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.

Analysis Area

Spatial Bounds

The area evaluated for this Fire and Fuels Section includes the Upper Swan Analysis Area. Evaluation is moderate, ranging from 3400 to 8600 feet. Topography is a moderate relief landscape composed of valleys, ridgelines, and crests. The area has a mean slope of 25 percent with only 12 percent of the area having slopes greater than 40 percent. Most of the Upper Swan Analysis Area falls within the montane ecotone with lesser amounts in the lower subalpine 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 Upper Swan Area.

Temporal Bounds

The length of time for effects in this cumulative effects analysis is approximately 10 years. This is based on the probable contract length for the proposed salvage project, the timeframes for related activities, and the reasonable foreseeable action identified.

Data Sources, Methods, and Assumptions Used

Data Sources

The Fire History Analysis in the Upper Swan 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, and data collected for the Sixmile Watershed Analysis supported the Upper Swan Analysis. Sixmile, though not an adjacent watershed, shares similar topographical, biophysical, and climatic characteristics. Local meteorological information was obtained from a WETS weather monitoring station in Condon, Montana for dates after 1962 and from The National Weather Service Station in Kalispell, Montana for dates prior to 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.

Methods

Fire Family Plus: The Fire Family Plus Version 3.0.1.0 software program (USDA Forest Service 2002) analyzes fire weather parameters associated with fire occurrence data. In this analysis, data from the Upper Swan Analysis was used to determine fire behavior thresholds.

Assumptions

During the summer of 2008, the Flathead National Forest experienced wind events that left blowdown damage to trees in the Swan Valley. Fuel profiles have changed because of this wind event. Before the wind event, a Fire Behavior Prediction System (FBPS) Model 10 best represented the fuels where ponderosa pine, larch, Douglas-fir, and other species occurred. Post blowdown FBPS Slash Fuel Model 13 was used to represent the heavy and moderate blowdown areas.

Measurement Indicators

To focus the Fire and Fuels Analysis and describe relevant effects, the following effects indicators were used:

- Fire behavior thresholds;
- Fire behavior indicators
  - Predicted rate of fire spread (chains/hour);
  - Predicted flame length (feet);
  - Type of predicted fire; and
- Acres of slash reduction treatments.

Affected Environment

Existing Condition

Past Forest Management: Although past timber harvest and associated fuel treatments have not replicated wildland fire, they have replaced wildland fire as the dominant process that changes the patterns of vegetation and woody debris accumulations within the project area. Since the 1950s, approximately one-third of the Upper Swan Area has been regeneration timber harvested and fuels have been treated (prescribed burning and machine piling of slash with pile burning).

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 Forest Plan requires that all fires be suppressed (excluding 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.

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 Condon, Montana, indicate drought fire season years (in which fire suppression occurred within the analysis area) in 1967, 1972, 1973, 1984, 1988, 1989, 1991, 1994, 1996, 2000, and 2001. This station was activated in 1962. The National Weather Service Station in Kalispell, Montana (active since 1899), was used to correlate the drought fire season years prior to 1962 with the number of fire suppressions in the area. These drought years were 1940 and 1961.

Fire Ignitions and Suppressions Since 1940: National Interagency Fire Management Integrated Database (NIFMID) identified 120 suppressed ignitions (82 lightning-caused and 38 human-caused) that occurred from 1940 though 2003 within the Upper Swan Analysis Area. Drought year dates were also cross-referenced with fire active dates recorded on the (NIFMID), the results were 34 lightning-caused and 19 human-caused ignitions during these more large fire-prone years. Of the total ignitions, 119 were promptly suppressed and averaged only 1.2 acres; the largest of the fires being the 2003 Crazy Horse Fire (lightning caused ignition) that burned 11,000 acres.

Since 1970, there have been 38 human-caused fires. There appears to be a direct relationship between the increase of forest use and wildland urban interface (WUI) density with human-caused fire occurrence.

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 Upper Swan Analysis Area only includes the Category 2 type of WUI called the Intermix Community, which is defined as follows:

> Category 2 - Intermix Community: 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 one 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 the Upper Swan categorized as Category 2 include small cluster developments, such as ranches, summer residences, hay meadows, timber production areas, ranch outbuildings, and other structures. Approximately 2620 acres of the Mid Swan Blowdown Salvage Project is located within the WUI.

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. There is potential for development and increased private ownership within the PCTC Sections currently for sale and/or privately owned land that could be further subdivided. The Montana Legacy Project appears likely to limit the amount of Plum Creek that would be sold to private development.

