter, succulent dead or highly stressed tree) was skipped and the beetles attacked an adjacent tree of much smaller diameter, more blackened. In many cases, it appears that one tree was found and attacked by beetles (perhaps randomly), and then emitted pheromones that attracted more beetles to that location, where they then infested adjacent trees, no matter what the size of those trees.

Infestation levels are mostly low, considering attacked trees per acre and number of attacks per tree. Based on survey results, the overall average infestation level is about 0.7 Douglas-fir trees per acre, ranging from a unit average of 0.09 to 5.67 infested trees per acre. The average infestation rate is probably closer to 0.9 trees per acre,

considering estimated number of additional trees in areas not covered by the surveys. This average may underestimate intensity of infestation in some larger units where beetle activity is concentrated in only part of the unit.

Over 2800 acres, or about 75 percent of the area surveyed, infestation density is below one infested tree per acre. Beetle infestation and mortality below one tree per acre is generally considered by entomologists to represent normal, endemic levels, while infestation above one tree per acre is considered to be epidemic. The remaining 25 percent of survey area (about 900 acres) has an infestation rate greater than one tree per acre. About one third, or 300 of these acres, have greater than two infested trees per acre; 45 of these acres have greater than five infested trees per acre. In all areas, the majority (>90%) of trees have *very-low* to *low* infestation levels (<12 hits per tree), with most of these in the very low category. Very few trees (<1%) were found to have what would be considered a high level of infestation, i.e. dozens of attacks surrounding the bole.

The approximately 900 acres infested at the higher levels (>1 tree per acre infested) tend to be scattered throughout the fire area, but particular “hot spots” of beetle activity are evident near the mouth of Big Creek along the North Fork Flathead River, on the southwesterly aspects within the Hallowat Creek drainage, and to a lesser extent in stands near the mouth of Elelehum Creek. As elsewhere, beetles mostly attacked trees killed by the fire. The Hallowat and Elelehum Creek area also contains numerous live Douglas-fir that survived the fire, which are prime targets for emerging beetles in the spring of 2003.

An additional 3500 acres within the fire area were not surveyed in 2002 – areas that were not proposed for any kind of beetle management treatments in the proposed action or its alternatives due to their lower risk to beetles and their location in areas where other resource or management emphases dominated (refer to Map 3-4). About 83% of these acres were rated low risk to beetle infestation, with most of the rest rated moderate risk. They are scattered throughout the Moose Fire area, primarily within the Inventoried Roadless Areas (about 1300 acres), riparian habitat conservation areas, and areas that the Flathead Forest Plan has classified as unsuitable for timber management. Considering the 2002 survey results across similar areas, we can assume that beetles have infested trees across most of these acres, and that infestation density and level is probably low, with <1 tree per acre infested, and less than 12 beetle attacks per tree. Considering both the surveyed and non-surveyed acres, it is likely that up to 7000 acres across the national forest system lands within Moose fire are currently infested with Douglas-fir bark beetle, with over ½ of that acreage confirmed by field monitoring.

Table 3-17 provides summary information for units surveyed for Douglas-fir beetle. Refer to Map 3-5 for area locations.

Table 3-17: Douglas-fir beetle survey results by unit groups (Units as depicted in Alternative 2 of the Draft EIS)

Units Surveyed (DEIS Alt. 2)	Survey acres	Comments
MA 9, 13, and 15: suitable for timber management		
Units with lower density of beetle infested trees (0.09 – 0.95 trees per acre)		
2,3,5,6,7,8,9,10,13,14,15,16,17, 18,19,20,21,22,23,24,25,26,27, 29,32,34,38,40,42,44,45,46,48, 49,52,53,55,59,60,61,63,64,45	**2305**	In some of these units beetles are concentrated in portions of the unit, where density of infested trees is higher than overall unit average (Unit 5,6,7,8,10, 19,32,34,38,61). Some units contain numerous remaining live trees, injured by fire (Units 22,23,24,38,40,42,45,46,66)
Units with higher density of beetle infested trees (1.03 – 5.67 trees per acre; * indicates >3 trees per acre)		
1*, 4*, 11*, 12, 28*, 30, 31, 33*, 35, 37, 41, 43, 50, 54*, 56, 57, 58, 62, 66	**586**	Units 1, 4 and 11, along the North Fork road, have some of the highest beetle concentrations, with over 200 infested trees across the 38 acres. Other units contain or are adjacent to remaining live Douglas-fir, susceptible to beetle attack (Units 37, 41, 43, 56, 57, 62, 66).
TOTAL	**2891**	
Special management emphasis areas: Inventoried Roadless Areas, Wild & Scenic River, and MA 13A (winter range, not suitable for timber management)		
Units with lower density of beetle infested trees (0.10 – 0.81 trees per acre)		
14, 15, 16, 17 (MA 13A) **70, 72, 73, 78 (Roadless)**	**465**	Scattered infested trees across most of the area. Units 14-17: Very low density of infested trees, with 79 trees tallied across total 266 acres, though probably closer to 100 trees. In Units 70,72,73,78, very low density of infested trees, with 63 trees tallied across the total 197 acres. Variable numbers of live underburned Douglas-fir trees remain in some units (Units 14,15,16,70).
Units with higher density of beetle infested trees (1.01 – 4.71 trees per acre; * indicates >3 trees per acre)		
75, 76, 77 (Roadless) **67*, 68*, 69* (Wild & Scenic River corridor)**	**300**	Unit 75, tallied 176 infested trees, with particularly high concentrations of beetles in central portion, where fire burned hottest. Unit 76 and 77 total of 153 tallied trees. All these units probably have more infested trees in areas not covered by survey. Unit 75 and to a lesser extent Unit 76 also have many live, underburned Douglas-fir trees remaining in the unit. Unit 67,68,69: These are narrow strips of forest along the North Fork road. High density of infested trees, with estimated 120 or more infested trees. Patch of live trees on south end of Unit 68 was effectively protected from infestation with the use of MCH.
TOTAL	**765**	
GRAND TOTAL	**3656**	

Typical characteristics of a spruce or Douglas-fir beetle outbreak, and assumptions used in this Moose Post-fire beetle analysis

There are a few “models” which help estimate beetle-caused mortality (currently available for Douglas-fir beetle, but not spruce beetle), but our best means of assessing outbreak effects is a review of past and ongoing epidemics (Gibson 2002b, Project Record J-29). When we refer to an acre being infested with either Douglas-fir or spruce beetles, it does not necessarily mean that every tree, or even most of the trees, on that acre have been attacked and thus killed by the beetles. Trees killed per acre can vary widely. Current Douglas-fir beetle outbreaks in the region averaged about 1.5 trees per acre killed in 2001 (an estimated 351,500 trees on 200,500 acres); however, ground-collected data from the past few years have shown that up to 50 trees per acre killed in heavily infested stands is not uncommon. Data collected in the early 1970s in northern Idaho showed in one Douglas-fir beetle-infested stand, 90 of 152 Douglas-fir were killed in one year (Furniss *et al*. 1979). An entomologist who has worked

on the ongoing spruce beetle outbreak in Utah indicated some ground plots, from which they have several year's data, showed more than 90 percent of the spruce over 5 inches (dbh) have been killed (Munson 2002). These examples illustrate the extent to which host stands may be impacted by extreme levels of bark beetle populations. Data collected in 2001 on the areas affected by the 2000 fires on the Bitterroot showed new Douglas-fir beetle attacks averaged 23 trees per acre for 12 plot areas, but one was as high as 46 trees per acre (Gibson 2002b, Project Record J-29). Some of those burned trees probably will not produce brood in the same quantity as green trees of the same size; but even if brood is only produced at a 2:1 rate (fairly low for an outbreak, it has been as high as 6:1), some areas will have substantial numbers of newly attacked trees in 2002.

In addition, it is helpful to understand the pattern of infestation and mortality that typically occurs across a stand or hillside, especially with Douglas-fir beetles. It frequently begins with beetles attacking small groups of trees scattered across a stand, from a few to a dozen or so trees killed in each spot – a "chicken pox" sort of appearance. Emerging adult beetles then spread to neighboring susceptible trees, and these relatively small pockets of infestation will grow year by year, depending upon individual stand conditions and other factors, such as favorable weather. Beetle populations and associated tree mortality can grow exponentially, and these infestation "cells" can eventually join one another, creating larger areas of infestation.

Based on many years of observation and data collection, we can assume that in a "typical" Douglas-fir or spruce beetle outbreak, before an outbreak subsides in 2-6 years, 60-80 percent mortality of the trees over 14-16 inches d.b.h. should be anticipated (Gibson 2002b, Project Record J-29). In an epidemic, one could also reasonably assume that a 3:1 increase in area infested by bark beetles could be experienced on a year-by-year basis. Under very high population levels, beetles may very likely attack and kill many trees that would normally be considered low risk, such as younger trees or those in smaller diameter classes.

Because of the information we now have on actual beetle populations and level of infestation in the project area, the assumptions and predictions of beetle infestation levels originally included in this section in the DEIS have been modified. Potential spread of beetles and mortality predictions next year and beyond is still based on similar assumptions as used in the DEIS, and consider our understanding of and past experience in bark beetle responses to their environment. However, the beginning point of our assessment is now based upon known beetle infestation levels on national forest lands within the Moose fire area. These assumptions have been developed for purposes of describing and displaying potential effects of the different Moose Post-fire project alternatives on ongoing bark beetle activity. The assumptions and predictions are described in Table 3-18 below.

Table 3-18: Assumptions and predictions applied to the effects analysis for spruce and Douglas-fir beetle

	Spruce Beetle	Douglas-fir Beetle
Infestation in 2002 based on survey results	Approximately 381 acres found to be infested with bark beetle, most were rated medium to high risk immediately after the fire. Density and level of infestation is high, up to 11 trees per acre and large number of beetle attacks per tree. Beetles infested underburned, fire-killed/severely injured spruce trees. Many trees are windthrown, and contain especially high numbers of beetle attacks.	About 3700 surveyed acres confirmed infested; another estimated 3500 acres not surveyed but some of these acres are also likely to contain Douglas-fir beetle. Majority found to be at low density of infested trees (<1/acre) and low level of infestation (mostly <6 attacks per tree). Some areas have more concentrated, higher levels of beetle activity. In nearly all cases, beetles have infested fire-killed trees: little to no mortality to live trees.
Predicted spread and mortality	Beetles would emerge in 2004, attacking the few remaining live trees within the fire area and spreading into older spruce stands just outside the fire area. With the high beetle populations within the fire area, an expected 1:3 ratio of current to new area infested could be expected in 2004 and subsequent years, given favorable weather. Most of the spread will occur outside the fire area. Up to 60-80% mortality of the susceptible trees within a stand (14-16”+ diameter) may occur over the course of an outbreak, which might last up to 4 years or more.	Beetles would spread mostly within fire area in 2003, attacking remaining live but fire injured trees. Level of infestation largely dependent upon weather conditions and success of preceding years brood. With normal or wet spring conditions, beetle populations may gradually decrease as they move into healthier live trees, dropping to well under 1 tree per acre average infestation levels. With warmer, drier spring conditions, beetle populations may grow, causing increasing levels of mortality both within and outside the fire area, averaging over 1 tree per acre, with some areas experiencing up to 60-80% mortality of susceptible trees within a stand in severe outbreak conditions.

The following table describes characteristics of the stands outside the fire area that have been identified as at risk, or susceptible, to spruce or Douglas-fir bark beetle infestation (as described under *Affected Environment* earlier in this chapter). This information helps in our understanding of the type and degree of change that might occur within these stands if beetles infest and kill some or most of the susceptible overstory spruce or Douglas-fir trees. This information has been used as a basis for the description of potential effects in the sections that follow.

