Fire and Fuels

Introduction

Fire has historically been the dominant disturbance factor in forests across the northern Rocky Mountains and has created the current mosaic patterns observed across the landscape. Most forests have evolved with the continual influence of fire. Forested communities and ecosystems depend on this type of disturbance regime for their continued perpetuation on the landscape (Habeck and Mutch 1973).

Natural historic fire regimes best illustrate fire disturbance patterns. A fire regime describes the frequency, predictability, and severity of fire in an ecosystem. Fire regimes can range from non-lethal to stand-replacing levels, typically becoming less frequent as severity increases.

Drought cycles and fuel availability have a considerable influence on fire regimes. Wildland fires often occur during the driest months of the year, typically July, August, and early September, and can have considerable effects to an area during drought periods. The quantity and type of fuels also affect fire behavior. Fire fuels are made up of dead woody debris and living vegetation. Fuel quantities can vary considerably, depending on the vegetation composition and recent fire history.

Pre-settlement wildland fires burned through the summer season until extinguished by fall precipitation. In the settlement period before 1941, wildland fire suppression efforts were often not successful and resulted in fires burning thousands to ten of thousands of acres. Suppression efforts since then have altered pre-settlement fire regimes and reduced the number of forested acres burned each year. The combination of fire suppression, fire exclusion, and natural disturbance processes has allowed fuels to accumulate in unmanaged timber stands. This situation currently exists in the Porter Mount Analysis Area.

An analysis of fire history in the Porter Management analysis area was used to characterize historical fire regimes that typify this area and to determine to what extent fire suppression has altered these regimes and affected fuel accumulations.

Information Sources

The fire history analysis for the Porter Mount Area was based on the data collected between 1997 and 2002 for the Swan Lake Ranger District's Timber Stand Management Record System. Fire history data collected for the Island Unit EAWS (Project File Exhibit Q-4) supported, in part, the Porter Mount Project Analysis. Local meteorological information was obtained from a WETS weather monitoring station in Kalispell, Montana for dates after 1962. Data gathered by the National Interagency Fire Management Integrated Database (NIFMID) evaluated fire ignition and suppression events and their associated causes from 1940 to the present.

Analysis Area

Spatial Bounds

The area evaluated for the Fire and Fuels Resource includes the Island Unit Geographic Area. The fire regime patterns in this area are characteristic of those in the northern Rocky Mountain region. Elevation is moderate, ranging from 3440 to 6280 feet. Topography is a moderate relief landscape composed of valleys, ridgelines, and crests. The area has a mean slope of 30 percent with only 15 percent of the area having slopes greater than 40 percent. The Porter Mount Analysis Area falls within the montane ecotone.

The western larch/lodgepole pine fire-initiated forest and the Douglas-fir fire-initiated and maintained forest are the major forest cover types within the Porter Mount Area.

Temporal Bounds

The length of time for effects analysis is approximately 5 years for the roads and fuel reduction portions of this project. This is based on the probable contract length for the proposed project, the timeframes for related activities, and the reasonably foreseeable actions identified. Ecosystem Burning proposed in this project might occur during the next 2 to 12 years, dependent on the availability of burning windows, funding, and equipment needed to achieve the desired results. When conditions are favorable, the actual burning would only take a day or less for each project, but this time frame provides a conservative margin for all these elements to come together.

Affected Environment

Historic Condition

A. Fire History

There are few records of fire starts prior to 1930, except for large fire maps, including the 1910, 1919, and 1926 Fires. Summer lightning storms occurred frequently over the analysis area. Lightning strikes were numerous on ridges and mid-slopes, and were less frequent at lower elevations. Most storms were accompanied by precipitation and fire ignitions, although common, seldom resulted in large fires. The analysis area probably averaged one large (>50 acres) fire every 10 to 15 years.

Prior to the 1930's, wildland fire was a dominant disturbance in the analysis area. Field surveys by H.B. Ayres for the U.S. Geological Survey in 1898 provide the earliest glimpse of the role fire has played in the area. Maps and narratives describe large areas that were "recently burned." "Most of the areas swept by fire in this region have been burned within the last 25 years". The maps did not document "Areas where light fires have run and not killed the trees" (The Flathead Forest Reserve, H.B. Ayres, 1898).

Four large wildland fires greater than 1000 acres burned in 1889 within the area analyzed in the Island Unit EAWS. Approximately 10 to 30 percent of the analysis area was burned in the 1910 fires. Wildland fires between 1910 and 1926 also burned thousands of acres (the beginning of effective fire suppression began in these decades). These fires were both a mixed severity and lethal fire types. In some areas, nearly all existing trees were killed; in other areas more of an underburn occurred, leaving varying amounts of the larger overstory trees or patches of unburned areas. This pattern and frequency of fire probably reflects what has been occurring within the Porter Mount Analysis Area for many centuries, with some variation depending upon climatic cycles and change in vegetative conditions through time.

Large fire history maps show typical patterns of fire spread. Fires would tend to spread from west/southwest in an easterly direction. The Swan Lake Ranger District conducted dendro-chronological research on fire-scarred trees in the Porter Mount Area, as part of the Island Unit EAWS analysis, and determined that significant fire years included: 1554, 1769, 1800, 1827, 1857, and 1889.

B. Natural Fire Regimes

A fire regime is defined as the frequency, predictability, and severity of fire in any given ecosystem. An analysis of fire history in the Porter Mount Area was used to determine:

- Spatial and temporal distribution of fire disturbances.

- Mean fire intervals in areas with similar bio-physical and climatic characteristics.
- Whether fire suppression has affected historical fire regimes.