Urban interface areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites that homes and other structures occupy. 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 unstaffed 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. Approximately half of the proposed treatments in the Mid Swan Blowdown Salvage Project occur in WUI Category 2.

Home Ignitability: Recent research (Cohen 2000a) addresses home ignitibility, or the potential for a home to ignite, in the WUI. Cohen concludes that homes ignite via one of two processes:

1. Direct flame contact with the structure and
2. 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 1 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 Managers 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.

Existing Condition of Forest Fuels and Fire Behavior:

Blowdown events are not unusual in the Swan Valley. A downburst storm in 1995 caused localized blowdown near Pierce Lake. In June 1988, a significant wind event in the Jim Lakes Area, southwest of the Mid Swan Blowdown Salvage Project Area, caused considerable blowdown on Federal, State, and PCTC lands, resulting in several million board feet of down timber. There have been numerous other wind events in the Upper Swan Valley that have caused varying degrees of damage.

The down timber from such storms is often suspended above the ground for several years, where it significantly adds to existing local fuels. Windstorms of this type do not generally flatten whole forests. Instead, they tend to blowdown erratic swaths a few hundred feet wide of the oldest, tallest, or most exposed trees (Heinselman 1996).

Current estimates of fuel loadings in proposed salvage units range between 9 tons per acre in areas of sparse blowdown, to 66 tons per acre in heavy blowdown areas. There are isolated concentrations that have been estimated by District Fuel Personnel to be 80-100 tons per acre.

Lightning strikes in the blowdown area may be more successful in initiating wildland fires than in past conditions. Fire intensities in these heavy fuels can be considerably higher than in previous surface fuels and could exceed the capabilities of hand crews. Most fire events have occurred in a boreal mix consisting of ponderosa pine, larch, Douglas-fir, with dead lodgepole pine often contributing to flammability. These fires maintain a relatively low rate of spread with light winds (< 8 mph or 14 kph), while accompanied by relative humidities above 20 percent. When these conditions change, the rate of spread and fire intensity could accelerate and move the fire into the crowns. Crown fires can spread at rates of 1.5 to 7 miles (2 to 11 kilometers) a day. Spotting can occur from 0.25 to 0.50 mile (0.4 to 0.8 kilometer) ahead of such fires. Fire shapes take on the elongated elliptical characteristics of wind driven fires. The winds driving these fires are generally out of the southwest.

Resistance to control of fires in blowdown fuels is very high due to the amount of handwork required to separate the abundance of large fuels. Fires in the blowdown under high to extreme conditions can also be expected to rapidly become plume dominated and would be driven by extreme fire behavior. This could include:

- Smoke columns reaching heights of 30,000 to 50,000 feet;
- Strong indrafts on the fire perimeter, which could quickly change to downdrafts up to 40 mph;

- Fire whirls along the fire perimeter;
- Long range spotting up to 3 miles or more; and
- High rates of spread.

Spotting can be expected to reach the same distance of 0.25 to 0.5 mile that was achieved prior to the blowdown wind event. However, the increased fuel loading would also increase the potential for plume dominated fire characteristics, lofting firebrands high into the atmosphere. This, in turn, can increase the likelihood of longer range spotting. Current fire spread and fire behavior models do not model plume-dominated fires. However, fires in the blowdown areas could have a tendency to move to plume-dominated conditions rapidly.

The greatest effect of fire suppression and exclusion in unison with other natural disturbance processes has allowed biomass to accumulate in most unmanaged timber stands. The bulk of the biomass currently occupying the analysis area is in the 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. The presence of blowdown in any fuel horizon adds complexity to management and to fire suppression scenarios.

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 would ignite, its rate of spread, and its intensity. The relationship of fuel load and depth segregates the 13 fuel models into two distinctive orientations, with two fuel groups in each. Grasses and shrubs are vertically-oriented fuel groups, which rapidly increase in depth with increasing load.

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.

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 three 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 zero 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).

Timber Litter Group (Areas adjacent to Proposed Salvage Units)

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 humidity's, 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 8/10 Mosaic and 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 3-inch (7.6 cm) 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.