Table 3-19: Characteristics of stands at different levels of bark beetle hazard

Spruce stands: Med/high to high hazard	Larger diameter spruce is on average >50% of the stand overstory tree stocking, with an average dbh in the 18-25” range. Stands may have from 10-40+ overstory trees per acre in these diameter ranges. An estimated half the stands also contain significant component of overstory larch or Douglas-fir (>10 tpa)
Spruce stands: Medium hazard	Larger diameter spruce is around 10-40% of the overstory tree stocking, with a wide range in stocking, from just a couple trees per acre up to perhaps 30 or more trees per acre. Diameters are 14-25”. Most of the stands also contain a significant component of larch or Douglas-fir, and in many areas subalpine fir.
Douglas-fir stands: Moderate to high hazard	Stand data indicates a rough average of about 42 sqft/acre basal area of Douglas-fir in the >14” diameter classes, equivalent to about 40 trees per acre >14” diameter. Given favorable beetle conditions and high beetle populations, and applying an estimate of 60% loss of the larger diameter trees, this could equate to a loss of about 24-32 larger diameter trees (14-16”+) per acre over the course of the epidemic.
Douglas-fir stands: Low hazard	Stand data indicates that there are roughly an average of 13 sqft/ac basal area of Douglas-fir in the >14” diameter class in these stands. That equates to an about 12 trees per acre >14” dbh. Given favorable beetle conditions and continuation of high beetle populations, and applying a reasonable estimate of 60% loss of larger diameter trees (14-16+” dbh), this could equate to an overall average mortality in these stands of about 7 trees per acre over the course of a typical epidemic.

Direct and Indirect Effects Common to All Alternatives 1 through 5

Acres at risk to spruce beetle infestation with no proposed treatments

An estimated 300 to 400 acres were identified at risk to spruce beetle infestation, but were not surveyed in 2002 for beetle populations, and are not proposed for treatment under any of the alternatives (refer to earlier discussion under *Survey Results*). It is not likely many of these acres have substantial amount of spruce beetles due to their low rating, indicating either a scarcity of larger diameter beetle susceptible spruce and/or higher fire severity. However, some trees are probably infested and they would contribute equally under all alternatives to the spruce beetle population increase within the Moose fire area and subsequent risk to remaining live trees and adjacent forests.

Acres at risk to Douglas-fir beetle infestation with no proposed treatments

Approximately 3500 acres were identified at risk to Douglas-fir beetle infestation in the fall of 2001, but were not surveyed in 2002 for beetle populations, and are not proposed for any kind of treatment under any of the action alternatives (refer to earlier discussion under *Survey Results.* It is expected that beetle activity is occurring in a similar pattern and intensity across many of these acres as was found across the surveyed acres (beetles infesting fire-killed trees and mostly < 1 infested tree per acre). These infested acres would contribute equally to current beetle population levels under all alternatives, as well as to any future beetle populations in the project area.

Direct and Indirect Effects of Alternative 1 (No Action)

No treatment of fire-affected forest would occur under this alternative, with no proposed actions of any kind (salvage or non-salvage methods of treatment) that might influence beetle populations.

Effects of Spruce Beetle Activity

On National Forest System Lands within the Moose Fire boundary:

About 381 acres of beetle susceptible burned spruce stands have been infested to high levels in 2002. Most of these acres are concentrated in the riparian areas of Big Creek and it's tributaries. Very few live spruce have been affected yet by spruce beetles: the beetles attacked fire-killed, severely injured, or windthrown trees. The beetles will complete their two-year life cycle in these trees, with a new generation of adults emerging in the spring/summer of 2004. There are patches and individual live, unburned spruce left within the fire area, which are very vulnerable to beetle infestation. Their scarcity makes them of particularly high value, especially considering their location in riparian areas and adjacent to streams. These would be the first trees the beetles attack upon emergence from the burned trees. Most remaining live spruce trees within the fire area that are greater than 14-16" DBH would very likely be attacked and killed by emerging spruce beetles in 2004. Many beetles would also spread outside the fire area in search of breeding habitat.

On National Forest System Lands within 5 miles of the Moose Fire boundary:

Susceptible spruce stands within a few miles of the fire area will be highly vulnerable to bark beetle infestation with the emergence of the adult beetles in 2004 from the fire-affected trees in the Moose Fire. Based on the number of acres of susceptible spruce stands, their hazard rating, the current level of infestation within the Moose Fire area, and the spread/mortality assumptions described earlier, this section will identify some of the resource values that may be affected in a region five miles from the fire perimeter, defined as that area most immediately at risk in the next 2-4 years from an outbreak initiated in the Moose Fire area.

Beetles emerging from infested stands within the fire area would find a relative abundance of desirable spruce beetle habitat outside the Moose Fire area (refer to Map 3-3 and Table 3-13). Given the relatively high rate of infestation across the 380+ acres within the Moose fire area, the potential exists for about 900-1200 acres of spruce

stands outside the fire area to be infested in 2004 upon emergence of the adult beetles. The beetles will seek out the closest desirable breeding habitat, which (after infesting whatever live trees are left within the fire) are likely to be the high hazard stands closest to but outside the Moose Fire area. Given favorable conditions, a portion of the 1500 acres of high hazard spruce in this 5-mile region is likely to be infested in 2004, with some of the medium hazard stands infested as well, depending upon their proximity to the Moose Fire area and the susceptibility of the spruce within these stands. Not all trees within these stands will be attacked by beetles this first year; perhaps 1-20 spruce per acre may be killed.

If weather and other variables continue to be "beetle friendly" over the next several years, the acres infested could reach up to 2700 acres, given up to six years of sustained high beetle populations and a "buildup ratio" of 3:1 as mentioned earlier. Tree mortality over the course of an epidemic of this magnitude could be from 60-80 percent of the larger diameter trees (>16"). In the med-high to high-risk stands surrounding the Moose Fire, this mortality rate would translate to about 6 to over 25 trees per acre. Mortality would occur over a several year period, and is highly dependent upon weather conditions, availability of susceptible trees, and other variables that interact to influence beetle populations and outbreak patterns.

Resource values outside the fire area that are potentially affected if spruce beetle epidemic conditions develop:

Some of the primary values that would be affected by spruce mortality are described in the following section. Readers should also refer to other resource sections in this chapter of the FEIS for further discussion regarding possible effects to resources given beetle outbreak conditions.

Late Seral/Old forest; forest structure, composition and diversity: There are an estimated 11,000 to 17,000 acres on National Forest System Lands within five miles of the Moose Fire that are either old forest or have substantial old forest/late seral character, based on past stand exams, project level analyses, and photo interpretation (Project Record J-5, O-17). This represents about 21 percent of the total National Forest System Lands within this five-mile region. It is highly unlikely that all of these stands would qualify as "old growth" according to the Western Montana Zone definitions (Project Record O-16). Many would fall short in such components as adequate number of large overstory trees, amount and size of downed wood and snags, or diversity of canopy layers. However, it can be assumed that these stands are the ones highly likely to contain at least some of the values associated with old or late seral forests, particularly an older, larger overstory tree layer.

As discussed earlier in the first part of this chapter, under *Vegetation structure, composition and timber resource*, some old forest/late seral forest was burned in the Moose Fire and converted back to an earlier stage of development. Though this old forest component has been reduced across the landscape because of the fire, the proportion is still estimated to be within the range of natural (historical) variability, which is quite wide in this fire-dominated ecosystem (USDA 1999). However, a greater amount of old forest than currently exists may be desirable to better meet wildlife habitat needs, especially considering the large area of seedling/sapling early seral forest that has been created by the Moose Fire. Loss of any remaining old forest in the surrounding area due to beetle attack and mortality is an undesirable effect.

An estimated 6100 acres of these late seral/old growth forests within five miles of the fire boundary are at risk of spruce beetle infestation (Project Record J-5). These acres represent up to 55 percent of the total "old forest/late seral" acres in this zone. Some of these acres overlap with the stands at risk to Douglas-fir beetle as well.

Most of these stands (an estimated 4900 acres) are rated medium risk to spruce beetle infestation, indicating spruce tree size and/or density are somewhat lower than if these were high risk stands (refer to Table 3-18). In these stands, spruce is typically less than 50 percent of the tree stocking, mixed with other species, and consist of only a few beetle susceptible trees per acre up to 30 or more trees per acre. The remaining high-risk stands (about 1200 acres) are heavily dominated by spruce, most of these larger diameter, older trees. Given spruce beetle epidemic population levels, high mortality rates could be experienced in both the medium and high risk stands, but especially the high risk, where up to 60 percent of the trees over 16" dbh could be killed over the next 2-6 years, before a typical epidemic subsides (Gibson 2002b, Project Record J-29). This would equate to perhaps one to over 20 trees per acre.

Applying our earlier assumptions of possible rate of spread (Table 3-18), with the current level of spruce beetle infestation within the Moose Fire area and favorable local weather conditions, adult beetles emerging out of these infested trees could feasibly spread across about 900 acres of beetle susceptible spruce stands outside the fire area in 2004, killing variable amounts of spruce trees in these stands. Because of the greater tree sizes and thus generally higher beetle risk in the stands that are late seral/old forest, beetles are likely to be more attracted to these stands and mortality would be disproportionately higher than that of younger/smaller diameter stands. If all 900 acres infested were in this late seral/old forest component, it would amount to about 7 percent of the 12,000+ total estimated acres in this structure class in the vicinity of the fire. With continuing high beetle populations in successive years, a major impact on both amount and quality of spruce old forest/late seral habitat would likely occur.

Riparian values: Forests in close association with streams have particular value for wildlife, providing summer thermal cover, old forest habitat, and adding to the diversity of forest structural conditions across the landscape. The riparian forests are often highly valued as wildlife travel corridors, particularly in situations where past harvest has fragmented the forest cover to some degree and converted areas to early seral stages, as has occurred in much of Big Creek. A disproportionately high amount of the old forest/late seral forest is typically located in riparian areas, containing the most productive growing sites and experiencing the longest fire-free intervals. Streamside forests influence fish habitat and stream conditions. The spruce/subalpine fir forest type dominates the riparian areas in Big Creek, Coal Creek, and most other drainages of the North Fork Flathead River.

It follows that many of the spruce stands at risk to bark beetle surrounding the Moose Fire occur along streams and in riparian areas. An estimated 40 miles of perennial streams are bordered by spruce stands at risk to beetle infestation, and many more miles of intermittent streams flow through older spruce stands as well (Project Record J-11). Though most of these stands are medium risk to beetle infestation, about 10 miles of stream within this five-mile zone is bordered by high-risk stands. Essentially, nearly all of the 1400+ acres of med -high and high hazard stands within five miles of the Moose Fire boundary are associated with riparian areas and streams (Project Record J-12). Many of these also qualify as old forest habitat, as described earlier. In sustained epidemic beetle conditions, these stands are especially vulnerable. Some of these stands could experience up to 60 percent mortality of overstory (>16”) spruce over a several year period, translating to an estimated 6 to over 25 trees per acre.

As described above under late seral/old forest, we might expect up to 900 acres of spruce forest infested with beetles in 2004 from beetles spreading out from Moose Fire stands. Some of this, and probably a high proportion of this, would be in riparian areas, where the highest risk and most susceptible spruce trees tend to be concentrated. Loss of high numbers of these trees over the next 2-4 years would change the nature of these stands.

In late seral/old forest stands, loss of many of the live, large diameter overstory trees in riparian areas would reduce the important old forest component, as described earlier. These trees will become large diameter snags and eventually downed wood, also highly valuable forest structural and wildlife habitat components. Heavy amounts of downed wood may impede movement of ungulates, which might be an issue if these areas of mortality are extensive or are particularly important as travel corridors. However, the high-risk spruce stands tend to be rather scattered across the landscape, not concentrated in large patches, so this condition is not likely to develop. Excessive numbers of trees falling into stream channels might cause some concerns with stream channel conditions (refer to Chapter 3 section on fisheries). But again, the high-risk stands generally do not extend for long distances along the streams or cover large areas. Forests in riparian areas are typically not considered suitable for timber management, so economic value of trees killed from spruce beetle would not typically be a concern.

Timber Productivity and Economic Value of Trees for Wood production: On National Forest System Lands, approximately half of the total 12,224 acres of spruce beetle susceptible stands within five miles of the fire occur on lands considered suitable for timber production by the Flathead National Forest Plan. Management of these lands to produce timber, while protecting land productivity and other resource values, is a Forest Plan standard for these lands. Loss of significant numbers of trees on these lands would have a detrimental effect on timber productivity, both by the loss of these trees as potential commercial products and by the change in forest structure and species composition that may occur.