Porter Mount Current Fire Regimes**:** Fire Regimes were assigned to each of the potential vegetation groups (PVGs) in the Porter Mount Area. The two predominant fire regimes that currently occur in the Porter Mount Area are as follows:

- Two mixed-severity regimes ranging from non-lethal underburns to stand-replacing fires at mean intervals of 15 to 75 years, and

- A regime of infrequent stand-replacing fires at mean intervals of 100 to 340 years (Barrett, Arno, Key 1991).

Mixed-severity fire regime areas can experience the full range of severities during either a single event or consecutive events. Mixed-severity fire regime areas may experience fires of intermediate effects, often consisting of fine-grained spatial patterns resulting from a mosaic of varying severity. The mixed-severity fire regime in the Porter Mount Analysis Area is predominately of a moderately low frequency with moderate to high severity.

In contrast, stand-replacement fire regimes typically have lethal fires with less than 10 percent of the forested canopy cover remaining after the fire; in Porter Mount Analysis Area, these are low frequency with high severity events.

The majority of the analysis area is forested; there are few non-forested areas. Some natural openings exclusively feature grass or shrubs and there are a few rock outcroppings. Historically, approximately 72 percent of the analysis area would have had non-lethal or mixed fire regimes. Such fires acted as a natural thinning agent, reducing the encroachment of the less fire resistant species like Douglas-fir with some alpine fir and spruce. Infrequently, fire would kill the overstory trees when large amounts of forest floor biomass accumulated on the forest floor and provide increased intensity and fuel ladders. In the lower elevation portions of the analysis area, fire regenerated and maintained open park-like stands of predominantly larch with some Douglas-fir and ponderosa pine. In the higher elevation areas, the present timber stand conditions of even aged trees with more of a lodgepole pine component suggests that fires were more intense but less frequent (Arno 1980; Fischer and Bradley 1987). Historically, this has led to a mosaic of single-aged and multiple-aged groups of trees in the analysis area.

In the absence of fire for the past 80+ years, tree species such as the more shade tolerant Douglas-fir, alpine fir, and spruce have become well established as an understory and have resulted in a dense tree stocking in the timber stands being considered for fuel reduction.

In addition to the regeneration harvesting, intermediate cuttings (salvage or thinning harvests) were conducted in the analysis area since the 1960s. In many instances the larger trees were removed from the stands (western larch, Douglas-fir, and ponderosa pine), leaving an understory of small diameter seedling-sapling component trees. This has reduced the species diversity of these sites, and resulted in conditions counter to what would have occurred during a non-lethal/mixed severity fire. Additionally, when a mixed severity fire does occur on these sites, there will be fewer large fire resistant trees (ponderosa pine, larch, and Douglas-fir) remaining to potentially survive the burn and provide seed for regeneration of the site. This could greatly affect species composition, as well as the structural diversity of the future stands

Of interest are the mid to high elevation lodgepole stands. Most of these stands are a result of fire early in the century and were prime targets for the mountain pine beetle in the 1980's. They were heavily impacted by insect infestations and many were subsequently salvage logged. This, combined with other stand reduction harvest methods used to limit the accessibility of these stands by the beetle, has modified the stand characteristics to a younger, more vigorous stand type. There are small areas of mixed severity-very frequent (7 to 15-year interval), shorter interval regimes occurring on west and south aspects of the analysis area.

The watershed could experience a large fire given the right combination of weather and fuel conditions. However, this is not as likely because of the high level of past vegetation management and overall access.

C. Current Condition Class Departures

The condition class departure is a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. Current Condition Class Departures are defined in terms of the relative risk of losing one or more key components that define an ecological system based on five ecosystem attributes (Laverty and Williams 2000):

- Disturbance regimes (patterns and frequency of fire, insect, disease, etc)
- Disturbance agents
- Smoke production
- Hydrologic function
- Vegetative attributes (composition, structure, and resilience to disturbance agents)

The higher the number of condition class departure, the more the risk of losing key components of an ecological system if a wildland fire occurs. Condition Class Departures are categorized by the National Fire Plan as:

- <u>Class 1 - Maintenance:</u> Fire regimes are within a historical range, and the risk of losing key ecosystem components is low. Vegetation attributes are intact and functioning within a historical range. No fire return intervals have been missed.

- <u>Class 2 – Restoration</u>*:* Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystems components is moderate. Fire frequencies have departed from historical frequencies by one fire or more return intervals. This results in moderate changes to one or more of the following: fire size, intensity and severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range.

- <u>Class 3 – Conversion</u>: Fire regimes have been substantially altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been substantially altered from their historical range (Laverty and Williams 2000).

Table 3-18 provides a summary of the historical average interval [mean fire interval (MFI)] between fires in the <u>mixed-severity</u> and <u>stand-replacement</u> fire regimes by potential vegetation group (PVG). The table also displays the current Condition Class Departure by vegetation type for timbered stands that have not been entered for timber management activities.

TABLE 3-18
HISTORICAL AVERAGE INTERVAL BETWEEN FIRES IN THE PORTER MOUNT ANALYSIS AREA

PVG and Fire Regime *	Pre-1940 Stand MFI's (years)	Condition Class Departure
Warm-Dry MS-2		2
Range	69-87	
Mean	80	
Warm-Moist MS-2		2
Range	54-83	
Mean	73	
Cold-Dry MS-2		2
Range	59-67	
Mean	63	
Cold-Moist MS-2		2
Range	51-97	
Mean	80	
Cool-Moist MS-2		2
Range	44-97	
Mean	79	
Warm-Moist SR		1
Range	131-180	
Mean	156	
Cold-Moist SR		1 to 2
Range	97-148	
Mean	120, 125 MAF[l1]	
Cool-Moist SR		1 to 2
Range	83-119	
Mean	106, 147 MAFI*	

[l]MS-2 is mixed severity fire regime; SR is stand replacement fire regime
*Multiple site Average Fire Intervals for ecologically similar types, i.e. PVG.