Logging Slash Group (Proposed Salvage Units)

Fire Behavior Fuel Model 13 - Fire is generally carried across the area by a continuous layer of slash. Large quantities of material larger than 3 inches (7.6 cm) are present. Fires spread quickly through the fine fuels and intensity builds up more slowly as the large fuels start burning. Active flaming is sustained for long periods and a wide variety of firebrands can be generated. These contribute to spotting problems as the weather conditions become more severe. The total load may exceed 200 tons per acre (89.2 tons per hectare) but fuel less than 3 inches (7.6 cm) is generally only 10 percent of the total load. Areas most commonly fitting this model are old-growth stands west of the Cascades.

For the blowdown, a manual rate of spread of 37 chains per hour was assigned to the extreme category for all time periods. This rate is documented from past fire growth observations in blowdown fuels from fires in blowdown, such as the Dryden #18 Fire in the 1975 publication, "The 1974 Wildfire Situation in Northwestern Ontario" by B.J. Stocks.

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).

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**. 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 or resistance to control will be. Fire Scientists and managers recognize three general types of wildland fire depending on the fuel stratum in which the fire is burning.

1. *Ground Fire*: A ground fire is one that burns in ground fuels such as duff, organic soils, roots, rotten buried logs, etc. 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.

2. *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.

3. *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.

    a. **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.

    b. **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 fuelbed 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.

    c. **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 windspeed, 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 and Fire Behavior Thresholds: Weather information was obtained from http://famweb.nwcg.gov/weatherfirecd/ for the Condon Remote Automated Weather Station for the time period from 1988-2007. The Fire Family Plus software program was also used to analyze fire weather parameters associated with fire occurrence data in determining fire behavior thresholds. Thresholds evaluated are listed below. These thresholds can be used as general guidelines to help warn fire managers and firefighters of impending fire danger. Discussion of the change in fire intensity that can be expected in blowdown areas when considering these thresholds are discussed in the Environmental Consequences Section below.

Fire Danger: 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. The Energy Release Component is often used for planning and estimating the relative fire danger on any given day. Ninetieth 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 effects indicators are used:

- Fire behavior thresholds
- Fire behavior indicators
  - Predicted rate of fire spread (chains/hour);
  - Predicted flame length (feet);
  - Type of predicted fire; and

- Slash reduction treatments

Fire Behavior Thresholds

Fire Family Plus, a software program used to analyze fire weather parameters associated with fire occurrence data, was used to determine fire behavior thresholds. The thresholds for significant fire growth are listed below. Fire occurrence is examined to establish any trends that may exist in fire cause and location. A study of weather conditions occurring during past large fires was conducted to determine weather parameters needed to support rapid fire spread. Fires occurring with weather parameters or fire indices above the thresholds listed have the potential to burn intensely or spread rapidly. These thresholds correlate well with the local fire history, and the potential for large, rapidly spreading fires, such as the 2003 Crazy Horse Fire. These thresholds can be used as general guidelines to help warn fire managers and firefighters of impending fire danger. The 90 percent threshold relates to "very high" fire danger while the 97 percent threshold relates to "extreme" fire danger.

TABLE 3-35.
FIRE BEHAVIOR THRESHOLDS (JUNE-OCTOBER)

Energy Release Component (ERC)	90 Percent = 40	97 Percent = 32
Relative Humidity (RH)	90% = 15%	97% = 10%
Temperature	90% = 87 degrees	97% = 90 degrees
100 Hour Fuels	90% = 10%	97% = 8%
1000 Hour Fuels	90% = 12%	97% = 10%
20 Foot Wind Speeds	90% = 5 mph	97% = 10 mph

The ERC listed in the above table are based on the National Fire Danger Rating System (NFDRS) Fuel Model 13. By changing to NFDRS Fuel Model 13 to represent the blowdown, the ERC values are close to six times higher than they were prior to the blowdown event. This is a good indicator of the change in fire intensity that can be expected because of the blowdown.

If two or more elements (wind, drought, below normal humidity, or above normal temperatures) occur at the same time, any new fire starts in the blowdown can be expected to create fire behavior that would complicate containment actions. If fires under these conditions in blowdown are accompanied by winds in excess of 10 mph, they would move at rapid rates of spread (36 chains per hour and up to 7 miles a day, or more).