Effects of spruce beetle activity on other land ownerships within 5 miles of the Moose Fire boundary:

State Lands: The estimated 247 acres of forest at high hazard to spruce beetle outside the fire area on the Coal Creek state forest (refer to Table 3-14) are very vulnerable to mortality of the larger diameter, >16" spruce trees. If the spruce beetles within the fire area spread to this area, these stands could well experience substantial mortality of the susceptible spruce. This is of concern to State Forest managers. As mandated by the state of Montana, these lands are held in trust for support of specific state institutions, and managers are required by law to administer the lands to produce the largest measure of reasonable and legitimate return over the long run (Section 77-1-202, Montana Codes Annotated [MCA], Mandates on state forest lands). Also, these stands are typically located in riparian areas and as such may have high values for wildlife, old forest habitat, stream stability, or other resources.

Private lands: Mortality of larger diameter spruce would likely occur on the private lands within 5 miles of the Moose Fire, with spread of the spruce beetle population outside of the Moose Fire area. Larger-diameter spruce tend to be concentrated in riparian areas, along streams, and on more moist sites. On average from a landscape perspective, effects would be low due to the small amount of susceptible stands and trees. However, value of individuals or stands of susceptible spruce trees may well be high to individual landowners for a number of reasons, including visual screening, economic values, riparian habitat, and aesthetics.

Effects of Douglas-fir Beetle Activity

On National Forest System Lands within the Moose Fire boundary:

Elevated levels of Douglas-fir beetle populations exist within the fire area. About 3700 acres have been confirmed through surveys to contain Douglas-fir beetle activity. As described above under *Direct and Indirect Effects Common to All Alternatives*, an additional 3500 acres probably contain at least low levels of Douglas-fir beetle infestation. Total acres within the project area with Douglas-fir beetle activity could be close to 7000. Beetles are thinly spread across most (nearly 90%) of these acres, with less than 1 beetle infested tree per acre, and most trees have fewer than six beetle attacks.

Many live, beetle susceptible Douglas-fir remain within the Moose Fire area, most with some degree of fire injuries. Most of these trees exist across an estimated 2000 acres of Douglas-fir forest that burned at relatively low severity. Additional live Douglas-fir exist as small groups and individual trees across many more acres of forest burned at moderate and higher severities. Beetles emerging in the spring of 2003 from currently infested trees would be drawn to these trees first, remaining largely within the fire area, before moving outside of the fire area in search of brood habitat. Many of these trees will probably be successfully attacked, being weakened by fire injuries. Other trees will be healthier, more able to resist attack, unless large numbers of beetles overwhelm the tree's defenses. Under normal conditions, these are natural limiting factors on beetle population levels (along with weather, predators and parasites), functioning both to help reduce high populations of beetles and maintain the typical low, endemic population levels experienced in most years.

Based on the thousands of acres currently harboring some level of beetles, it is reasonable to expect that nearly all of these 2000 acres and any additional acres within the fire area containing live Douglas-fir would experience some beetle caused mortality in 2003 and succeeding years. Overall mortality may be less than 1 tree per acre per year on most of these acres, with possibility for far more mortality in localized areas of high beetle activity. These include areas nearest the current "hot spots" of beetle activity (primarily Hallowat Creek drainage, mouth of Elelehum and Big Creek, and along North Fork road). Milder winters or dry, warm spring/summer weather conditions would favor beetle survival and increase tree stress, raising potential mortality rates of Douglas-fir – perhaps substantially – over the entire fire area.

In years 2004 and beyond, level of infestation would depend greatly upon weather conditions, and intensity and success of preceding years beetle attacks. Two main scenarios are possible. One would be a gradual decrease in infestation intensity and beetle populations as beetles find fewer highly stressed trees to attack and are forced into less favorable smaller or more healthy trees. Success of attack and brood survival tends to be less in these trees. This first scenario would be most likely under normal or particularly cool/wet spring conditions. Depending on the

abundance of more severely fire-injured and stressed Douglas-fir, substantial mortality in the live tree component remaining within the Moose Fire area could still result over the next few years under this scenario.

A second scenario could occur given continuing warm, dry drought conditions, resulting in higher beetle attack and brood success ratios and expanding beetle populations. This would result in increasing levels of Douglas-fir tree mortality within the fire area over the next few years, and the possibility of beetle spread to regions outside the fire.

Over 70,000 acres of forest burned in the Moose Fire – over 27,000 acres at high severity (essentially all trees killed) and another 10,200 acres at moderate severity, with 40-80% tree mortality. Very large areas devoid of or containing only scattered remnants of their former live tree components exist across the area. Remaining live trees across this burned landscape hold particularly high value and importance, and these are the trees most likely to experience beetle mortality in 2003 and beyond. Further loss of live Douglas-fir trees in the fire area – particularly the larger trees that are most susceptible to beetle attack – would have a variety of effects, including reducing the present and future forest structural diversity of this area; affecting future old forest and wildlife habitat values; reducing remaining wildlife thermal cover; and decreasing potential seed sources and site protection values for tree regeneration. The trees that die would contribute to the larger diameter snag component, which, though also important and a valuable wildlife habitat and forest structural component, already exists in abundance across this landscape compared to live overstory tree components. The degree of all these effects would be dependent upon how many of the remaining live trees are lost, which in turn is dependent upon the growth or decline of the Douglas-fir beetle population. A full effects analysis is disclosed in the Moose Fire FEIS.

On National Forest System Lands within 5 miles of the Moose Fire boundary:

Due to low density and level of infestation that has occurred, and the abundance of fire damaged Douglas-fir beetle host trees still remaining within the Moose Fire area, it is expected that most of the trees infested next year (2003) and possibly beyond would still be within the Moose Fire perimeter. Beetles will first attack the most severely fire-stressed trees, in succeeding years attacking less severely damaged trees, flying only so far as necessary to find these suitable host trees. Attack success in the healthier trees is typically lower, and beetle populations tend to decline when faced with situation. Continuing drought conditions will not favor beetle populations growth, but will increase the stress on live trees, rendering them more susceptible to beetle attack and mortality.

If widespread epidemic conditions of Douglas-fir beetle do develop, available host trees will become increasingly scarce within the fire area. Stands outside the Moose Fire area would become more vulnerable to attack and mortality of the beetle-susceptible Douglas-fir, particularly in the areas within five miles of the fire perimeter. About 83 percent of this zone is national forest system land. Refer to Map 3-4 and Table 3-14 for the acres and hazard ratings of Douglas-fir stands in this zone. With over 90 percent of the nearly 12,000 acres of Douglas-fir stands within five miles of the Fire boundary at low or low/moderate beetle hazard, there will be relatively few larger Douglas-fir vulnerable to beetle attack in this region. High populations of Douglas-fir beetle could still cause substantial mortality of the Douglas-fir within these stands, but net effects and net losses would be low overall, and the potential for beetle populations to continue to build within these stands would be low.

Nearly 1100 acres within the 5-mile zone outside the Moose Fire are considered moderate to high hazard to Douglas-fir beetle. These are the acres that could support and sustain high populations of Douglas-fir beetles and where significant mortality and loss of the larger diameter, older Douglas-fir could be seen if an outbreak develops and spreads outside the fire area over the next few years. Tempering this risk level is the fact that these moderate to high risk stands mostly exist as relatively isolated pockets, surrounded by stands at low or no risk to Douglas-fir beetle. Under these conditions, high populations of Douglas-fir beetle may still cause significant mortality in the Douglas-fir components of these stands, but beetle populations may not find adequate high quality food sources to allow them to build up to extreme population levels where extensive mortality can occur across the landscape as a whole (Randall and Tensmeyer 1999).

Resource values outside the fire area that are potentially affected if Douglas-fir bark beetle epidemic conditions develop:

Primary values that may be affected if epidemic conditions of Douglas-fir develop are discussed below. Readers should refer also to other resource sections within Chapter 3 of this EIS, such as Wildlife and Fish habitat, for further discussion regarding possible effects to resources from a beetle outbreak.

Late Seral/Old forest; forest structure, composition and diversity: As stated under the section on spruce beetle, there is an estimated 11,000 to 17,000 acres of forest on National Forest System Lands that are possible late seral/old forest (Project Record J-5). About 42 percent (or 4960 acres) of these acres are at risk to Douglas-fir beetle. This relatively high proportion is not surprising, considering it is the stands with larger diameter Douglas-fir trees that are most at risk to attacking beetles. These acres represent about 28 percent of the total old forest/late seral acres within five miles of Moose Fire.

Of these 4960 acres, 60 percent (2984 acres) are rated very low hazard to Douglas-fir beetle. Another 31 percent (1553 acres) are low/moderate hazard. These stands typically are low hazard because larger diameter, beetle susceptible Douglas-fir do not comprise a major portion of the stand. They may be composed of mostly smaller diameter Douglas-fir, or have high proportion of other species, such as larch or spruce. Loss of some of the overstory Douglas-fir would have a relatively minor impact on old forest character overall in these stands. However, in some of these stands, these larger, older Douglas-fir may constitute the majority of the overstory old trees. Based on assumptions of susceptible trees per acre and expected overall mortality (see Table 3-18), many of these low hazard, old-forest stands may lose an average of seven larger diameter Douglas-fir trees per acre. The beetle-infested trees would be converted from live overstory tree component to large snags, and eventually downed large wood, both of which also have high value as old forest structural components and as wildlife habitat. However, their loss as a live tree component might alter, and in some cases reduce, the stand's old forest character or qualification as "old growth" habitat according to Western Montana Zone definitions (Project Record O-16).

The remaining nine percent of the stands with old forest features (422 acres) are considered moderate to high hazard to Douglas-fir beetle, with an estimated average of about 42 sq. ft/acre basal area of Douglas-fir, roughly 40 tpa >14". These stands may lose an average of 24-32 larger diameter trees per acre if beetle populations continue to build over the next 2-5 years. Because Douglas-fir generally comprises a larger portion of these stands than those of low hazard, loss of this magnitude would have a detrimental effect on the old forest character of the stand. These stands would probably not meet "old growth" definitions with this level of mortality. This is in fact the situation that was occurring prior to the Moose Fire in many of the older Douglas-fir stands within Big Creek, with the high levels of root disease and bark beetle mortality in the Douglas-fir (refer to earlier discussion under "Affected Environment"). The mortality of the larger Douglas-fir would result in an increase in the numbers of large snags and downed trees, also important components of the old forest with high value as wildlife habitat.

Mortality of 60-80 percent of the Douglas-fir overstory over the next few years may also cause a substantial shift in species composition and/or structure in Douglas-fir dominated stands. A shift to the more shade-tolerant species that probably already exist in the understory of some of these stands may occur. The understory trees would experience a growth release with the loss of the overstory. Most of these high hazard stands, though, are on relatively dry sites, where Douglas-fir is often the climax species, and subalpine fir and spruce are absent or only minor components. Though loss of overstory Douglas-fir would not result in a major shift in species diversity in these types of stands, structural and size class diversity could be reduced with the loss of most of the live larger diameter overstory trees. Large diameter snags would increase across these stands, which have values associated with forest structural diversity, wildlife habitat, and other ecological values.

In addition to stands that have significant old forest character presently, there may be other stands at risk to Douglas-fir beetle infestation that are not currently old forest, but have the potential to become old forest in the future. These are stands that are in their mid-seral stage of development – the "middle aged" forests on the landscape, anywhere from 50 to 150 years old or so. Exact acreage of these types of stands is not known. They are typically low risk to Douglas-fir beetle at present, due to smaller and more vigorous trees, and are at little risk of significant tree mortality. However, if beetle populations have the opportunity to build to very high levels over the next few years, increasing proportions of the overstory trees in these "mid-seral" stands may be lost, as beetles are

more likely to attack thrifty or smaller diameter trees under these epidemic conditions. The stand's potential to achieve old forest status may be severely delayed or lost entirely.