D. Forest Management

In the Porter Mount Analysis Area, timber harvest and associated fuel treatments have replaced wildland fire as the dominant process that changes the patterns of vegetation and woody debris accumulations in the forest. These previously managed areas are considered to be in a Condition Class 1.

The forest management activities in the area have created fuel mosaics, which are breaks or changes in standing timber and surface fuel patterns. Along with road access, these fuel mosaics increase the success of initial attack, allow for effective fire suppression under the appropriate management response, and decrease the risk of high intensity stand-replacement wildland fire. The existing Forest Plan requires that all fires be suppressed (excluding wilderness areas covered under an approved Fire Management Guide or Plan) using the appropriate management response. The appropriate management response in the analysis area is suppression using aggressive initial attack actions to control a wildland fire with safety of the public and fire management personnel being the first priority, and sequentially the protection of property/natural resources.

E. Drought History

Studies indicate that severe single-year droughts occurred in the Northwest at least 10 times between 1940 and 1995, and they occurred in every decade (Barrett 1997, Karl and Koscielny 1982, Graumlich 1987, Meko, et al. 1993). Local meteorological information from a WETS weather monitoring station in Kalispell, Montana indicates drought fire season years (in which fire suppression occurred within the analysis area) in 1967, 1972, 1973, 1984, 1988, 1989, 1991, 1994, 1996, 2000, 2001, 2003, and 2006.

F. Fire Ignitions and Suppressions since 1940

Wildland fire, other than prescribed fire, has had a limited role as an ecological process in the analysis area over the past 70 years. There were 158 lightning-caused fire starts recorded within the analysis area from 1940 to 1994. There were 103 human-caused fires in the same time frame. These ignitions were suppressed with the exception of the Upper Truman Fire (over 100 acres) that occurred in 1990. Lightning-caused fires account for 61 percent of the fire starts and human caused fires account for the remaining 39 percent of the wildland fires. Currently, any wildland fire in the analysis area would necessitate an appropriate management response. The Flathead Forest Plan directs that wildland fires, in the management areas which encompass the Porter Mount Project, will be aggressively attacked and controlled. Appropriate management response would depend on values to be protected, risk, complexity, weather, fuel conditions and other criteria. If a wildland fire is not being actively suppressed, it is considered a wildland fire managed for resource objectives. The DNRC has initial attack protection responsibility for the lands within the analysis area. Extended attack responsibility remains within Forest Service jurisdiction.

Areas such as Roger's Lake, and various rural communities in the Emmons and Truman Creek drainages, could be threatened by wildland fire. Fire start records show increasing person-caused fires in these areas.

Roads give the general public access to much of the analysis area. Human use has added to the values to be protected. Housing developments can be found in most drainages adjacent to, and within, the analysis area. These areas are both up and downwind of the analysis area. The downwind developments pose the greatest risk for wildfire escaping onto private property.

The fuel hazard, wildland fire risk, and values-to-be-protected in the analysis area require aggressive initial attack and control. When fuel, weather, and ignition conditions are combined for rapid fire growth, wildland fires may be extremely resistant to control. This was the case with the 1994 Little Wolf Fire on the Tally Lake Ranger District, which burned thousands acres of similar wildlands less than 20 miles northwest of the Porter Mount Analysis Area.

G. Fire Suppression Effects on Fire Intervals and Current Condition Class Departures

Before 1940 when effective fire suppression techniques are generally considered to have begun, a spreading wildland fire severe enough to change stand structure occurred once every 8.5 years. Wildland fire occurrence was two to three times more frequent within the mixed-severity fire regime than the stand-replacement regime. The large fire-free interval from 1930 to the present is more than seven times longer than the historical major fire interval. The spread of a typical moderate to severe large fire was on a west-to-east axis with a broadening north-south axis as it moved across the moderate relief landscape, while low to moderate fire spread was confined to a valley to ridgeline pattern. The mean slope for the Porter Mount Area is 30 percent, with 15 percent of the area containing slopes greater than 40 percent.

After comparing the mean fire intervals and current fire intervals for mixed-severity regimes in the Porter Mount Area, it appears that the warm-dry, warm-moist, cold-moist, and cool-moist PVGs would likely have experienced one spreading fire since 1940, and the cold-dry PVG would have had two spreading fires since 1940. Other studies suggest many stands with the mixed-severity fire regime have missed one or two fire cycles because of long-term fire suppression (Sneck 1977, Barrett et al. 1991, Barrett 1995). Therefore, effective fire suppression since 1940 has probably precluded one spreading fire at a minimum for all PVGs within the mixed-severity fire regime. This is indicative of a Condition Class Departure 2, which suggests that restoration activities be done in late-mid seral and late seral stands that are currently unmanaged.

The stand replacement regime fire intervals varied widely throughout the area, ranging from 16 to greater than 200 years long. The conservative approach is to compare the pre-fire effective suppression period mean average fire intervals (MAFIs) with current fire intervals for the cold-moist and the cool-moist PVGs. There is little variation between them, so that suggests cold-moist and cool-moist PVGs in the Porter Mount Area are within historical range of fire regimes. Dendrochronological research on fire-scarred trees in the Porter Mount Area indicates that on warm-moist PVGs, fires occurred more frequently before the mid-1700s with no large fires occurring since then.

