III. FIRE AND FUELS

1. Analysis Area

The Moose Post-Fire project area is the area used for analysis of fuels and fire influences (refer to Map 2-1) because activities are proposed within the fire area. It is located within a much larger ecosystem, which expands across the Northern Rocky Mountains. In most years, fire commonly occurs throughout this area. Fires are occasionally large in size and have widespread influence on social and biological resources. The following discussion provides an overview of how fire has affected the landscape conditions.

2. Affected Environment

Fire Ecology

Historically, fire has been the dominant disturbance factor to the forest communities across the Northern Rocky Mountains. The mosaic patterns of the current forested communities are the result. The frequent occurrence of fire across the landscape can cause high mortality to all life forms found in these communities. However, due in part to frequent fire activity many of the vegetation species are well adapted to this fire-dependent environment and display unique survival characteristics. "Fire dependent forest ecosystems require fire treatment for their continued perpetuation on the landscape" (Habeck and Mutch 1973).

Fire often arrives to these sites during dry periods of July and August, and becomes a significant disturbance event during severe drought periods. During severe drought periods fire activity would often last well into September.

Where fire has occurred in the most recent past, fuel loadings can be quite variable depending on the forest structure found pre-fire. Prior to the Moose Fire, much of the surrounding area has not had a significant fire event for the last 80-100 years, over 250 years in some portions of the fire area. Although fire starts occur frequently from lightning in summer storms, fires greater than one acre are rare. Most, if not all, of the forested communities on the Flathead National Forest have been disturbed by fire in the last 2-3 centuries.

Wildland Fire History and Suppression

Wildland fire was a dominant disturbance in the Big Creek watershed prior to the 1930s. 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 watershed. Maps and narrative of the Flathead Forest Reserve [including the area in which the Moose Fire occurred] describe large areas of "recently burned". His notes state "most of the areas (Whitefish Range) swept by fire in this region have been burned within the last twenty-five years."

Fire history for the North Fork indicates that large fires occurred in 1910, 1919, and 1926 (refer to Map 3-14). Summer lightning storms occur frequently over the Big Creek drainage. Lightning strikes are numerous, and occur on ridges and mid-slopes, and are less frequent at lower elevations. Most storms are accompanied by precipitation and fire ignitions, although common, seldom resulted in large fires. The watershed averages one large wildland fire (greater than 100 acres) within its boundary every 16 years.

Prior to the Moose Fire, sixty percent of the Big Creek watershed had not been disturbed by large wildland fire since 1864, much of it undisturbed for over 200 years (Big Creek EAWS, 1999). Thirty-one percent of the Big Creek watershed total acreage was burned in the 1910 fires. Within the Moose Fire area, approximately 30% of the Flathead National Forest acres had not been disturbed by large wildland fire since 1864 or earlier. Wildland fires in 1919 and 1926 also burned thousands of acres. Four wildland fires greater than 1000 acres occurred within the watershed from 1864 to 1926 (the beginning of effective fire suppression). These fires were both a mixed severity and lethal fire type. In some areas, nearly all existing trees were killed; in other areas more of an under burn occurred, leaving varying amounts of the larger over story trees or patches of unburned areas. This pattern and frequency of fire probably reflects what has been occurring within the project 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 to southwest in an easterly direction.

When a large, and unusually severe fire occurs, it ultimately creates a correspondingly large mass of heavy fuels, starting 12-15 years after the fire when much of the dead timber has fallen (Arno, Parsons and Keane 1999, Lyon 1984). This becomes incorporated into a new dense fuel bed with small conifers and large shrubs, which can readily support another severe wildfire, often called a reburn or "double burn" (Arno, Parsons and Keane 1999). In the initial years after the Sleeping Child Fire (1961) tree seedling densities averaged 34,000 per acre (Lyon 1984). Similar tree densities were noted post-fire in the Red Bench Fire (1988) area. Historically, reburns have occurred with some regularity in the Northern Rockies. In fact, the Moose Fire reburned portions of the Adair (1994) and Anaconda (1999) fires in Glacier National Park. The Biggs Flat Fire (2001) on the Lewis & Clark N.F. reburned over 4000 acres of the Gates Park Fire (1988). The McDonald II Fire (2000) and the Cabin Creek Fire (2001) burned portions of the Canyon Fire (1988).