Riparian values: Some of the nearly 12,000 acres at risk to Douglas-fir beetle within the 5-mile zone occurs in or near riparian areas, but these stands are overwhelmingly low hazard to the beetle. In addition, Douglas-fir is not typically a major component in these riparian zones, where spruce plays the more dominant role by far. In general, the low proportion of Douglas-fir in most of the stands at risk, and the even lower proportion that probably occurs actually adjacent to streams, should result in a minimal level of impact to riparian area values should high bark beetle populations spread to lands surrounding the Moose Fire.

Timber Productivity and Economic Value of Trees for Wood production: On National Forest System Lands, approximately 70 percent, or 8300 acres, of the nearly 12,000 acres of Douglas-fir beetle susceptible stands occur on lands considered suitable for timber production by the Flathead National Forest Plan (1986). Management of these lands to produce timber, while protecting land productivity and other resource values, is a Forest Plan standard for these lands. Most of these stands are low risk to Douglas-fir beetle, and are estimated to have perhaps an average of 15 trees per acre of >14" Douglas-fir. Given the estimate of 60 percent mortality in this tree class, loss of this magnitude would equate to about 75,000 trees total (about nine trees per acre). Some effect on lost value as a commercial product would be realized in these stands.

Effects of Douglas-fir beetle activity to forests on other land ownerships within 5 miles of the fire boundary:

State Lands : About 13 percent of the lands within 5 miles of the Moose Fire perimeter are state forestlands (Figure 3-3). All 1400 acres of forest at risk of Douglas-fir beetle infestation on these lands are rated low to moderate hazard. As such, when compared to high hazard stands, there is lower probability of infestation by beetles spreading out from the Moose Fire area, and overall net losses would be less. If widespread epidemic beetle population levels develop over the next 2+ years, these areas could well experience substantial mortality of the susceptible Douglas-fir, which is of concern to State Forest managers. As mandated by the state of Montana, these lands are held in trust for support of specific state institutions, and managers are required by law to administer the lands to produce the largest measure of reasonable and legitimate return over the long run (Section 77-1-202, Montana Codes Annotated [MCA], Mandates on state forest lands).

Private lands: There are no areas with substantial amounts of Douglas-fir at risk to beetle on the few acres of private lands within five miles of the fire. Individuals and small groups of Douglas-fir trees do occur, which, though their death may not cause any measurable change in terms of total stand density or species composition, they may be of high value to individual landowners for a variety of reasons, such as visual aesthetics and screening.

Direct and Indirect Effects Common to All Action Alternatives

All action alternatives propose to treat some portion of the stands currently infested with Douglas-fir and/or spruce bark beetle within the Moose Fire area, with salvage and non-salvage methods. The following situations and actions are common to Alternatives 2, 3, 4 and 5.

Timing of salvage and other treatments

Under all action alternatives, timing of beetle treatments is an important factor in the development and implementation of an effective bark beetle management plan. When using pheromone baited beetle funnel traps or the anti-attractant MCH pheromone, placing them in selected locations in a timely manner normally does not pose a problem. Use of Douglas-fir trap trees or baited trees also requires timely felling or baiting of the trees in late fall or early spring, before beetle flight. Then these trees must be removed before the new generation of beetles emerges.

Timeliness of salvage efforts, sometimes combined with removal of trap or baited trees, can be more difficult to achieve, because of the intensive and complex planning, preparation and implementation that is required. The window of opportunity for salvage of trees infested with spruce beetle is wider than for Douglas-fir beetle, since spruce beetles in this area remain within the same tree for the duration of their two-year life cycle. In all action

alternatives, it should be possible to complete proposed salvage efforts in the acres infested with spruce beetle within two years (by the spring of 2004), before adult beetles emerge.

In the case of Douglas-fir beetle, beetles infesting trees the first year after the fire (2002) will be emerging as adults starting the spring of 2003. The most effective method to influence Douglas-fir beetle populations in the Moose Fire area is removal, i.e. salvage, of beetle-infested trees prior to emergence of this first generation of adults (Gibson 2002b). Given the current timeline for issuance of a decision on the Moose Post-Fire Project (i.e. October 2002), it must be assumed that if an action alternative is selected, not all of the units with Douglas-fir beetle infestations will be able to be harvested by spring of 2003. This means that adult beetles emerging that spring would have the freedom to spread to other live trees both within and outside the fire area, unless action is taken to affect this. Because of this, methods designed to manipulate and contain the spread of Douglas-fir beetle in areas of concern would be included in the action alternatives. Surveys of the area in the summer of 2002 have provided site-specific information on location and extent of Douglas-fir bark beetle infestations. This site-specific knowledge has been incorporated into the development of the action alternatives and the beetle management plan. This plan would include some or all of the following actions:

1. Prioritization of treatment areas, with salvage efforts, if possible, focused first on the units with highest risk or levels of infestation and mortality. Under Alternatives 2, 3 and 5, many of the units with Douglas-fir beetle infestation could feasibly be logged during the winter of 2002/03, substantially increasing the effectiveness of the beetle management plan by allowing removal of many trees harboring the first generation of bark beetles. These include Units 1, 2, 3, 3A, 4, 8, 10, 11, 13, 19, 20, 21, 26, 27, 28, 29, 35, 43, 44, 67, 68 and 69 along the Big Creek/Coal Creek road system (total up to 531 acres, estimated up to 700 or more trees infested). However, the option to log in the winter does not exist under Alternative 4.

2. Use of Douglas-fir trap trees or pheromone baited trees in selected locations. Refer to discussion later in this section.

3. Continued use of the anti-attractant pheromone MCH to protect identified high-value areas of live Douglas-fir. Refer to discussion later in this section.

Spruce beetle management using pheromone-baited beetle funnel traps, burning, or debarking

Under all four action alternatives, the primary method employed to address concerns with the spruce beetle populations buildup within the Moose fire area is the use of pheromone-baited beetle funnel traps. All alternatives propose nearly the same acres and locations of this treatment, applying traps across 272 to 281 acres of beetle infested spruce stands. Best estimates at this time would involve the placement of about 50-80 clusters of funnel traps (3 traps per cluster) in selected locations, nearly all within the riparian areas of Big Creek and the lower portions of its tributaries, with one area located in the Dead Horse Creek drainage and one area along the North Fork Flathead River. These acres have been confirmed by the spruce beetle monitoring completed in August of 2002, and includes all stands found during the surveys to contain higher levels of spruce beetle infestation (refer to monitoring results discussion earlier in this Chapter and to Project Record J-32). The alternative maps found in Chapter 2 of the FEIS display the areas to be treated.

Spruce beetles, as with many insects, rely on chemicals known as pheromones to communicate with one another. The funnel traps contain an “aggregate” pheromone, the attractant chemicals naturally released by unmated female bark beetles after locating a suitable breeding site. It attracts both males and females to a tree, and in the natural system has the function of stimulating mass attacks, which allow beetles to concentrate on a scattered resource or overcome the natural defenses of a live tree. The intent of the trapping is to draw in and capture as many of the adult beetles as possible emerging from the burned trees in 2004, before they have a chance to spread, attack and kill live spruce trees in areas in and around the site of infestation (Gibson 2002a, Project Record J-28). With selective placement of adequate numbers of traps, the majority of the emerging beetles on a particular infested site can be captured, which could well be many hundreds of thousands of beetles. This will aid in preventing these beetles from spreading out further from the area of infestation.

Funnel traps have been used to successfully “trap out” small, isolated populations of beetles in the past (Gibson 2002a, Project Record J-28). The situation that exists within the Moose Fire is favorable for successful use of the

pheromone trap method for spruce beetles for several reasons (Gibson 2002c). Beetle infested spruce cover a relatively small, manageable area, concentrated in treatable pockets with fairly good access, rather than broadly scattered infestation patterns over a very large area, as is the case with the Douglas-fir beetle infested trees. At most infestation sites, there are relatively few spruce left alive, so beetles emerging from the infested trees will have no readily available host trees nearby. The pheromone traps will be the nearest attraction for the beetles, increasing their effectiveness. With accurate location of infestation sites, treatment of a high proportion of the infested sites, and diligent monitoring and weekly emptying of the traps, this method is expected to be highly effective in the treatment areas, capturing the majority of the emerging adult beetles from these sites (Gibson 2002c).

There may be a few opportunities to treat a spruce beetle infested tree by burning (i.e. with propane torches) or debarking the tree to kill the beetles under the bark before they emerge. Though these are labor intensive and relatively costly methods, there may be situations where it is useful and desirable to employ. For example, it may be used on a beetle infested spruce tree that is immediately next to one or more unburned, non-infested trees. The close proximity of these trees would greatly increase the probability that the emerging beetles would immediately infest the unburned adjacent trees. If these trees are considered valuable enough to protect, it may be worthwhile to mechanically destroy the beetle brood in the nearby infested trees. Specific sites and situations where these methods might be employed would be field verified prior to spring of 2004, when adult spruce beetles would emerge.

Douglas-fir beetle management using anti-attractant MCH pheromones

Under all action alternatives, the anti-attractant pheromone “MCH” would be used equally to protect live Douglas-fir remaining at sites considered to have unique values. This includes the Glacier Institute/Big Creek campground area and portions of the Wild and Scenic River corridor. Protecting these particular trees from beetle attack is considered important for their visual and aesthetic values, as well as a potential seed source and for wildlife habitat. MCH pheromone sends the chemical message of “no vacancy” to the flying bark beetles, indicating the tree is at maximum capacity and the beetle should look elsewhere for breeding sites. It is a simple method to implement, requiring the stapling of “bubble capsules” to individual trees in the early spring, before beetle flight has begun (Ross et al 2001).

MCH is most commonly and efficiently used in localized, smaller treatment areas. Application of MCH has already occurred to protect the trees on the Glacier Institute and Wild and Scenic River sites during the 2002 beetle flight (Project Record J-22), and monitoring has shown that it has successfully prevented beetle attack on these trees. Past experience has also proven MCH to be very effective in protecting trees from infestation (Gibson 2000). MCH application would continue to occur under all alternatives for as long as beetle populations remain high (a minimum of 2-3 years).

Douglas-fir beetle management using trap trees or pheromone-baited trees

The use of trap trees or baited trees has proven an effective tool to manage beetle populations in bark beetle infested or susceptible stands (Gibson 1984, Hodgkinson 1985). Trap tree methodology can be applied similarly to manage both spruce and Douglas-fir bark beetles, though it’s use in the Moose post fire project is recommended only for Douglas-fir bark beetles (refer to discussion under Alternative 6 in Section V of Chapter 2).

Trap trees are essentially human-made “blowdown”, with the felling of live green Douglas-fir trees in places where they can be accessed for removal. These downed trap trees are extremely attractive to bark beetles in the vicinity searching for feeding and breeding sites and act as “decoys” to reduce losses in standing, live trees (Gibson 2002a, Project Record J-28). Trap trees can be very effective, drawing 8 to 14 times the number of beetles than a comparable standing tree (Schmid and Frye 1977, Gibson 2002c), and effectively drawing beetles from ¼ to ½ mile away (Hodgkinson 1985, Gibson 2002c). Trap trees focus and contain beetle attacks on fewer numbers of trees, in a more predictable pattern and in known locations where the trees can later be removed. In most situations, 1 trap tree for every 5 standing infested tree is the typical recommendation (Hodgkinson 1985, Gibson 2002c). This number can be varied depending upon the intensity of infested trees in the area. Trap trees are best felled as small groups of 2-4 trees. It is expected that some “spillover” of beetles at trap tree sites would occur, with a few nearby standing Douglas-fir attacked by beetles as well. Trap trees and adjacent infested trees would be removed before beetles within them have a chance to emerge. It is very important to make sure the commitment is there to remove these trees. Leaving them on site may only exacerbate an already undesirable situation (Gibson 2002a).