H. Wildland Urban Interface

The Federal Register (January 4, 2001) supplied the three categories of WUI considered in the National Fire Plan. The WUI is defined as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. The Porter Mount Analysis Area only includes the Category 2 type of WUI called the Intermix Community, which is defined as follows:

> <u>Category 2 - Intermix Community:</u> The Intermix Community exists where structures are scattered throughout a wildland area. There is no clear line of demarcation. Wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to 1 structure per 40 acres. Fire protection districts funded by various taxing authorities normally provide life and property fire protection and may have wildland fire protection responsibilities. Areas with Porter Mount categorized as Category 2 include small cluster developments such as ranches, summer residences, hay meadows, timber production areas, ranch outbuildings, and other structures. Approximately **8649 acres** of the Porter Mount Analysis Area is located within the WUI. The Wildland Urban Interface is spatially defined for the Porter Mount Analysis Area by the Flathead County Community Wildfire Fuels and Mitigation Plan. This fire plan was collaboratively developed by Flathead County with citizen and agency input. A copy of this fire plan is located in the project file as Exhibit Q-1. Please refer to Map 3-2 which displays the Wildland Urban Interface within the Porter Mount Project Area.

Although the amount of private ownership is finite within the analysis area, the current trend for development on private ownership is one of further subdivision and subsequent increase in population/dwelling-structure density.

These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites. When wildland fire enters these areas, the suppression efforts require a large commitment of firefighting resources. During the fires of 2000, large portions of otherwise high-priority fires remained un-staffed because resources were committed to structure protection. Experienced fire managers know that the intermix area is one of the most dangerous environments in which to conduct fire suppression operations. Poor ingress and egress compromise firefighters' escape routes. Hazardous materials and other manmade materials produce toxic gases when burned and pose major threats to firefighters and the public. The high values at risk (homes, vehicles, domestic animals, etc.) can lead even the most seasoned wildland firefighters to take risks that he or she would not consider in the wildland environment.

I. Home Ignitability

Recent research (Cohen 2000a) addresses home ignitibility, or the potential for a home to ignite, in the wildland urban interface. Cohen concludes that homes ignite via one of two processes, direct flame contact with the structure and lofted firebrands landing on a receptive fuel such as a house. The Structure Ignition Assessment Model (SIAM) developed by Cohen (1995) and results from the International Crown Fire Modeling Experiment (Alexander et al. 1998) generally concur that a flaming front at a distance of 40 meters or more from a structure does not deliver sufficient heat energy to ignite the exterior of a home. However, lofted firebrands, such as those experienced in the 2000 Cerro Grande Fire in New Mexico, ignited surface fires on homes while leaving green needles on trees around the home (Cohen 2000b). Highly ignitable homes can ignite during wildland fire without fire spreading near the structure. This occurs when firebrands are lofted downwind from fires. The firebrands subsequently collect on and ignite flammable home materials (such as roofs) and adjacent flammables (such as woodpiles, decking, or landscaped vegetation). Firebrands that result in ignitions can originate from wildland fires that are a distance of one kilometer or more (Cohen 2000a). Cohen concludes, “Because homeowners typically assert their authority for the home and its immediate surroundings, the responsibility for effectively reducing home ignitability can only reside with the property owner rather than wildland agencies.”

Because of the problems and complexities associated with the Intermix Community, resource mangers and fire managers find it desirable to exclude, to the extent possible, wildland fire from these areas and may use limited, carefully controlled, prescribed fire treatments or, more commonly, mechanical treatments to reduce fuels in such areas. The purpose of these fuel treatments is to provide fire fighter safety and minimize future loss of property and natural resources. Sociopolitical and logistic constraints may preclude or limit prescribed fire use near residences (Kalabokidis and Omi 1998, DellaSalla, et al. 1995). Limitations to use of prescribed fire within the WUI include public attitudes toward smoke, fear of escaped fire, negative visual effects of burns, and limited windows of opportunity in conditions dry enough to achieve fuel reduction objectives while still insuring containment near homes.

Existing Condition

Forest Fuels and Fire Behavior

The greatest effect of fire suppression and exclusion in unison with other natural disturbance processes has been the accumulation of biomass in most unmanaged timber stands. The bulk of the biomass currently occupying the analysis area is in the combination form of dead standing and downed trees and shrubs, as well as live shade-tolerant true firs, spruce, lodgepole pine, and Douglas-fir. The combination of dead fuel and continuous live vegetation from the forest floor to the upper forest canopy creates a complex of fuel that, when ignited under severe fire conditions, would leave little or no surviving above-ground vegetation.

Fuels, weather, and topography influence fire behavior. Fuels are the only factor that management can modify. Fuels are made up of the various components of vegetation, live and dead, that occur on a site. These components include litter and duff layers, the dead-downed woody material, grasses and forbs, shrubs, regeneration, and timber. Various combinations of these components define the major fuel groups of grass, shrub, timber, and slash. The differences in fire behavior among these groups are basically related to the fuel load and its distribution among the fuel particle size classes. Fuel load and depth are critical fuel properties for predicting whether a fire will ignite, its rate of spread, and its intensity.

Fuel component characteristics contribute to fire behavior properties. Fuel loading, size class distribution of the load, and its arrangement (compactness or bulk density) govern whether an ignition will result in a sustaining fire. Horizontal continuity influences whether a fire will spread or not and how steady the rate of spread will be. Loading and its vertical arrangement will influence flame size and the ability of a fire to torch into the overstory. With the proper horizontal continuity in the overstory, the fire may develop into a crown fire. Fuel moisture content has a substantial impact upon fire behavior affecting ignition, spread, and intensity.

Wildland fires would still occur and may escape initial attack during severe fire conditions. The intensity of these fires would be dependent upon weather, fuels, and topography. When burning conditions are less than severe, fires may be of low to moderate severity and result in only moderate or no damage to overstory trees. If downed fuels are present, tree mortality can occur even during moderate burning conditions.