The size, spread, intensity and severity of a reburn fire are affected by many factors. These factors include seasonal timing of the start, drought effects, weather, wind, appropriate management response, terrain and fuels. The McDonald II Fire only burned a few hundred acres of the Gates Park Fire, because it occurred in late July, when the available live surface fuels were still green. Yet when a similar start occurred in late August of 2001, the live surface fuels sustained fire because they were cured and affected by long-term drought (McBratney, personal communication). A similar scenario would occur over time within the Moose Fire. Reburns are not undesirable in and of themselves, but only where the effects of such fires are inconsistent with land management goals and objectives (i.e. desired watershed, soil, fisheries, wildlife, or vegetation conditions).

The change in policy and effectiveness of wildland fire suppression has contributed to the changing landscape and the influence of future fires on vegetative condition (structure, composition and fuel loading) within the analysis area. Over time, the changes and consequences inherent in the continued active suppression of fire include:

a. Vegetation conditions would continue to progress towards older, more dense stands dominated by shade-tolerant trees, with extensive "ladder fuels" to carry a fire to the treetops
b. Fuels loadings would increase
c. Suppression of wildland fires would increase in risk, complexity and cost and the probability of large lethal fires would increase
d. Increased intensity and severity exposes firefighters to greater risk and hazard during initial attack and extended attack.

The effects of suppression vary depending on site conditions, but in many cases, the changes in vegetative condition over time increase the likelihood of large lethal fires over what would have occurred historically.

Near the end of a natural fire cycle, increased fuel loading and greater continuity of fuels results in the increased probability that any fire could quickly develop into a mixed to lethal severity fire and involve burning large areas with uniform lethal severity. This was the case in the Moose Fire.

The appropriate management response for all wildland fires under the existing Flathead 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 National Forest portion of the Moose Post Fire Project area has two different Fire Management Units[1]. In both FMU B (Mixed Values) and C (Developed Area Concerns), the appropriate management response is suppression with safety of fire management personnel being the first priority. FMU C values to be protected would be a higher priority during multiple fire situations than FMU B. Initial attack in both FMUs would be aggressive initial attack actions to control a wildland fire.

[1] Flathead National Forest Fire Management Plan- 2002, Appendix C. Draft

Map 3-14: FIRE HISTORY MAP

See adjacent color insert.

The risk of a wildland fire affecting private property continues to escalate as settlement patterns increase along the private-public interface. The 2001 fire season highlighted the increased risk of major economic and resource losses due to large wildland fire. Although the Moose Fire affected a small portion of the Flathead Valley's wildland/ urban interface, the potential for loss of life and property were real. The North Fork area includes many residences that are in heavily wooded areas and are relatively remote. No zoning or building restrictions currently exist in Flathead County that would limit fire hazard around these homes.

Flammable building materials such as wood shake roofs are popular, but can reduce the likelihood that homes would survive a wildland fire. Bridges with low weight capacities and narrow roads that lack turnarounds can limit emergency vehicle access to homes and limit escape routes. Firefighters have trouble in reaching and successfully protecting homes that have poor access, no defensible space or aren't built or maintained to resist catching on fire. Even if firefighters can access property, they often cannot remain on site due to the extreme fire behavior and intense heat caused by heavy fuel loadings adjacent to the buildings. In addition, greater human use of the interface area leads to a higher potential for human-caused fire starts, and a greater risk of fires originating on private land would spread to national forest system land.

Fire Effects

Fire commonly results in high mortality to the above ground portion of plants. However, it is well known that a high percentage of the plants in the Northern Rocky Mountains can also survive fire and grow from underground stems or root crowns that are not killed in the fire (Stickney 1990). This unique adaptation to a fire-frequented environment provides a readily available, on-site colonization event soon after the fire is out. This is particular true in areas where low to moderate intensity fires are common. However, in large fires, areas with heavy fuel loadings fire would burn at intensity and severity levels that would result in greater mortality to more of the understory plant community. Therefore the potential is much greater for more severe and long-term effects to the pre-burn community. This type of fire activity has been termed lethal fire and is becoming more common throughout the Northern Rocky Mountain landscapes.