Fires in the blowdown areas could burn at a higher, prolonged intensity, with a potential for an increased daily spread rate at lower fire danger levels, compared to the rapid spread crown fires that are associated with high winds at high fire danger levels in past fires, prior to the blowdown. However, it is not expected to reach the same rapid spread rates that were achieved by previous standing timber with crowning and spotting associated with winds exceeding 10 mph. Fire behavior analyses predicts an increase in complexity for future fires burning within the blowdown area. It predicts these fires would have a common daily spread that is 8 to 15 times greater than fires burning in Fuel Model 10 (pre-blowdown). That means that large fire growth can occur under moderate weather conditions and may not be dependent on wind events. Fires occurring in the blowdown fuels would tend to grow slower than wind driven crown fires in Fuel Model 10, but would continue to increase in size under a broader range of weather conditions, and have the potential over time to cover more distance and acres. A steady fire growth can be expected during the majority of the fire season. Fire perimeters should be more circular and may tend to out-flank natural barriers. The most critical element to be alert for is the tendency to move to a plume-dominated fire and the associated extreme fire behavior.

As stated above, post blowdown Slash Fuel Model 13 is used to represent the heavy and moderate blowdown areas. In Model 13, fire is generally carried across the area by a continuous layer of slash. Large quantities of material larger than 3 inches are present. Fires spread quickly through the fine fuels and intensity builds up more slowly as the large fuels start burning. Fire effects on the soil horizons can be detrimental to areas experiencing these fire intensities. Active flaming is sustained for long periods and a wide variety of firebrands can be generated. These contribute to spotting problems, as weather conditions become more severe. Total fuel loads may exceed 200 tons per acre (448 tons per hectare), but less than 3 inches diameter material is generally only ten percent of the total load (Anderson 1982).

Conclusions:

- Blowdown fuels can be expected to produce more consistent fire growth under a wider range of weather conditions than in the undamaged forest. This means that fires may to become larger, more frequently, under a wider range of weather conditions than in a pre-blowdown forest.
- There is an increased likelihood of high intensity fires starting, or increasing in intensity, in the blowdown areas on Federal land and then spreading into non-Federal lands. There is also an increased likelihood that wildfires starting in the untreated blowdown areas would be more difficult to control and would jeopardize other resources on State and private land. The ability for firefighters to control these types of fires is low.
- Fuel treatment in the blowdown area will slow fire progress through the blowdown fuels and reduce the likelihood of fire entering adjacent stands.
- The affected areas in this project are generally small concentrations of blowdown and are mostly disconnected, reducing the likelihood of large, plume dominated fire events.

Fire Behavior Indicators

The proposed silvicultural treatment for each action alternative is Salvage. There are no ecosystem burning projects proposed for this project. Although no treatments are proposed in Alternative A (No Action), fire behavior is still displayed by stand group in order to provide a comparison in similar stand groups for the no action and action alternatives.

The Salvage Treatment correlates to the following fuel treatment code used to compare the changes in fire behavior for each alternative displayed in Table 3-36:

TABLE 3-36.
FIRE BEHAVIOR INDICATORS

Silvicultural Treatment	Fuel Treatment Code
Salvage	1
Fire Type	**Fire Behavior Descriptor**
Active	Crown fire
Passive	Surface fire with torching of individual, or groups, of trees
Surface	Surface fire

Alternative A – No Action
Direct, Indirect, and Cumulative Effects

Under Alternative A, fuel on NFS lands would not be treated in the project area. This lack of treatment may place residents, adjacent land owners, and Flathead National Forest visitors adjacent to fires with increased intensity, should a wildfire occur in the next 10 years. In addition, the likelihood of a high-intensity wildfire starting in the blowdown areas on NFS lands and then spreading into non-Federal land would be highest under this alternative.

TABLE 3-37.
FIRE BEHAVIOR INDICATORS FOR ALTERNATIVE A

Fuel Treatment Code	Rate of Spread (chains/hour)	Flame Length (feet)	Fire Type
None	20-38	10-30	Active/Passive

Alternatives B, C. and D
Direct and Indirect Effects

Under Alternative B, blowdown areas would be treated on 690 acres of NFS lands. When compared to all other alternatives, it provides the greatest reduction in risk of wildfire adjacent to structures adjacent to the project area. In addition, there would be a lower risk of a wildfire starting in the blowdown areas and spreading to non-NFS land.

Fuel treatments in the project area have been focused on strategic placement of removal in areas of concentrated blowdown to affect fuel model change and slow fire spread. A patchwork of fuel treatment units has been designed for slowing progress throughout the blowdown fuels with a conversion from a Fuel Model 13 to a Fuel Model 10/8.