Fuel Models and Fire Behavior

Fuel models are a tool to help the user realistically estimate fire behavior. Each fuel model is described by:

- The fuel load and the ratio of surface area to volume for each size class.
- The depth of the fuel bed involved in the fire front.
- Fuel moisture, including that at which the fire will not spread (called the moisture of extinction).

These are based on Albini's (1976) paper "Estimating Wildfire Behavior and Effects." The criteria for choosing a fuel model includes the fact that the fire burns in the fuel stratum best conditioned to support the fire. The 13 fuel models for fire behavior estimation are for the severe period of the fire season when wildland fires pose greater control problems and impacts on land resources.

The nine surface Fire Behavior Fuel Models listed below best represent the landscape fuel mosaic for the area analyzed and are described in terms of vegetation, expected fire behavior and acreage. There are acres in the analysis area that are assigned a “0” for Fire Behavior Fuel Model (ponds, lakes, large rock outcroppings, and gravel pits) and may function as fuelbreaks. The reference material used in the description and design of the Fire Behavior Fuel Models for the project is Anderson (1982). A description of the fuel models follows.

A. Grass Group

Fire Behavior Fuel Model 1 (mountain grasslands and private pastureland) - Fire spread is governed by the fine, very porous, and continuous grasses and herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through contiguous cured grass and associated material if untreated. Very little shrub or timber is present, generally less than one-third of the area.

Fire Behavior Fuel Model 2 (post timber harvest stands; non-stocked and seedling*)* - Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition too little and dead-down stemwood from the open shrub or timber overstory, contribute to the fire intensity. Open shrub lands or low brush and pine stands that cover one-third to two-thirds of the area may generally fit this model; such stands may include clumps of fuels that generate higher intensities and that may produce firebrands.

B. Shrub Group

Fire Behavior Fuel Model 5 (sapling stands and riparian shrub) - Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. The riparian shrub portions of this fuel model in the analysis area are usually intermingled with riparian marsh grass and separated by expanses of water greater than 30 feet.

C. Timber Litter Group

Fire Behavior Fuel Model 8 (closed timber litter) - Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Close canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer.

This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Refer to representative Photo Guides for Appraising Down Woody Fuels.

Fire Behavior Fuel Model 10 (timber litter and understory) - The fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead and down fuels include greater quantities of three-inch or larger limbwood resulting from overmaturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy downed material is present; examples are insect or disease-ridden stands, windthrown stands, overmature situations with deadfall, naturally thinned stands, and aged light thinning. These types may have a well-developed vertical or ladder fuel component.

D. Logging Slash Group

Fire Behavior Fuel Model 11 (Pre-Commercial Thinning, 4 to 15 years old) - Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential. Thinning operations in mixed conifer stands are considered.

Fire Behavior Fuel Model 12 (Pre-Commercial Thinning, 0 to 3 years old) - Rapidly spreading fires with high intensities capable of generating firebrands can occur. When fire starts, it is generally sustained until a fuel break or change in fuels is encountered. The visual impression is dominated by slash and much of it is less than three inches (7.6 cm) in diameter. The fuels total less than 35 tons per acre (15.6 t/ha) and seem well distributed. This fuel model is represented by heavily thinned conifer stands.

Analysis Methods - Fire Behavior Modeling

Fire behavior modeling is performed to estimate a number of fire behavior characteristics. There are three main categories of inputs to fire behavior modeling; weather, fuels and topography. Weather is classified and discussed in more detail in the climatology section later in this report. Historic weather information is used as an input to estimate fire behavior. Fuels are classified as surface fuels and crown fuels. Surface fuels are described with a fire behavior fuel model number (Anderson 1982). Crown fuels are described by canopy bulk density (the foliage contained per unit crown volume), canopy base height (the average height from the ground to the lowest living foliage), and canopy fuel load (the volume of canopy fuel load) (Scott and Reinhardt 2001). Crown fuels are important for determining crown fire characteristics such as whether a fire can transition from the ground to the tree crowns. The topography input related to fire behavior is percent slope. Slope can effect how a fire burns. Fires generally burn with more intensity and faster spread rates when burning on steeper slopes.

There are several outputs available with fire behavior modeling. The outputs of most concern for this project include rate of fire spread, flame length, type of fire, torching index, and crowning index. Fire behavior characteristics are used to estimate resistance to control. This is defined as the relative difficulty of constructing and holding a control line as affected by resistance to line construction and by fire behavior (National Wildland Coordinating Group Handbook 3, 2004).

The rate of spread indicates how fast a fire will move. The flame length is important to fire suppression techniques. If flames are over 4 feet, suppression with hand crews is generally unsuccessful. If flame lengths are over 8 feet, mechanized equipment is not considered effective.

The type of fire is also very important to estimate how successful suppression efforts will be, or resistance to control. Fire scientists and managers recognize three general types of wildland fire depending on the fuel stratum in which the fire is burning.

A. Ground Fire

A ground fire is one that burns in ground fuels such as duff, organic soils, roots, and rotten buried logs. Ground fires are generally ignited by surface fires. Ground fires have very low spread rates. For these reasons, ground fires are not predicted or further discussed in this analysis because they would be secondary to and in association with a surface fire.

B. Surface Fire

A surface fire is one that burns in the surface fuel layer, which lies immediately above the ground fuels but below the canopy, or aerial fuels. Surface fuels consist of needles, leaves, grass, dead and down branch wood and logs, shrubs, low brush, and short trees. Surface fire behavior varies widely depending on the nature of the surface fuel complex. Surface fires are generally easier to contain than any type of crown fire.

C. Crown Fire

A crown fire is one that burns in the elevated canopy fuels. Canopy fuels normally consumed in crown fires consist of the live and dead foliage, lichen, and very fine live and dead branchwood found in the forest canopy. We generally recognize three types of crown fire: passive, active and independent.