The influence of fire on the Moose area can be described in a number of ways:

- Effects of the recent Moose Fire – burn pattern and severity
- Historical Fire Regime – how fire has historically shaped the landscape
- Condition Class – how current conditions may depart from the historical fire regime

Effects of the Moose Fire

The Moose Fire burned at a range of intensities, severities and durations, resulting in a mosaic of effects on the vegetation and soil. These effects are referred to as the ecological effects of fires, usually on the dominant organisms of the ecosystem, i.e. a stand dominated by lodgepole pine (Agee 1997). Muraro (1971) discusses a typical diurnal wildfire burning cycle in lodgepole pine that highlights the interaction of fuels, humidity, and temperature and the resulting mosaic burn. Severity is a function of the total fuel consumed by fire, a reflection of both total heat produced and duration of heating of the soil surface. A discussion of fire severity is included in the vegetation section of this chapter.

Table 3-29 displays the approximate acres burned by severity level on national forest system lands in the Moose Fire perimeter, including both Big Creek and Coal Creek drainages. Map 3-1 displays the entire fire area and the severity levels.

Table 3-29: Forested Acres burned & % of Total Fire Acres by Severity Level

Severity	High*		Moderate		Low		Unburned**		*Total Acres****
Totals	16024	*45%*	6580	*19%*	7481	*21%*	5295	*15%*	35380

* Includes "Burned: seedl/sapl" severity class as displayed on Map 3-1
** Unburned areas within the fire perimeter
*** Does not include non-forest acres (primarily river, water, wetlands)

Although fire suppression for over 80 years on these sites have resulted in changes to forest communities, fire behavior and resulting fire severities were not outside the range of what has historically occurred in this area. The coarse scale mosaic of lethal and non-lethal burn patterns is typical of what occurs in this fire regime. Suppression has been and would continue to be the appropriate management response for these forested systems given the high land values and proximity to adjacent human occupancy.

Although fire starts have occurred at regular intervals as a result of frequent lightning storms in the area, all of these starts have been rapidly extinguished. The fire seasons of 1988 and 2001 provide two extreme exceptions in the Red Bench and Moose fires respectively. Fires that have commonly occurred in this area have created forest communities dominated by western larch and lodgepole pine and to a lesser extent, Douglas-fir.

Fire Regimes

Fire regimes are a classification system used to describe areas of similar fire behavior (frequency, severity, extent, pattern) across an ecosystem. According to the Big Creek Ecosystem Analysis at the Watershed Scale (an analysis conducted in 1999, prior to the Moose Fire), the watershed had not changed significantly from its historic fire regimes. The summary document prepared for this watershed scale analysis stated that:

> "A majority of the watershed is [was] in a lethal fire regime with a 200+ year fire return interval based on the previous vegetation and cover types. Under a lethal fire regime, fires burn into tree canopies and can kill most of the overstory trees. Mortality can vary depending on time of day when the fire burned through an area, fuel conditions, fire intensities (how hot the fire is burning), terrain, and weather. This 200 year lethal fire regime was found throughout the drainage primarily in the cool, moist habitat types.
>
> A very small portion of the watershed is [was] classified in a mixed severity fire regime with a fire return interval of 35-100 years. This regime is confined to the drier south and west aspects in the Douglas-fir cover types."

Currently, fire regimes within the Moose Fire perimeter remain in predominately a lethal fire regime with a 200+ year fire return interval based on the fuels and cover type typical for the area. Outside the fire perimeter, the fire regime also remains lethal with a 200+ year fire return interval.

Condition Class

Condition classes (refer to Table 3-30) are used to describe the degree of departure from historical fire regimes, and thus potential fire effects in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure (Schmidt *et al*. USDA). The relative risk of losing one or more key components that define an ecological system (such as hydrologic function and vegetative attributes) is the basis for defining current fuel condition class within a project area.