Pheromone-baited trees are live Douglas-fir trees to which an "aggregation" (attractant) pheromone is attached, which attracts both female and male beetles. These beetles then produce more of the attractant, initiating the "mass attack" pattern, drawing in many more beetles to the tree. Though not quite as effective, baited trees function essentially like the trap tree method described above, except the tree is not felled at the time of baiting. Baited trees serve to focus and contain active infestations within desired areas where the infested bait trees can then be removed before the beetles within them emerge. They are most effective in situations of lower or more moderate beetle populations levels (project record exhibit J-36, J-37). Using baited trees rather than trap trees also may be preferable in a situation where live trees are of particularly high value. Baited trees would only be felled and removed if they become infested, allowing for the possibility that a decline or lower level of beetle populations than anticipated might occur, and the tree might not become infested. The attractant pheromones are also relatively quick, simple and inexpensive to apply.

Limited use of trap or baited trees are proposed under all action alternatives in the Moose project. This method would be potentially used in units where Douglas-fir beetle infestation levels are relatively high; numerous live, beetle susceptible trees remain within or around the units; salvage of the trees infested by beetles in 2002 is delayed beyond the spring of 2003 (emergence of the first generation of beetles); and/or infested units are dropped from the salvage proposal in the final decision.

Several proposed salvage units fit these criteria. They include Units 37, 37A, 41, 56, 57, 66, 75, 76. Other units do not themselves currently contain high numbers of beetle infested trees, but do contain various numbers of live beetle susceptible Douglas-fir trees and are in the vicinity of higher beetle concentrations. These include Units 14, 15, 16, 22, 23, 24, 38, 40, and 63. Units included and acres treated vary somewhat among the alternatives. Trap/baited trees could be used within any of these units, though focus would be in those localized areas where beetle populations are highest and remaining live trees are thus very vulnerable to mortality. This includes the Hallowat Creek area, parts of lower Elelehum Creek, and in small areas within upper Lookout Creek. An approximate ratio of 1 trap tree for every 5 infested trees would be used. Baited trees would be dispersed across the units at a density of one every 25-50 yards. Highest priority for trap/baited trees would be within proposed Units 37, 38, 40 and/or 41 in Hallowat Creek to address the particularly high beetle concentrations in this area, and draw beetles away from the many remaining live Douglas-fir trees, particularly within the adjacent Roadless area (Unit 75). Up to an estimated 50 trap/baited trees would be created in this area.

Lower priority areas would be within Units 56 and 57 in Lookout Creek, where trap or baited trees could be used to protect more of the remaining live, standing trees in these units and surrounding areas. Up to an estimated 25 trap/baited trees would be created. An additional lower priority area for trap/baited trees would be within Units 23 and/or 24 in Elelehum Creek, drawing beetles in from nearby high density infestation areas, using up to an estimated 20 trap/baited trees. Field verification of all potential trap/baited tree areas would provide final confirmation on number, location and availability of suitable trees, and the actual numbers of trap/baited trees may be slightly more or less than estimated.

Trap and baited trees would be felled or baited in early spring, before beetle flight begins in about May of 2003. With selection of an action alternative, the salvage harvest would remove the infested trap or baited trees along with other dead, dying and infested trees within the unit. This recommended strategic use of trap or baited trees would improve the effectiveness of the salvage effort in reducing beetle population concentrations and the threat of mortality to remaining live trees.

All these units except Unit 38 are included in all action alternatives. Alternative 4 drops unit 38 and there is slight reduction of acres within the other units, but the same trap/baited tree scenario could be followed within the treated areas in this alternative also. Its efficiency and effectiveness may be less under Alternative 4, considering the limited logging operating season (i.e. no winter logging) and the resulting delay in salvage across more acres and more time. More beetles would have opportunity to emerge and spread into live Douglas-fir in 2003 and subsequent years, before salvage operations might finally remove beetle infested trees and any trap or baited trees.

Direct and Indirect Effects of Each Action Alternative

In addition to the pheromone and trap/baited tree methods described above, varying levels of salvage harvest is proposed under each action alternative to address concerns related to spruce and Douglas-fir beetle population levels. Though the majority of spruce beetle infested stands occur within riparian areas and are proposed for pheromone baited funnel trap treatments, approximately 94 acres of spruce beetle infested acres are known to be within proposed salvage units. All proposed salvage harvest units were found to contain Douglas-fir beetle activity, and salvage harvest is the primary treatment method proposed for managing the Douglas-fir beetle population within the Moose fire area. Salvage harvest would remove currently infested trees and those most at risk to beetle infestation in 2003 and beyond, as determined by evaluating the degree of fire injury (refer to Appendix B, Post-fire mortality guidelines).

The effectiveness of the salvage action alternatives on influencing Douglas-fir beetle populations is basically proportional to the amount of infested and highly beetle susceptible trees that are removed from the site. Under conditions of high infestation levels, removing one infested tree means you have theoretically saved 5-10 live trees from attack and mortality (Gibson 2002c). The current intensity of infestation is not excessively high across most acres within the Moose fire area, so this mortality ratio is probably lower. There are localized areas of concentrated beetle activity (the “hot spots” described earlier under survey results) where higher rates of mortality might occur. Table 3-20 below displays the number of Douglas-fir beetle infested acres treated with salvage harvest under each action alternative.

Table 3-20: Proportion of Douglas-fir beetle infested acres treated by alternative

Infestation Level	Surveyed acres	Treated Acres: Alternative 2/5	Treated Acres: Alternative 3	Treated Acres: Alternative 4
Lands suitable for timber management (MA 9, 13 and 15)				
Areas with low density of Douglas-fir beetle infested trees	2305	1541	1541	1192
Areas with higher density of Douglas-fir beetle infested trees	586	611	617	516
Lands with special management emphasis (Inventoried Roadless, Wild & Scenic River, Winter range unsuitable for timber management)				
Areas with low density of Douglas-fir beetle infested trees	465	448	254	252
Areas with higher density of Douglas-fir beetle infested trees	300	289	13	0

Alternative 2 (Proposed Action) and Alternative 5

Spruce beetle – salvage treatment

Alternatives 2 and 5 salvage harvests all known spruce beetle infested acres within salvage units, treating an estimated 94 infested acres within Units 44, 55, 57 and 76. With implementation of these Alternatives, beetle infested trees would likely be salvaged from all these areas before adult beetles emerge in the spring of 2004. With the additional 272 acres being treated with pheromone-baited funnel traps (as described earlier), these alternatives would treat a total of about 366 acres of spruce beetle infested stands, or essentially all of the known acres that are infested with high levels of beetles. This integrated and aggressive approach to spruce beetle management within the fire area should prove efficient and effective. Alternatives 2 and 5 have a high probability of successfully containing a spruce beetle population buildup within the Moose Fire area, containing a beetle outbreak, and maintaining the currently low beetle population levels in the region outside the fire area. There would likely be some amount of mortality in remaining live spruce within the fire area, because the beetle traps are not expected to capture all emerging beetles. Also, there are undoubtedly some undetected areas of infested spruce within the fire area.

Douglas-fir beetle – salvage treatment

Alternatives 2 and 5 salvage 2428 acres (66%) out of a total 3656 known infested acres. Essentially all (nearly 900 acres) of the known areas of high beetle infestation densities would be salvaged. Based on the expected timeframe for implementation of a decision, salvage of many areas currently infested with beetles would probably not occur until after the first generation of adult beetles has emerged in the spring of 2003. Though this will reduce the effectiveness of the salvage effort on managing the beetle population and reducing mortality of live trees, there are actions that would compensate to some degree, as described earlier under *Direct and Indirect Effects of all action alternatives.* Salvaging as many acres as possible in the winter of 2002 and 2003, particularly units with higher beetle population levels, would address this concern. Strategic use of trap/baited trees is one important method, as is continuing use of the anti-attractant pheromone MCH at selected sites. In some units with surviving Douglas-fir, many of the emerging beetles will probably remain within the salvage unit area, infesting nearby live, fire-injured Douglas-fir trees. In some areas, baited trees would be used to complement and enhance this containment. Though salvage may not have occurred soon enough to remove the first generation of beetles, a large portion of this second generation would then be removed if units are salvaged before spring of 2004.

Under Alternatives 2 and 5, units that could be most readily logged in the winter prior to the beetle flight in spring of 2003 include Units 1, 2, 3, 3A, 4, 8, 10, 11, 13, 19, 20, 21, 26, 27, 28, 29, 35, 43, 44, 67, 68 and 69 – all ground based skidder units along Big Creek, Coal Creek or North Fork road system. This is a total of about 531 acres, estimated over 700 infested trees. Included are about 130 acres of highest infestation (Units 1, 4, 11, 28, 35, 43, 67, 68, 69). This is about 14 percent of the total area known to have high beetle populations, and six of these units are near particularly sensitive sites (the Glacier Institute, Big Creek Campground, and Wild and Scenic river corridor), where a few live Douglas-fir still exist.

Alternatives 2 and 5 treat as large a portion of the known currently beetle infested acres as is possible, considering the limitations imposed by timing and other resource concerns and objectives. These alternatives allow the flexibility to fully apply methods of beetle management that address concerns with delay of salvage and potential live tree mortality in 2003, such as salvaging this winter, use of trap/baited trees, and application of the pheromone MCH. Alternatives 2 and 5 would considerably reduce beetle populations and risk of mortality to live Douglas-fir trees both within and outside the fire area.

Some mortality to live Douglas-fir would still occur, because not all areas or trees infested with beetles would be treated, under these or any alternative. Many areas have been left unsalvaged because of other resource or social concerns (refer to earlier discussion under *Direct and Indirect Effects of All Alternatives 1 through 5*). Other areas within or next to proposed salvage units have been left as buffer strips adjacent to wetlands or streams, patches left for snag habitat, forest structural diversity or site protection. Most trees attacked by beetles next year and perhaps beyond would be within the fire area, with beetles infesting remaining live but fire-injured trees (refer to discussion under *Direct and Indirect Effects of Alternative 1)*. These remaining live trees are of particularly high value because of their scarcity across this burned landscape, and the values they hold for wildlife, forest structure and diversity, site protection, and future seed sources. Their loss/conversion to snags and downed wood through beetle mortality is likely to affect these values, as discussed further under Alternative 1 and in other resource sections of this chapter.

Units 14 through 17, and 67 through 78 are in areas that allow salvage harvest to meet very specific resource objectives (in this case, to decrease potential beetle populations and thus future mortality to live trees) and only if the special values of these lands are maintained or enhanced (i.e. Wild & Scenic River corridor, inventoried roadless areas, and winter range classified as unsuitable for timber management). The treatments prescribe removal only of currently beetle-infested trees. The level of infestation and potential effects on beetle populations should be considered in determining whether salvage harvest is warranted. Units 14 through 17, and Units 70, 72, 73 and 78 contain well under one infested tree per acre, widely scattered across the area, with the majority less than six beetle attacks/tree (refer to Table 3-17, Douglas-fir beetle survey results). All are proposed for helicopter logging (722 acres). The low density and thinly scattered nature of the infestation substantially reduces concerns related to their expected contribution to beetle population levels and subsequent future mortality of live Douglas-fir. It also increases logistical difficulty and costs of the logging operation. In addition, Unit 17, 72, 73, and 78 have nearly 100 percent tree mortality. Because of the projected timeframes of the FEIS and the helicopter logging systems, there is very little likelihood these units would be treated prior to emergence of the current generation of bark beetles in the spring of 2003. There are few to no trees within these units that would be suitable for the emerging adults to attack in 2003.

Beetles will go elsewhere to find new breeding habitat, and few to no infested trees will exist to salvage within these units in 2003.

Units 67, 68 and 69 are areas of higher density Douglas-fir beetle infestation (refer to Table 3-17, Douglas-fir beetle survey results). In addition, they are easily accessible tractor units along the North Fork Road, and adjacent to high value sites (Big Creek campground and Glacier Institute) that contain some remaining live, beetle susceptible Douglas-fir trees. Removal of beetle-infested trees from these sites (particularly prior to emergence of the adults in 2003) would reduce risk of mortality to remaining live trees in the surrounding areas.