> Passive: A passive crown fire, also called torching, or candling, is one in which individual or small groups of trees torch out, but a solid flame is not consistently maintained in the canopy. These can encompass a wide range of fire behavior, from the occasional tree torching out, to a nearly active crown fire. The increased radiation to surface fuels from passive crowning increases flame front spread rate, especially at the upper end of the passive crown fire range. Embers lofted during passive crowning can start new fires downwind, making containment more difficult and increasing the overall rate of fire growth. Passive crowning is common in many forest types, especially those with an understory of shade-tolerant conifers.
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> Active: An active crown fire is a crown fire in which the entire fuel complex becomes involved, but the crowning phase remains dependent on heat released from the surface fuels for continued spread. Active crown fires are characterized by a solid wall of flame extending from the fuel bed surface through the top of the canopy. Greatly increased radiation and short-range spotting of active crown fires lead to spread rates much higher than would occur if the fire remained on the surface. Medium and long-range spotting associated with active crowning leads to even greater rates of fire growth. Containment of active crown fires is very difficult.
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> Independent: An independent crown fire is one that burns in canopy fuels without aid of a supporting surface fire. Independent crown fires occur rarely and are short-lived, requiring a combination of steep slope, high wind speed, and low foliar moisture content. Many apparently independent crown fires may actually be active crown fires in which the canopy phase is momentarily pushed ahead of the surface phase under the influence of steep slope or strong wind. Few cases of independent crown fire have been documented. Independent crown fires are not addressed because they occur so rarely and because no model of their behavior is available.

Climatology

Weather information was obtained from http://famweb.nwcg.gov/weatherfirecd/ for the Kalispell Weather Station for the time period from 1986 to 2006. The computer program Fire Family Plus version 3.0.1.0 (USDA Forest Service 2002) was used to summarize the weather data. Table 3-19 shows the percentile weather used for fire behavior calculations (Project File Exhibit I-1).

TABLE 3-19
PERCENTILE WEATHER BY ENERGY RELEASE COMPONENT (ERC)

Fuel Characteristics	90 Percent ERC
1 Hour Fuel Moisture	4
10 Hour Fuel Moisture	5
100 Hour Fuel Moisture	10
1000 Hour Fuel Moisture	12
Herbaceous Fuel Moisture	48
Woody Fuel Moisture	86
20 Foot Wind Speed	5

Energy Release Component (ERC), a number related to the available energy per unit area within the flaming front at the head of a fire, was used to categorize weather. ERC is often used for planning and estimating the relative fire danger on any given day. The 90th percentile ERC would only be expected to occur on approximately 10 percent of the fire season days. The 90th percentile ERC weather conditions were calculated to be used as inputs when modeling fire behavior.

Fuel moisture is the amount of moisture in a piece of fuel relative to its oven-dried weight. Fuel moistures are displayed in six categories based on type of fuel (live or dead) and size class. The size classes for dead fuels are as follows;

- 1 hour fuels are 0 to 0.25 inch in diameter,
- 10 hour fuels are 0.25 to 1 inch in diameter,
- 100 hour fuels are 1 to 3 inches in diameter, and
- 1000 hour fuels are 3+ inches in diameter.

Dead fuels are classified in this manner because different sizes of fuels take different amounts of time to gain or lose moisture, thus the number of hours associated with each (Anderson 1982). Live fuels are classified as either herbaceous or woody, depending on the type of plant.

Twenty-foot wind speed is the speed of the wind measured 20 feet above the vegetation. It is important to note that 20-foot winds are often three times the strength of the wind we feel on the ground in a forested area. For example, in a moderately dense conifer stand, it would take a 20 mph 20-foot wind to produce a 6 mph eye level wind (National Wildland Coordinating Group Handbook 3, 2004). Eye level winds are often referred to as mid-flame winds because these are the winds that most directly effect surface fires. Mid-flame wind speeds are calculated from 20-foot winds by using a wind adjustment factor (National Wildland Coordinating Group Handbook 3, 2004). When a forested stand density is reduced through removal of trees, the potential mid-flame wind speeds increase. This was considered and adjusted when estimating fire behavior in post fuel reduction treatment areas.

Environmental Consequences

This section describes the direct, indirect and cumulative effects of the proposed treatments on the Fire and Fuels Resource. To focus the fire and fuels analysis and describe relevant effects, the following indicators are used:

- Predicted rate of fire spread (chains/hour)
- Predicted flame length (feet)
- Type of predicted fire

Proposed silvicultural treatment areas for each alternative were categorized into 3 fuel treatment codes. The first 2 types represent fuels and stand conditions in areas proposed for mechanical treatments. The 3rd code consists of an area proposed for Ecosystem Burning. Table 3-20 displays the silvicultural treatments and how they correlate to the fuel treatment code used to compare the changes in fire behavior for each alternative.

TABLE 3-20
SILVICULTURAL TREATMENT CORRELATION TO FUEL TREATMENT CODES

Silvicultural Treatment	Fuel Treatment Codes
Clearcut with Reserve Trees and Seed Tree Harvests	1
Commercial Thin, Salvage, Sanitation, Sanitation with Pre-Commercial Thin, and Thin From Below – Non-Commercial Harvests	2
Ecosystem Burning	3

Alternative A
Direct and Indirect Effects

Under Alternative A, no fuel treatment would occur. In the absence of disturbance, fuel conditions would generally persist or fuel loadings would increase throughout the analysis area. The overall result would be a continuation of current fuel loadings with an increased fire hazard over time. Although no treatments are proposed in Alternative A, fire behavior is still displayed below in Table 3-21 in order to provide a comparison for Alternative A and the action alternatives.