Table 3-30: Condition Classes (*from Laverty and Williams 2000*)

Condition Class	Attributes	Example management options
Condition Class 1	• Fire regimes are within or near a historical range. • The risk of losing key ecosystem components is low. • Fire frequencies have departed from historical frequencies by no more than one return interval. • Vegetation attributes (species composition and structure) are intact and functioning within a historical range.	Where appropriate, these areas can be maintained within the historical fire regime by treatments such as fire use.
Condition Class 2	• Fire regimes have been moderately altered from their historical range. • The risk of losing key ecosystem components has increased to moderate. • Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been moderately altered from their historical range.	Where appropriate, these areas may need moderate levels of restoration treatments, such as fire use and hand or mechanical treatments, to be restored to the historical fire regime.
Condition Class 3	• Fire regimes have been significantly 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, frequency, intensity, severity, or landscape patterns. • Vegetation attributes have been significantly altered from their historical range.	Where appropriate, these areas may need high levels of restoration treatments, such as hand or mechanical treatments. These treatments may be necessary before fire is used to restore the historical fire regime.

Subsequent to the Moose Fire, the area is condition class 1. The area unburned in the upper Big Creek drainage is also in condition class 1 but nearing the end of its natural fire cycle.

3. Environmental Consequences

No significant issues related to fire influences were identified (refer to Chapter 2).

The following Effects Indicator was used to focus the fire influences analysis and disclose relevant environmental effects:

- Effects on fuel conditions, fire behavior and fire regimes within the project area (risk, hazard, severity, frequency, size, reburn potential)
- Effects on wildland fire starts and suppression (effectiveness, cost, safety)
- Effects on prescribed fire escape risk (pile burning and/or jackpot burning)

Direct and Indirect Effects

Alternative 1- No Action

No acres are treated under this alternative, and thus there are no direct or indirect effects to the vegetation. Existing conditions as described above under “Affected Environment” would be maintained.

Fuel Condition, Fire Behavior, Wildland Fire Starts and Suppression

In Alternative 1, there would be no fuels reduction and the probability of more severe fire behavior will increase as snags fall (Arno & Brown 1991). Currently in areas within Moose Fire that burned at high severity, most of the potential fuel has burned and is charred. As snags fall and fine fuel from grasses, shrubs and conifers develop, a fuel complex capable of burning will exist. Fuel loads will exceed 70 tons per acre, and in many cases may surpass 100 tons per acre (Fischer 1981). Fires of this nature are not without precedent on the Glacier View Ranger District, as witnessed with the 1910 wildfire and reburned areas in 1926.

In areas of light to moderate severity fire, the potential for difficulty in extinguishing future fires also exists; however, the fuel complex will be somewhat different. Although these areas did not experience a crown fire, charring all vegetation, subsequent mortality is expected. Ground fire effectively killed trees without consuming foliage. The result will be a greater accumulation of fine fuels than in areas that burned more intensely. This fuel complex includes dead needles, branches and stems, and large woody material. In the event of a fire, the fuels may burn hot enough to consume organic matter in the soil (Moose Post-Fire Assessment 2001). When dead and live tree biomass increase, so does flame length and fire line intensity (Rothermel 1983).

Fire intensity is driven by the amount of fine fuel in the fuel complex and fuel moisture, both dead fuel and live fuel where it is a significant component of the fuels complex (Rothermel 1983, Agee 1993). The risk for future high intensity fire in the post-fire plant community is driven, in part, by the amount of fine fuels in the fuel bed and the extent and type of live fuels present that are also available for burning (live fuel moisture drops below a critical level). Fuel loads in the salvaged units would be reduced to levels that would preclude intense fire behavior.

Fire severity as it relates to soil damage is a function of fire duration. Fire duration, in turn, is a function of fuel loading, fuel moisture, particle size, and packing ratio. As well documented in smoke management literature (see for example NWCG 1985) the more fuel available to burn (loading and moisture), the greater the consumption. The smaller the particle size, the quicker it would burn, hence the importance of fine fuels to fire intensity (Rothermel 1983, Agee 1993). The higher the packing ratio of the fuels, the longer such fuels can burn. Thus downed logs and duff are the main contributors to fire severity as defined above (Agee 1993). Burnout time for duff and downed logs can be days, as opposed to hours for finer fuels. Where large concentrations of downed logs may occur, the potential for fire severity increases due to potential for long fire residence time. When large amounts of fuel are present, soil temperatures can remain high for several hours with large changes in soil properties; whereas the soil temperatures produced in low severity fires may not result in any appreciable changes in soil properties (DeBano 1991).