Alternative 3

Spruce beetle – salvage treatment

Alternative 3 proposes the same treatments as Alternatives 2 and 5, except it eliminates all proposed salvage units that are within inventoried roadless areas (Units 70 through 78). The focus of the description of effects for this alternative is on the resulting effects to beetle population with elimination of all salvage within Roadless.

Unit 76 is the only salvage unit within the Roadless Areas found to be infested with spruce beetle. The relative isolation of Unit 76 within the Roadless Area would make it difficult to implement other measures of spruce beetle control, specifically placement of beetle funnel traps. An estimated 30 acres, about 45 trees, are infested with spruce beetle in Unit 76. This is a relatively small area in the context of the landscape with its many thousands of acres of spruce stands. Little effects to vegetative conditions and resource values would be noticed at the landscape scale, though at the stand level, there could be some mortality of overstory spruce trees in 2004 or beyond across some acres (estimated <100 acres), with resulting impacts on such values as old forest character. These acres are likely to be concentrated in the low severity/unburned riparian area immediately below Unit 76 (Kletomus Creek and tributaries).

With the elimination of the Inventoried Roadless units, Alternative 3 results in the salvage treatment of 64 spruce beetle infested acres within Units 44, 55, and 57. Beetle infested trees would likely be salvaged from these units before adult beetles emerge in the spring of 2004. With the additional 272 acres being treated with pheromone baited funnel traps (as described earlier), this alternative would treat a total of about 336 acres of spruce beetle infested stands, or 92 percent of all the known acres of high beetle infestation. This integrated and aggressive approach to spruce beetle management within the fire area should prove efficient and effective. Alternative 3 has a high probability of successfully containing the spruce beetle population within the Moose Fire area, containing a beetle outbreak, and maintaining the currently low beetle population levels in the region outside the fire area. There would likely be some amount of mortality in remaining live spruce within the fire area, because the beetle traps are not expected to capture all emerging beetles. Also, there are undoubtedly some undetected areas of infested spruce within the fire area.

Douglas-fir beetle – salvage treatment

Alternative 3 proposes the same salvage treatments as Alternatives 2 and 5, except that it eliminates all proposed salvage units within inventoried roadless areas (Units 70-78). These total about 470 acres, with an estimated 151 treated acres (estimated actual area where trees would be salvaged because of beetle infestations). Because of the special management emphasis of these lands, treatment prescriptions specify the removal only of currently beetle-infested trees to meet the specific objective of reducing beetle population levels.

Some of the Roadless Area units have low infestation levels. These include Units 70, 72, 73 and 78, with a total of 194 acres and an estimated 63 infested trees across the total area. This amounts to well under one tree per acre infested, with infested trees widely scattered across the units, and most with less than six beetle attacks per tree, and an estimated 63 infested trees across the total area. All were proposed for helicopter logging, with little likelihood that harvest would be completed prior to emergence of the adult beetles in spring of 2003. Units 72, 73 and 78 have nearly 100% tree mortality. After beetles emerge from the trees in these units they will go elsewhere, finding little or no suitable breeding habitat within the units in 2003 due to the deterioration and drying out of the dead trees. The low density and thinly scattered nature of the infestation within these units substantially reduces

concerns related to their expected contribution to beetle population levels and subsequent future mortality of live Douglas-fir. For all these reasons, dropping these units from salvage harvest results in a relatively minor impact on beetle population levels.

Most of the Douglas-fir beetle infestation within the Inventoried Roadless areas occurs within Units 75, 76 and 77. These units total 276 acres (estimated 110 treated acres), with an estimated 1.0 to 2.64 infested trees per acre, and over 350 infested trees. Unit 75 has the highest number of trees (estimated at nearly 230), and is one of the "hot spots" within the project area, with some of the highest levels of beetle activity (Project Record J-32). The infested acres within these units would contribute to increased beetle populations in the localized area. The numerous fire injured but live, beetle susceptible Douglas-fir within Unit 75 will be highly attractive to emerging beetles, and continuing mortality could be expected in this area. Implementation of proposed trap or baited tree treatments within the Hallowat Creek area would aid in reducing potential mortality of live trees in this area (refer to discussion under *Direct and Indirect Effects of All Action Alternatives).* Trap or baited trees placed within Unit 41 would be designed to draw emerging beetles out of Unit 75 and into trees that could ultimately be removed in the salvage harvest. This opportunity does not exist for Units 76 or 77, which are more isolated and not near enough to any suitable area where trap/baited trees could be placed.

Units 14 through 17, and 67, 68 and 69 are in areas that allow salvage harvest only to meet very specific resource objectives and only if the special values of these lands are maintained or enhanced (i.e. Wild & Scenic River corridor and winter range classified as unsuitable for timber management). All these units are proposed for treatment under Alternative 3. The treatments prescribe removal only of currently beetle-infested trees. The level of infestation and potential effects on beetle populations should be considered in determining whether salvage harvest is warranted. Units 14 through 17 (252 acres total) contain well under one infested tree per acre, widely scattered across the area, with the majority less than six beetle attacks/tree (refer to Table 3-17, Douglas-fir beetle survey results). All are proposed for helicopter. The low density and thinly scattered nature of the infestation substantially reduces concerns related to their expected contribution to beetle population levels and subsequent future mortality of live Douglas-fir. It also increases logistical difficulty and costs of the logging operation. In addition, Unit 17 has nearly 100 percent tree mortality from the fire. Because of the projected timeframes of the FEIS and the helicopter logging systems, there is very little likelihood this unit would be treated prior to emergence of the current generation of bark beetles in the spring of 2003. There are few to no trees in the unit that would be suitable for the emerging adults to attack in 2003. Beetles will go elsewhere to find new breeding habitat, and thus no infested trees will exist to salvage in Unit 17 in 2003.

Units 67, 68 and 69 are areas of higher density Douglas-fir beetle infestation (refer to Table 3-17, Douglas-fir beetle survey results). In addition, they are easily accessible tractor units along the North Fork Road, and adjacent to high value sites (Big Creek campground and Glacier Institute) that contain some remaining live, beetle susceptible Douglas-fir trees. Removal of beetle infested trees from these sites (particularly prior to emergence of the adults in 2003) would reduce risk of mortality to remaining live trees in the surrounding areas.

Alternative 3 treats 2266 acres (61%) out of a total 3656 known Douglas-fir beetle infested acres. This is the second largest among the action alternatives. With the elimination of the Inventoried Roadless salvage units with higher levels of beetle infestation, Alternative 3 is somewhat less effective than Alternatives 2 and 5 at reducing overall beetle populations and risk of mortality to remaining live Douglas-fir trees. Use of trap or baited trees will compensate to some degree.

About 630 acres, or 70 percent of the total 900 acres, of known areas of higher Douglas-fir beetle infestation densities, would be salvaged under Alternative 3 (refer to Table 3-17, Douglas-fir beetle survey results). As under Alternatives 2 and 5, based on the expected timeframe for implementation of a decision, salvage of most areas currently infested with beetles would not occur until after the first generation of adult beetles has emerged in the spring of 2003. Though this will reduce the effectiveness of the salvage effort on managing the beetle population and reducing mortality of live trees, Alternative 3 still allows high levels of flexibility to address concerns related to beetle spread and future tree mortality. This includes allowing winter salvage operations, using trap trees or baited trees and application of MCH pheromone. The units that could potentially be logged this winter prior to beetle flight in the spring of 2003 are the same units listed under Alternatives 2 and 5.

Some mortality to live Douglas-fir would still likely occur, because not all areas or trees infested with beetles would be treated, under this or any alternative. Reasons for this and effects of this mortality would be very similar to that described under Alternatives 2 and 5 earlier.

Alternative 4

Spruce Beetle – salvage treatment

Alternative 4 does not propose any salvage harvest treatments within Inventoried Roadless areas (Units 70 through 78) or within the Wild and Scenic River corridor (Units 67,68,69). In addition, it expands the buffer zones (riparian habitat conservation areas) adjacent to streams, with no salvage within 300 feet on both sides of any stream, perennial or intermittent.

Alternative 4 salvage harvests an estimated 55 spruce beetle infested acres within proposed salvage Units 44 and 57, dropping from salvage the estimated 30 acres of infested spruce within Unit 76 in the Inventoried Roadless Area and the estimated 9 acres of infested spruce within Unit 55. Unit 55 was dropped because the expanded riparian habitat conservation area essentially absorbs most of this unit. It is along the Lookout Creek road system, is a small area and readily accessible, and would be treated with pheromone baited beetle funnel traps under Alternative 4 (refer to earlier discussion under *Spruce beetle management using pheromone-baited beetle traps).* This treatment is expected to reduce the spruce beetle population in this unit. On the other hand, Unit 76 is more isolated within the roadless area and would not be treated with any method under Alternative 4, for reasons and with effects as described under Alternative 3 earlier.

With implementation of Alternative 4, beetle infested trees would likely be salvaged from Units 44 and 57 before adult beetles emerge in the spring of 2004. With the additional 281 acres being treated with pheromone-baited funnel traps, this alternative would effectively treat the same acres as under Alternative 3, or a total of about 336 acres of spruce beetle infested stands, 92 percent of all the known acres of high beetle infestation. This integrated and aggressive approach to spruce beetle management within the fire area should prove efficient and effective. Alternative 4 has a high probability of successfully containing the spruce beetle population within the Moose Fire area, containing a beetle outbreak, and maintaining the currently low beetle population levels in the region outside the fire area. There would likely be some amount of mortality in remaining live spruce within the fire area, because the beetle traps are not expected to capture all emerging beetles. Also, there are undoubtedly some undetected areas of infested spruce within the fire area.

Douglas-fir beetle – salvage treatment

Alternative 4 eliminates Units 70-78 in inventoried roadless areas (470 acres) and Units 67-69 in the Wild and Scenic River Corridor (15 acres). The discussion and effects of eliminating the roadless units are the same as those described under Alternative 3 above. Eliminating the 15 acres within the Wild and Scenic River corridor would allow beetles from the many infested trees in this area (up to 120) to spread to nearby live Douglas-fir trees. Most of the trees in Unit 69 (about 20 trees) are on the steep bank above the river, not accessible or available for salvage (within the 300 foot riparian habitat conservation area). The anti-attractant pheromone MCH has been placed in parts of corridor and its continued use should effectively reduce the probability of beetle attack in and around remaining live trees in the corridor (refer to MCH discussion under *Direct and Indirect Effects Common to All Action Alternatives* earlier).

In addition to the elimination of some salvage units, Alternative 4 prohibits winter logging on all units, expands the riparian habitat conservation areas (RHCAs) to 300 feet on either side of all streams, and alters the snag retention prescription in all units. All larger diameter (>18” DBH) severely burned Douglas-fir would be left to provide higher level of large diameter snag habitat and eventual downed wood. Some of these are currently infested with bark beetles, though with relatively small amounts of brood (less than six beetle attacks per tree). The expanded RHCAs also contain varying levels of current Douglas-fir beetle activity.

Alternative 4 treats 1793 acres (49%) out of a total 3656 known infested acres, the third highest among the action alternatives. About 516 acres, or 57 percent of the total 900 acres, of known areas of high beetle infestation

densities would be salvaged. Across all the treated acres, some of the beetle-infested trees (the severely burned >18" DBH Douglas-fir) would be left on the site, as the snag retention prescriptions require. With the prohibition on winter logging, none of the beetle-infested trees would be salvaged before the first generation of adult beetles has emerged in the spring of 2003. All these situations reduce the effectiveness of the salvage effort substantially under Alternative 4 for managing the beetle population and reducing subsequent mortality to live trees. Most trees attacked by beetles next year and perhaps beyond would be within the fire area, with beetles infesting remaining live but fire-injured trees (refer to discussion under *Direct and Indirect Effects of Alternative 1)*. These trees are of particularly high value because of their scarcity across this burned landscape, and the values they hold for wildlife, forest structure and diversity, site protection, and future seed sources. Their loss/conversion to snags and downed wood as a result of beetle mortality is likely to affect these values, as discussed further under Alternative 1 and in other resource sections of this chapter.