TABLE 3-21
EFFECTS INDICATORS FOR ALTERNATIVE A

Fuel Treatment Code	Rate of Spread (chains/hour)	Flame Length (feet)	Fire Type
1	12	7	Passive
2	12	7	Passive
3	12 (81% of the area proposed for burning) 54 (19% of the area proposed for burning)	7 8	Passive Passive

Continued Dense Understory and Ladder Fuels: Large-diameter Douglas-fir and larch in most of the drier forest stands would continue to lose vigor due to competition from dense understories of shade-tolerant tree species. This would perpetuate a denser understory. This understory also would serve as ladder fuels that would permit a surface fire to expand into the canopy, thereby killing many of the existing large-diameter trees that would have otherwise survived a ground fire. Insects and disease have existed in the past and would continue in the foreseeable future within the analysis area. It can be anticipated that fuel build-up would continue due to tree mortality from these sources.

Historically, stand-replacing fires were less common in the drier forest types, where frequent moderate intensity fires maintained a mosaic pattern of vegetation with an overstory component of large diameter trees. If a stand-replacing fire were to occur in the Porter Mount Area today, the overstory trees that remain could be killed and the burned areas would likely regenerate to lodgepole pine. However, the largest threat of stand-replacing fires in the lower elevations is to private property, homes, public safety, and firefighter safety throughout the landscape.

Alternative B and Alternative C
Direct and Indirect Effects

A. Vegetation Treatments

The proposed fuel reduction methods focus on reducing the potential for crown fires and high intensity surface fires in treatment units, which results in reducing the resistance to control. Thinning trees would reduce the crown density. By removing understory trees, it would also increase the canopy base height, making it more difficult for a crown fire to be initiated. The thinning would primarily focus on removing the smaller trees and species that are less resistant to fire, leaving larger, fire resistant species where possible. The proposed surface fuel treatments would reduce the amount of surface fuels to lower potential flame lengths. This would decrease the resistance to control and reduce the likelihood of crown fire initiation. Table 3-22 summarizes the changes in fire behavior for Alternatives B and C.

TABLE 3-22
EFFECTS INDICATORS FOR ALTERNATIVES B AND C

Fuel Treatment Code	Rate of Spread (chains/hour)	Flame Length (Feet)	Fire Type	Acres Treated Alt. B	Acres Treated Alt. C
1	3	1	Surface	733	626
2	3	1	Surface	701	711
3	3 (81% of the area proposed for burning) 54 (19% of the area proposed for burning)	1 8	Surface Passive	128	128

To further reduce hazardous fuel conditions that existed prior to or created from timber harvest activity, would vary based on the number of acres treated and the hazardous fuels reduction prescribed. In general, the more acres of effective fuel reduction treatment, the better the alternative would be at reducing fuel hazard and subsequent fire behavior characteristics. Table 3-23 summarizes the numbers of acres treated by hazardous fuels reduction activity by alternative.

TABLE 3-23
FUEL REDUCTION TREATMENTS BY ALTERNATIVE

Fuels Treatment (Acres)	Alternative A	Alternative B	Alternative C
Excavator Pile/Chipping	0	724	673
Excavator Pile/Yard Tops/Lop and Scatter	0	30	30
Lop and Scatter	0	13	8
Underburn	0	532	452
Yard Tops/Lop and Scatter	0	135	174
Ecosystem Burning	0	128	128
Total Acres of Fuel Treatment	**0**	**1562**	**1465**
Fuel Reduction within the Wildland Urban Interface (WUI)	0	1171	1123

An Ecosystem Burn (Unit #1) was identified based on site-specific conditions that would meet vegetation management objectives. The area proposed is a mix of open shrub dominated areas and timber. Prescribed burning is intended to reduce dead and down fuels, as well as cause mortality in understory trees and some of the larger trees. It will also kill the above ground portion of shrubs and forbs. This would only have a short-term effect on fire behavior in the shrub dominated areas because re-sprouting is expected to occur. The resulting vegetation in the timber dominated areas should be in a more open condition with fewer ladder fuels and surface fuels.

This stand may need some slashing or slashing and hand piling of ladder fuels prior to burning. This would decrease the potential for crown scorching of residual trees and assist in carrying the fire at a low severity level to achieve vegetation management objectives. Refer to the Vegetation Section for the effects of burning on vegetative structure. Table 3-24 displays the activities associated with the Ecosystem Burn Unit #1.

TABLE 3-24
PROPOSED ECOSYSTEM BURN ACTIVITIES

Rx	Acres	Potential Slashing (Acres)	Fuelbreak (approximate)	
			Chains	Feet
Haskill East (Unit 1)	128	72	52	3440

B. Effective Fuel Reduction Zones (FRZs)

The Island Fuels Reduction Project (completed in 2006) treated portions of the Porter Mount Analysis Area. Nearly all treatment areas proposed by the action alternatives in this project are linked to previously treated stands or natural fuel breaks. This helps to create larger, more effective treatment areas. These fuelbreaks are important to either slow the spread or reduce the intensity of wildland fire, thus increasing the effectiveness of suppression efforts to protect values at risk.

The fuel treatment areas adjacent to the intermix community are designed to protect primarily private and government structures and improvements; secondarily, they are designed to protect NFS land resource values. Wildland fire can threaten a structure in three ways:

- Direct exposure from flames,
- Direct exposure to radiated heat, and
- Exposure to airborne firebrands.

The treatments proposed are meant to decrease the probability that airborne firebrands could reach structures. This would be of particular concern when viewing both long-range and short-range spotting potential of forested areas adjacent to developed areas.