Currently the Flathead Forest Fire Management Plan and the Federal Wildland and Prescribed Fire Management Policy direct that the appropriate management response to a wildland fire would be suppression in the Moose Fire project area. Aggressive initial attack actions would be used to control the wildland fires. This would continue to be the case where human life, property and certain resource values are highest priority.

The large fuels remaining in the burned area would decay slowly, and likely remain on the landscape until it burns again. A reburn results when fall-down of the old burned forest contributes significantly to the fire behavior and fire effects of the next fire. The possibility of a reburn is small on any site, but it is high over the landscape. Accumulations of large woody fuels can hold a smoldering fire on a site for extended periods. Heat from the large fuels in direct contact with the ground could have severe effects on soils. Potential for spotting and crown fires is greater where large woody fuels have accumulated (Brown *et al.* 2001, *unpublished*). A severe fire occurrence in the next several decades would depend on amount of fuels present, vegetation development, point of ignition, and weather. Based on Brown’s paper, potential spread of a future fire in the areas that burned in 2000 at a moderate to high severity are described as follows.

0 to 10 years after 2000 fires – Severe fire is unlikely because large woody fuels would still be accumulating and there would not be enough decay to support prolonged smoldering combustion.

10 to 30 years after 2000 fires – Most of the large woody fuels would have fallen down, with some decay to support prolonged burning. A duff layer would not be well established. High severity burns would primarily occur where large woody material was lying on or close to the ground. High severity burns could be substantial where a large portion of the soil surface was directly overlain by large woody pieces.

30 to 60 years after 2000 fires – Large woody fuels would have considerable rot; a duff layer may be well established depending on the amount of overstory conifer. More severe burning is possible, depending on extent of soil coverage by large woody pieces. If a conifer overstory is present, crowning and burnout of the duff could amplify the burn severity.

The Moose Fire area would resist fire growth and spread in the short-term until there is enough vegetation to carry and sustain fire into the larger dead downed fuels that have and would continue to accumulate on the ground (refer to Direct and Indirect Effects Alternative 1- No Action above for additional discussion). It would take over 30 years for a duff layer to become established in areas that burned with moderate to high severity (Brown *et al*. 2001, *unpublished*). Fine fuels would increase as shrubs and grasses resprout and new seedlings become established. Snags would begin to fall, with the majority being on the ground in the next 10 to 30 years. Fire hazard and resistance to control reach high ratings when large woody fuels exceed 25 to 30 tons per acre, in combination with small, woody fuels of five tons/acre or more (*Ibid*).

Fire behavior is the manner in which a fire reacts to the influences of fuel, weather and topography (Glossary of Wildland Fire Terminology 1996). Forest fuel is combustible material or organic matter that could burn if ignited (Brown 1983). Fuels contribute to the rate of spread of a fire, the intensity of the fire, how long a fire is held over in an area, flame length, and the size of the burned area (Rothermel 1983). Removal of fuels helps to reduce or retard wildfire spread and severity (Pollet and Omi 1999). Fuels are broken into 3 categories: fine fuels (such as grass or forbs), small woody fuels less than three inches in diameter, and large woody fuels greater than three inches in diameter. Fine fuels carry the ignition. Small woody fuels can lose their moisture faster, start easier, and burn more readily (Agee 1993) influencing a fire's rate of spread and intensity. Large woody fuels contribute to development of large fires and high fire intensity (Brown *et al.* 2001). Fire hazard and resistance to control are highest when large woody fuels exceed 25 to 30 tons per acre with small woody fuels of five tons per acre or more (*Ibid*).

Fire behavior is affected by fuel characteristics such as forest density, species composition, amount of surface fuel, arrangement of fuels, and fuel moisture content (Rothermel 1983). Fuels are the only element affecting fire behavior that can be controlled. Fuel management modifies fire behavior, ameliorates fire effects, and reduces fire suppression costs and danger (DeBano *et al.* 1998). Fuel management includes: reducing the loading of available fuels, converting fuels to those with a lower flammability, or isolating or breaking up large continuous bodies of fuels (*Ibid*).