Some actions would be implemented that compensate to some degree. Continued use of the MCH pheromone is one important tool, as is strategic use of trap/baited trees, similar as described under Alternatives 2, 3 and 5 earlier. The efficiency and effectiveness of trap/baited tree use may be less under Alternative 4, considering the limited logging operating season (no winter logging) and the resulting delay in salvage across more acres and more time. More beetles would have opportunity to emerge and spread into live Douglas-fir in 2003 and subsequent years, before salvage operations might finally remove beetle infested trees and any trap or baited trees. In a few units with surviving Douglas-fir, many of the emerging beetles would likely remain within the salvage unit area, infesting nearby live, fire-injured Douglas-fir trees, which would then be removed in the eventual salvage operation. This may reduce the overall impact of this salvage delay in a limited number of units, but even here, over time beetles would eventually spread outside unit boundaries. All these other actions are more fully described above under *Direct and Indirect Effects of All Action Alternatives.*

Alternative 4 also includes Units 14 through 17, which similar to the roadless and Wild and Scenic River units, are in areas that allow salvage harvest only to meet very specific resource objectives and only if the special values of these lands are maintained or enhanced (i.e. winter range). The discussion of the beetle infestation condition and the appropriateness of salvage, considering the resource objectives, are the same as described under Alternative 2, 3 and 5 earlier.

Cumulative Effects

The following section discusses past, ongoing or foreseeable actions that, in combination with the proposed Moose Post-Fire Project alternatives, may have a cumulative impact on bark beetle activities within and around the Moose Fire area and on potential for outbreak conditions to develop. Refer to list of actions at the beginning of Chapter 3.

Cumulative Effects from burned forest conditions and management actions on the other land ownerships burned in the Moose Fire

Glacier National Park: ***Douglas-fir beetle*:** Park managers have no plans for any actions within the Moose Fire area that would alter the natural course of beetle activity. The estimated 2800 acres of national park lands within Moose Fire at risk of Douglas-fir beetle infestation could potentially provide additional feeding and breeding habitat for the Douglas-fir beetle (refer to Affected Environment). However, all these acres are relatively low hazard. Monitoring results on national forest lands within the Moose Fire leads one to assume that these stands within the Park probably contain Douglas-fir bark beetle activity, but probably at low levels of infestation.

Spruce beetle: A total of about 900 acres at risk of spruce beetle infestation exist on the burned lands within Glacier National Park, with an estimated 290 acres at moderate to high risk (Map 3-3 and Project Record J-13). No spruce beetle surveys were completed on these acres, so it is unknown what level of spruce beetle infestation occurred. If mapping accuracy and stand conditions were similar to that on national forest lands within Moose fire area, it is probably safe to assume that some portion of these acres have high levels of spruce beetle. Applying similar ratio of mapped acres of moderate to high risk to acres actually found to be infested in 2002 on national forest system lands, there might be perhaps 150 acres of beetle-infested spruce on national park lands within the fire area. These acres are likely to contribute to an elevated spruce beetle population in the area once adults emerge in the spring of 2004. Under a high level of infestation, the potential exists for beetles emerging from 150 acres of spruce

stands to infest another 400+ acres of live, beetle susceptible spruce stands in 2004. These areas may be within the fire (in remaining live spruce) or outside fire boundaries. Mortality of spruce on National Forest System Lands and other ownerships may occur as a result. Whether the beetles are able to successfully attack and breed across these acres depends heavily on weather and other conditions being favorable to beetle success. Implementation of the proposed treatments on National Forest System Lands (salvage or pheromone traps) would have little influence on the growth and spread of spruce beetle populations from these acres within Glacier National park.

Coal Creek State Forest: The exact acreage of spruce or Douglas-fir bark beetle susceptible stands on state lands within the fire area is not known, nor has there been any known post-fire beetle monitoring completed. However, based on survey results on national forest lands, it is likely that burned Douglas-fir experienced widespread but low levels of bark beetle infestation, and many of the underburned, fire-injured and killed spruce are heavily infested with bark beetles. State forest managers have been aggressively pursuing salvage actions on the burned portion of the Coal Creek State Forest. The "Environmental Assessment, Phase I" of the "Moose Fire Salvage and Reforestation Project" (MT DNRC 2001) was released in November of 2001, and focused on some immediate resource rehabilitation and reforestation needs, as well as salvaging nearly 1000 acres of the most seriously burned timber accessible from existing roads. Implementation of these actions began in December of 2001. An evaluation of the effects of these actions on bark beetle activity was not disclosed in this environmental assessment, but it is highly probable that the salvage removed numerous Douglas-fir beetle infested trees, thus reducing potential beetle population buildup.

The *"Moose Fire Salvage and Reforestation Project, Phase II", Draft Environmental Impact Statement* was released in March 2002 by the MT DNRC. Harvesting in less accessible and lower severity burned areas was evaluated. Alternative D was selected, with harvest of over 1200 acres of burned forest. The timber sale implementing this action was sold in August 2002, and salvage should start soon thereafter.

Silvicultural goals for this phase of the project included reducing "the risk of spruce and Douglas-fir bark beetles utilizing large-diameter dead or dying trees to build epidemic-level populations of beetles in and adjacent to the burned area." The alternative reduces the potential effects of bark beetles by logging and removing highly susceptible fire-killed and stressed host trees. This alternative in particular has one of the greatest effects on bark beetles by harvesting stands in the South Coal area, where conditions of adjacent stands could facilitate large build-ups of beetle populations – primarily Douglas-fir bark beetles.

It is highly likely that this salvage action would remove many more beetle-infested trees, primarily Douglas-fir but also some of the spruce beetle infested trees outside riparian areas. This action reduces the beetle population in this area and would add cumulatively to all action alternatives proposed in the Moose Post Fire project, increasing the overall degree and effectiveness of proposed national forest salvage and other beetle management efforts.

Larger diameter, beetle-susceptible spruce occur on state lands within the Coal Creek riparian area and its tributaries. Though the extent is unknown, it is likely that some of these spruce are infested with bark beetles, based on survey findings on national forest lands. Because of their location in riparian areas, most of these trees are not being removed in the salvage harvest effort that has and is presently occurring on state lands. The beetle within these trees would contribute to population buildup of spruce beetles in and around the fire area. It is expected that if there are any live beetle susceptible spruce left on state lands within the fire area, they would likely be infested with and killed by emerging adult beetles in 2004.

Private Lands: There were few areas identified as susceptible to spruce or Douglas-fir bark beetle on the small area of private land within the Moose fire area. Though no beetle surveys have occurred on these lands, based on the infestation levels experienced in other parts of the Moose fire it is likely that a few fire-killed larger diameter Douglas-fir is probably infested with beetle, as well as underburned, fire injured spruce trees. These beetles would contribute to beetle population levels, but due to their scarcity, the contribution would be negligible.

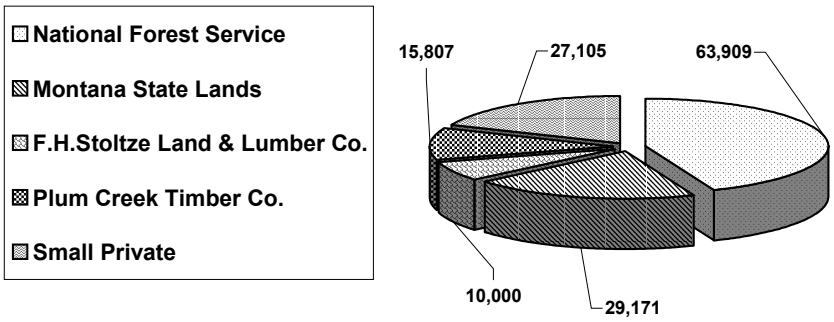
Cumulative Effects of potential beetle activity in future years (4+ years) and to forests several miles from the project area

With the current information we have on spruce and Douglas-fir beetle populations on national forest lands within Moose fire, we can now predict with somewhat greater confidence potential beetle activity next year and beyond.

There will always be some uncertainty in these predictions because of all the unpredictable and uncontrollable factors, with local climatic conditions as related to beetle survival being a major factor. The possibility exists that under conditions highly favorable to Douglas-fir beetle survival, populations could expand within the fire area and spread to forests outside the fire area. However, given relatively "normal" or wetter weather patterns, populations are likely to decline in future years, and a prolonged and widespread Douglas-fir beetle epidemic is not likely to occur. The probability of prolonged and widespread outbreak conditions developing with spruce beetles is similar to that of Douglas-fir beetle, highly dependent upon weather and success of previous years brood.

To provide a full evaluation of effects in these future years, the region reaching from 5-miles to 10 miles distance from the Moose Fire boundary (refer to earlier section *Analysis Area)* was evaluated to disclose potential impacts resulting from a possible prolonged epidemic level of either spruce or Douglas-fir beetles. Map 3-6 and Figure 3-4 below show land ownerships and acreages within this zone. Refer also to Project Record J-2.

Figure 3-4: Acres by land ownership in zone 5 to 10 miles from Fire boundary
Total: 145,992 acres



Effects of beetle activity on National Forest System Lands within 5-10 miles distance from the Moose Fire boundary:
Spruce beetle: There are an estimated 7470 acres at risk to Douglas-fir beetle in this zone on National Forest System Lands. This is about 12 percent of the total National Forest System Lands in this zone. About 6840 acres, or 92 percent, are rated low hazard to Douglas-fir beetle. The remainder is moderate to high hazard (Project Record J-6). This information indicates there are relatively few acres in this region that would sustain high populations of Douglas-fir beetles. With normal or wet spring conditions, it is not likely that the Douglas-fir beetle populations in the Moose Fire area would develop into a widespread and prolonged, serious outbreak, and overall mortality on these lands would be low. Given favorable dry, warm weather and subsequent increase in beetle populations, Douglas-fir beetles may eventually spread into these areas and mortality rates may be higher.

Douglas-fir beetle: An estimated 14,120 acres of National Forest System Lands in the zone 5 to 10 miles from the fire boundary are at some level of risk to spruce beetle infestation (Project Record J-12). This is about 19 percent of the National Forest System Lands in this zone. About 14 percent (1980 acres) are high hazard, indicating that larger diameter spruce is a dominant component of the overstory. About 24 percent (3375 acres) are at medium risk, where spruce is typically less than 50 percent of the stand stocking, or is smaller in diameter and somewhat less susceptible to beetle infestation. The majority of the stands (8765 acres, or 62%) are rated low hazard, where larger diameter beetle susceptible spruce are few in number. Based upon the known high level of spruce beetle populations in the Moose fire area, if weather conditions and brood survival are favorable over the next few years, beetles may have opportunity to spread and some mortality of spruce in the medium and high hazard stands could be expected.

Loss of trees to either spruce or Douglas-fir bark beetles would pose the same concerns described earlier under direct and indirect effects of Alternative 1, influencing values associated with riparian, old forest, and timber production.

Effects of beetle activity on state forest lands within 5-10 miles distance of the Moose Fire boundary:
Douglas-fir: A large portion (29,000 acres) of the Stillwater State Forest lies in this zone, with an estimated 7400 acres (or 25%) of forest lands containing beetle susceptible Douglas-fir. It is believed that most of these acres represent mixed species stands and are probably in the low to moderate hazard range. Some older stands on drier, southerly aspects may be higher hazard depending upon tree density and size. With normal or wet spring conditions, it is not likely that the Douglas-fir beetle populations in the Moose Fire area would develop into a widespread serious outbreak lasting several years, and overall mortality on these state lands is likely to be low. Given favorable dry, warm weather and subsequent increase in Douglas-fir beetle populations, beetles may have opportunity to spread onto these lands and mortality rates may be higher.

Spruce beetle: Based on data provided by state forest managers (Project Record J-17, J-18) and review of aerial photos, there are very few acres (<100) of spruce stands at medium to high hazard for spruce beetle on the Stillwater State Forest. Though not detected, larger diameter beetle susceptible spruce probably do occur along riparian areas. Overall impact from any prolonged spruce beetle outbreak is likely to be relatively small on Stillwater State Forest lands.