Treatments proposed would also reduce the potential of direct exposure from flames and radiated heat by creating a “defensible space” around a property or structure. Defensible space refers to that area between a structure and an oncoming wildland fire where the vegetation has been modified to reduce the wildland fire threat and to provide an opportunity for firefighters to effectively and safely defend the structure. Fuels can be treated in a relatively small area immediately adjacent to structures to reduce exposure to flames and radiant heat. Some evidence suggests that fuel reduction within 40 meters of a structure can substantially reduce ignitions from direct exposure to flames or radiant heat (Cohen 1999). These stands would likely be managed into the future to maintain fire resistant tree species, light surface fuels, and no ladder fuels. This would provide an effective fuel reduction area to reduce the potential of the short-range and long-range spotting threat associated with those stands during wildland fire.

To reduce the threat of ignition from firebrands, fuels need to be reduced both near and at some distance from the structure. Firebrands that result in ignitions can originate from wildland fires that are at a distance of 1 kilometer or more (Cohen 1999). However, firebrands pose a greater threat the closer the fire is to the structures and other existing resources.

Implementation of the action alternatives would result in modifying the behavior of a wildland fire and would increase the likelihood that fire suppression efforts would be successful in containing the fire at a small size.

Alternatives B and C
Cumulative Effects

The Cumulative Effects Worksheet (Project File Exhibit I-2) considers and describes proposed activities in addition to the past, current, and reasonably foreseeable activities listed at the beginning of this chapter in Tables 3-1 and 3-2. Those activities that cumulatively contribute indiscernible effects on fuel conditions are not included in this section. Those activities that cumulatively affect the fuels conditions are discussed below.

Regeneration harvest, intermediate harvest, non-commercial thinning from below, underburning, whole-tree yarding, and yarding of unmerchantable material coupled with slashing ladder fuels, excavator piling and chipping activities would continue to reduce fuels and the associated risk of wildland fire that follows insect attacks. These stands would be more resistant to insects and disease, be able to better withstand low-to moderate intensity wildland fires over time, and may be machine or hand piled as needed. The overall cumulative trend would be a continued improvement in forest health conditions as management moves stands towards desired future conditions.

A. Past Activities

A portion of the NFS lands within the Porter Mount Analysis Area have been harvested in some manner (See Vegetation Section). Timber harvest has also occurred on private lands in the analysis area. Most of this is on private timber lands; some on small private holdings. These past activities have broken up the fuel connectivity on a landscape scale. Some of the recent regeneration harvests still function as effective fuel reduction areas. Even in areas where an intermediate harvest occurred, the crown connectivity has been altered enough to affect the sustainability of crown fire within these stands. Past treatments can make an area more defensible for fire suppression activities for up to 50 years.

Firewood cutting has an annual effect on forests 200 feet adjacent to roads open year round and seasonally. Larch and Douglas-fir are the preferred species, however, due to the high demand and scarcity of available area, lodgepole pine and any other dead species are removed. This activity has the potential to reduce down woody material, snags, and fuel up to 200 feet from roads. It is difficult to know how many acres have been affected by this activity. Removing the dead fuel component creates a corridor of defensible area necessary for successful suppression activities. In areas of heavy firewood collection, the removal of dead wood breaks up horizontal and vertical fuel continuity. This action combined with the fuel-free road surface would assist in successful suppression operations.

Private land development has been occurring for the last century in the analysis area, however it has been most intense in the last two decades. The vegetative conditions on small private land are highly variable and range from grassland to dense old forest. The effect of private land development has been to convert some forested land to low density forest or grassland and roads. There has been a recent response to fire prevention education involving effective fuel reduction within some of these private inholdings. Although in most cases, the desire of the landowners has been to maintain a forested setting, on one or more aspects, in the immediate vicinity of dwellings and structures that is contiguous with forested public lands. In many cases, small private forested areas have not been managed and forests have become densely stocked stands with large quantities of dead trees. These sites are highly vulnerable to insect and disease outbreaks and wildland fire.

B. Reasonably Foreseeable Activities

Firewood cutting is anticipated to continue along seasonal and yearlong open roads. This activity has the potential to reduce down woody material, snags, and fuel up to 200 feet from roads. This removal of dead standing and downed wood would reduce the amount of fuel left on NFS lands. Firewood gathering contributes to the overall effort to reduce fuels in the wildland urban interface.

Plum Creek Timber Company has plans to harvest approximately 1360 acres in the analysis area. The anticipated change in the fuel and fire behavior characteristics would be similar to the post treatment scenarios described in this analysis.

Private inholdings in the Porter Mount Analysis Area have been developed in the recent past with an increase in the number of residences adjacent to the analysis area. The probable development trend would be to expect further home construction within the limits of county zoning practices. It is reasonable to foresee that some additional home development may occur on private lands within the analysis area with a likely consequences being the removal of some additional vegetation on private lands to accommodate new landowner’s objectives. The presence of more dwellings elevates the importance of fuel reduction to reduce the potential loss of life and property.

Other foreseeable actions include noxious weed control, road maintenance, administrative road use, public recreational use, and small forest products gathering for personal use. These activities are not expected to contribute to, or inhibit, efforts to achieve desired stand conditions.

Regulatory Framework and Consistency__________

Action alternatives are consistent with the following Forest Plan Fire Management Direction (Appendix G, Forest Plan 2001) and Fire and Fuels direction for all affected management areas:

- Use existing fire management literature as reference documents to guide project development, execution, and evaluation.
- Integrate an understanding of the role fire plays in regulating stand structure into the development of silvicultural prescriptions.

- Use existing fire behavior prediction techniques to evaluate prescribed fire application and evaluate emerging wildfire ignitions.
- Evaluate prescribed fire alternatives from a risk of escape and economic cost/benefit analysis when complex applications are planned.
- Assure that the appropriate suppression response is applied to each wildfire ignition.