TABLE 3-38.
FIRE BEHAVIOR INDICATORS FOR ALTERNATIVES B, C, AND D

Fuel Treatment Code	Rate of Spread (chains/hour)	Flame Length (feet)	Fire Type
1	8-12	7-10	Surface

Slash Reduction Treatments

Tree boles, limbs, and foliage were deposited in the forest floor adding to both fine down wood and coarse down wood material fuel loadings. In some areas this material is scattered and in other areas it is concentrated in large amounts. As suggested by Brown and others (2003) this fine and coarse down wood contribute to fire hazard and severity. Table 3-39 below summarizes the number of acres of slash reduction treatments by alternative. See Appendix C of this document for more detailed descriptions of fuel reduction treatments.

TABLE 3-39.
SLASH REDUCTION TREATMENTS BY ALTERNATIVE

Activity	Alt. A (Acres)	Alt. B (Acres)	Alt. C (Acres)	Alt. D (Acres)
Slash Treatment				
Lop & Scatter	0	157	96	152
Lop and Scatter/Jackpot Burn	0	6	6	5
Whole Tree Yard (WTY)	0	32	32	10
WTY/Excavator Pile/Burn Piles	0	209	209	205
WTY/Excavator Pile/Burn Piles/Jackpot Burn	0	286	279	264
Total Acres of Slash Treatment	**0**	**690**	**622**	**636**
Fuel Reduction Treatments				
Fuel Reduction within the Wildland Urban Interface	0	332	298	321
Fuel Reduction outside the Wildland Urban Interface	0	358	324	315
Fuels removed from blowndown areas on NFS lands - Tons	0	93,000	70,000	78,000

Alternative A – No Action
Direct, Indirect, and Cumulative Effects

Under Alternative A, no salvage of blowndown trees would occur. Fuel conditions associated with the blowndown trees would persist and fuel loadings would increase throughout the project area. The overall result would be a continuation of current fuel loadings with an increased fire hazard over time. The potential of surface fires would not be reduced, resulting in no reduction in resistance to control and modifying fire behavior characteristics. Insect and disease would continue in a variety of tree species. It is anticipated that fuel-build up would continue due to tree mortality from these sources (Refer to Forest Vegetation Section).

Alternatives B, C. and D
Direct and Indirect Effects

Under these alternatives the proposed salvage and associated activity fuels (slash) treatments would reduce the fire hazard and fire severity risk through reduction of fuel loading. As discussed above, salvage treatments would reduce the potential of surface fires with torching and crown fires, thus reducing the resistance to control. The salvage treatments would reduce the amount of surface fuels to lower potential flame lengths. In general, the more acres of effective slash reduction treatments, the better the alternative would be reducing fuel hazard and subsequent fire behavior characteristics.

Alternative B removes the most amount of fuel at 93,000 tons, with Alternative D removing 78,000 and Alternative C removing 70,000. Alternative B would be most likely to modify fire behavior and increase the likelihood that fire suppression efforts would be successful in the containing the fire at a small size.

Alternatives B, C, and D
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.

Activities associated with this project would continue to reduce fuels and the associated risk of wildland fire. Stands treated would increase the effectiveness of suppression efforts to protect values at risk. Stands treated would be more resistant to insects and disease and be able to better withstand low-to moderate intensity wildland fires over time. The overall cumulative trend would be a continued improvement in forest health conditions as management moves stands towards desired future conditions.

Past Activities: A portion of the NFS lands within the project area have been harvested in some manner (See Forest Vegetation Section). Timber harvest has also occurred on private lands near the project area. Most of this past activity is on NFS lands, private timber lands, as well as 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 decades.

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 coarse 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 in-holdings. 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.

Reasonably Foreseeable Activities: Firewood cutting is anticipated to continue along seasonal and yearlong open roads. This activity has the potential to reduce course 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 WUI.

Private in-holdings in the Mid Swan Analysis Area have been developed in the recent past with an increase in the number of residences adjacent to the project area. The probable development trend would be to expect further home construction within the limits of county zoning practices (Project File Exhibit R-10). It is reasonable to foresee that some additional home development may occur on private lands within the analysis area with 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 gathering small forest products 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 B, C, and D are consistent with the following Forest Plan Fire Management Direction (Appendix G, LRMP 2001) and fire and fuels direction for all affected management areas:

- Implement prescribed fire to maintain healthy, dynamic ecosystems that meet land management objectives.
- Integrate an understanding of the role fire plays in regulating stand structure into the development of silvicultural prescriptions.
- Planned ignition prescribed fire may be utilized to reduce hazards from activity-caused fuel concentration and to maintain or enhance vegetative components or wildlife habitat (Forest Plan, pp. III-74).