Effects of beetle activity on private commercial forest lands within 5-10 miles distance of the Moose Fire boundary:
Spruce and Douglas-fir beetle: Plum Creek and F.H Stoltze Land and Lumber companies comprise approximately 38 percent of all private lands within the 5 to10-mile zone (see figure 3-4). From aerial photo interpretation, most forests on Plum Creek timberlands are in an early seral stage of development, dominated by seedlings and saplings. Relatively few acres are in mature, larger diameter category, where spruce or Douglas-fir comprise major portions of the stand and where beetle hazard is high. Therefore, potential losses from a sustained epidemic conditions of either spruce or Douglas-fir beetles is expected to be relatively low. There are undoubtedly some undetected acres containing trees susceptible to beetles which would experience some mortality, particularly within riparian areas.

On F.H. Stoltze lands, it is estimated that about 2800 acres (37% of the total acres within this zone) are at some level of risk for Douglas-fir beetle, and about 1345 acres are at risk to spruce beetle. These figures are based on inventory data provided by Stoltze foresters (Project Record J-19). Hazard ratings could not be precisely determined, and it would depend primarily upon density and proportion of susceptible trees and their size classes. Many of these stands are relatively young (<100 years old), but are on highly productive sites and therefore have grown into larger diameter classes, where they are more susceptible to beetles. In many cases, stands are composed of vigorous and healthy trees, usually able under normal, endemic beetle conditions to resist beetle attacks. However, under epidemic conditions, where very large numbers of beetles exist, the smaller diameter/younger trees can become far more susceptible to attack and mortality. Beetles under epidemic conditions have been known to attack and kill large numbers of these smaller or more vigorous trees, though resulting brood survival in these trees may be very low (Gibson 2002c). These types of stands do not typically produce and sustain high beetle populations in and of themselves. However, they may experience mortality of spruce and Douglas-fir if large scale epidemic conditions develop in the surrounding landscape.

With normal or wet spring conditions, it is not likely that the spruce or Douglas-fir beetle populations in the Moose Fire area would develop into a prolonged serious outbreak, spreading far outside the fire area, and overall mortality on these private lands originating from the Moose Fire area would be minimal. Given favorable dry, warm weather and subsequent increase in spruce or Douglas-fir beetle populations, beetles may have opportunity to eventually spread onto these lands and mortality rates may be higher. High value is placed on these trees by the landowner. Mortality at even relatively low levels may be undesirable.

MAP 3-6: 10-mile Cumulative Effects Area for Beetle Analysis

Effects of beetle activity on small private landholdings within 5-10 miles of the Moose Fire boundary: *Spruce and Douglas-fir beetle:* Small private landholdings cover over 30,000 acres within the 5-10 mile influence zone from the Moose Fire. These are lands near Whitefish and to the north of Columbia Falls; the mid and lower portions of Big Mountain Ski and Summer Resort; along Whitefish Lake; and include the municipal watersheds of Whitefish and Columbia Falls (refer to Map 3-6). Many thousands of individual landowners are affected. Field observations, local knowledge and photo interpretation suggest that large areas of forest on these private lands are at some level of risk to beetle infestation -- lands that contain older, larger diameter trees. Rough photo estimates place between 3000 to 4000 acres of this zone in a mature/larger tree category (>14 or 16" average diameter) (Project Record J-20). These estimates represent the larger, most obvious blocks of mature forest. The stand hazard to spruce or Douglas-fir beetles has not been determined. It is likely that beetle susceptible spruce trees would mainly occur in the streamside/riparian areas, on the more moist northerly aspects and higher elevations. Douglas-fir dominated stands tend to occupy the drier sites, such as south and west facing slopes. Douglas-fir trees are also common in the lower elevations. In addition to the more obvious large patches of forest are the many smaller patches, groups or individual Douglas-fir and spruce trees that exist across thousands of small private land parcels and around homes and businesses. There are certainly many trees in this category that would be at risk of mortality due to bark beetles, though exact numbers are impossible to determine.

With normal or wet spring conditions, it is not likely that the Douglas-fir beetle populations in the Moose Fire area would develop into a serious and prolonged outbreak, and overall mortality on private lands would be low. Given favorable dry, warm weather and subsequent increase in spruce or Douglas-fir beetle populations, beetles may have the opportunity to eventually spread onto these lands and mortality rates may be higher. The diversity of forest conditions across the landscape reduce the potential for widespread outbreak conditions developing on a landscape scale, though mortality in individual beetle susceptible stands may be high. The value the landowner places upon these trees may be quite high. Loss of these trees would be of concern to these landowners, though it is difficult to assess the magnitude of loss that might occur and the overall degree of private landholders concern.

Selection of any of the action alternatives would reduce the potential for high beetle populations to buildup in the Moose Fire area and the probability they would ultimately spread outside the fire area.

Cumulative Effects of past harvesting on National Forest System Lands

Past harvesting activity is described under the general vegetation section of this chapter. Extensive harvesting in the 1950s and 60s occurred in the upper reaches of the Big Creek drainage (not affected by the Moose Fire), in response to a significant spruce beetle epidemic (refer to discussion under "Affected Environment"). As a result of high mortality in older overstory spruce and the widespread harvest activity, many acres of what were once mature and older spruce forests were converted to young, early seral seedling and sapling forests. As a result, the amount and quality of potential spruce beetle host material has been substantially reduced from pre-1950 conditions in the local area, and the overall vulnerability of the landscape to spruce beetle is lower.

Past harvesting in the lower reaches of Big Creek occurred largely in mature and older stands dominated by larch and Douglas-fir, with spruce and subalpine fir on the more moist aspects and draws. Hundreds of thousands of larger diameter trees were removed, also resulting in a substantial reduction of potential host trees for Douglas-fir and spruce beetle. The Moose Fire burned over most of these past harvest areas, and if harvesting had not been done, there could potentially be far more forest at high risk to bark beetle infestation than currently exists.

Cumulative Effects of the Moose Peak prescribed burn

A decision to implement a series of prescribed burns in the subalpine fir/whitebark pine forest type in the vicinity of Moose Peak was signed in August of 1998. Approximately 2000 acres is targeted for burning, both in spring and fall seasons, creating a mosaic of openings with shrubs and grasses, forested patches and rocky ridges. Burned openings will provide sites for whitebark pine regeneration (Project Record V-4).

None of the burning has been implemented as of this time, and with the Moose Fire event, burning would be delayed for several years to allow some vegetative recovery in the Moose Fire area. If implemented, the prescribed burn would potentially affect up to an estimated 1000 acres of spruce stands currently rated at medium hazard to bark beetles. Whether this would affect spruce beetle activity in the burned area and in the surrounding regions

depends upon many unknown and unpredictable factors, such as severity of burn and resulting conditions of larger diameter beetle susceptible spruce, populations of beetles in surrounding area, weather conditions and their affect on beetles, etc. The implementation of the Moose Peak prescribed burns at some time in the future is not likely to have a measurable cumulative effect associated with actions proposed in the Moose Post-Fire Project. The Moose Peak prescribed burn decision will be revisited to consider changed conditions and new information, and a determination made at that time as to what course of action to take.

Cumulative Effects of past wildfires and fire suppression activities on National Forest System Lands

Past wildfire activity and suppression efforts in the project area and surrounding lands is described under the "Fire and Fuels" section of this chapter. Past wildfires influenced the conditions and pattern of forests in the Moose Fire area and surrounding lands, introducing diversity in forest age and size classes and species composition. This in turn has an influence on the potential activity of bark beetles, which typically require certain habitat and host conditions to prosper. Wildfire suppression activities can alter this natural disturbance pattern within an area, thus also influencing forest patterns and conditions, and the actions of associated pathogens.

The majority of the Big Creek drainage (including the portion burned over in the Moose Fire of 2001) had not experienced a large-scale or stand replacing fire for well over 200 years. Prior to the beginning of timber harvest activities in the 1950s, stands of older trees dominated the watershed (USDA 1999). The long fire interval and resulting extensive areas of densely stocked and/or mature forest type created a landscape of relatively high vulnerability to effects from disturbances such as fire or bark beetles. The vast blowdown and resulting large-scale spruce beetle epidemic in the 1950s and 60s illustrate this, as does the Moose Fire event to some degree. These both were natural events, not unprecedented and not unpredictable, considering the fire regimes within the area, the long fire free interval, and the forest conditions across the landscape. Because of the size and maturity, density, and species composition of these forests in Big Creek before the Moose Fire, we now are experiencing post-fire conditions in this area favorable to both spruce and Douglas-fir bark beetles.

Conversely, most of the Coal Creek portion of the Moose Fire area was dominated by dense, small diameter lodgepole pine, Douglas-fir and larch before the Moose Fire event. The post-fire condition of this area poses no threat of Douglas-fir or spruce bark beetle, due to the small size of the trees. This area had experienced a stand replacing wildfire in 1910, which burned at high severity across the vast majority of the area, both within and outside the current Moose Fire perimeter (refer to Map 3-7). This is apparent by examining the characteristic of the forest over 90 years later. Before the Moose fire, it was a sea of small diameter trees dominated by the fire-associated lodgepole pine, with larger diameter overstory snags present in some areas, but largely devoid of live overstory trees that survived the 1910 fire. Before the 1910 fire, there was likely mature and old forest across at least some of this region, with some level of vulnerability to spruce and Douglas-fir bark beetle and other disturbances. The 1910 fire converted this to early seral forest, at no risk to bark beetles for many decades.

Cumulative Effects of proposed slash treatment and reforestation activities within the Moose Fire area

The proposed slash treatments include excavator piling and burning; jackpot burning of fuel concentrations on steeper slopes; or whole tree or yarding of the tops of trees to reduce fuels in the unit. Most units would not have any specified slash treatment after harvest. Unmerchantable trees would remain either standing or felled/pushed/blown down before or during the logging operation. This material poses no hazard for Douglas-fir or spruce bark beetle, primarily because of its smaller size and in most cases, its deteriorated, burned condition. Various beetles that feed and breed in dead wood would find this material highly desirable.

Depending upon the alternative, from about 700 to 1200 acres are proposed for planting within salvage units following harvest activities. Species planted will include western larch, ponderosa pine, Douglas-fir and western white pine. All trees are native and adapted to the site. Planting would help increase the diversity of species within the future forest, which increases the resilience of these areas to the potential future effects of insects (including spruce and Douglas-fir bark beetles), disease, fire events, or even local/global climatic changes (refer to analysis under "Vegetative structure, composition and timber resource").

Cumulative Effects of potential future beetle treatments, such as pheromone treatments and use of trap trees

In the Moose Post-Fire Project proposal, salvage harvest, use of pheromones treatments and use of Douglas-fir trap or bait trees is anticipated and described. However, it is difficult to predict at this time to what extent and where beetle treatments farther into the future may occur (i.e. 5 or more years from now). Continuing monitoring of beetle populations and brood survival within the Moose Fire area and in surrounding forests over the next few years will provide us with information needed to ascertain whether additional actions to manage beetle populations are needed. If so, the appropriate analysis and assessment of effects would occur before implementation.

Cumulative Effects of past, present and proposed road decommissioning activities on National Forest System Lands

These actions may influence beetle activity by limiting access to portions of the forest for potentially desired beetle treatments in the future. Salvage harvest and the use of trap or baited trees as tools to influence beetle populations would be most affected; but using pheromones, both as bait and as repellents, would also be affected due to reduced access and increased cost of application. Options for treatment of vegetation and forest stands would be reduced across many thousands of acres of forest lands with the decommissioning of ±60 miles of road on Forest Service lands (refer also to discussions under “Vegetation structure and composition”).

4. Regulatory Framework and Consistency

Flathead Forest Plan direction specifies that landscapes should be managed to reduce the risk of undesirable fire, insect and pathogen disturbances, and to apply an understanding of natural disturbance regimes, landscape patterns and dynamics to management of the forest (page II-5-9). Forest Plan standards for insect and disease (page II-65) specify that integrated pest management strategies should be considered in project analysis design and that “project silvicultural prescriptions would emphasize treatments that reduce losses due to insects and/or disease.” In accordance with this direction, the area has been analyzed and determined that all action alternatives are within the standards of, and consistent with, the Forest Plan.