Beschta *et al.* (1995) states that "We are aware of no evidence supporting the contention that leaving large dead woody material significantly increases the probability of a reburn." We agree with the authors of the Beschta Report that the amount of fuel does not affect the probability of reburn or wildland fire ignitions in general. The meteorological and physical processes that generate lightning, and the human behavior that leads to human-caused fires determine the probability of ignition. The purpose and need of the fuel reduction portions of the Moose Post Fire project proposal is not to reduce the probability of ignition or the occurrence of future fires. Rather, it is to reduce the intensity and severity of future fires, when they inevitably occur, by reducing the amount of dead vegetation that would fall to the ground and accumulate over time. There is abundant scientific evidence that increased fuel loads can result in increased fire intensity and severity (DeBano *et al.*1998, Omi & Martinson 2002, Rothermel 1983, Arno & Brown 1991, etc.). In other words, given the same weather and topographic conditions, areas with higher fuel loads would release more energy (burn hotter), exhibit longer flame lengths, have greater potential to convert to crown fires, be more difficult to contain, pose greater risks to firefighters, kill more vegetation, and damage soils more severely than areas with lower fuel loads. In addition, there is clear scientific evidence and abundant experience demonstrating large continuous areas of relatively high fuel loads are more likely to result in larger fires than areas where the spatial arrangement of high fuel loads is discontinuous.

As stated in the Beschta document, the degree of alteration of fire regimes varies across the landscape. Moist forest types (low frequency-high intensity fire regime), such those found in Big Creek, have been less altered through fire suppression activities than dry pine forests (high frequency-low severity fire regime) (Agee 1994).

Escaped Prescribed Fire

No prescribed fire would occur under the no action alternative, therefore there would be no risk of escape.

Effects Common to All Action Alternatives

The direct effects of the alternatives differ primarily in the acreage treated, where fuel loadings will be reduced, as described in Table 3-31. Specific differences in Alternative 4 are addressed below.

Table 3-31: Effective Fuel Reductions by Alternative

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Salvage Areas	0 acres	3024 acres	2704 acres	2147 acres	3024 acres
Fuel Reduction Treatment Areas	0 acres	235 acres	235 acres	196 acres	235 acres
Total Treatment	**0 acres**	**3259 acres**	**2939 acres**	**2343 acres**	**3239 acres**

Fuel loadings will be reduced to approximately 10-30 tons per acre in the salvage units. A maximum of 15 tons/acre will be left in the Fuel Reduction treatment areas.

The landscape level risk of large wildfire within the Moose Fire project area would increase over time as vegetation continues to fill in the burned area.

Fuel Conditions and Fire Behavior

All of the action alternatives would have an effect on fuel conditions and fire behavior within the Moose Fire area. Salvage logging under Alternatives 2, 3, 4, and 5 would reduce the standing dead and eventual downed slash within the treated areas. This would change the potential fire behavior in the short term, reducing the fire intensity and severity within the salvage harvest units relative to similar untreated stands. Fuels left on the proposed salvage harvest units would be within Forest Plan guidelines for retention of coarse woody debris (10-15 tons per acre).

Treatment of the fuel reduction areas would affect the fire behavior in the immediate vicinity of private property and admin sites. Slashing and/or harvesting and piling the dead standing trees would dramatically reduce the current and future downed fuels. The fuels reduction treatments would modify the fuels so the primary fire carrier is the light grass, brush and shrub fuels, not the whole profile including dead down fuels. This change in fuel conditions reduces the fire intensity and severity, but lighter fuels can increase the rate of spread. This is because opening up the canopy allows more sun and wind into the lower layers of the forest, increasing fuel temperatures and decreasing humidity, drying out the lighter fuels. However, it would improve the probability of suppressing a fire, as suppression resources can be very effective on rapidly moving, low intensity fires. Fuel management modifies fire behavior, ameliorates fire effects and reduces fire suppression costs and danger (DeBano 1998). Fuel management includes reducing the loading of available fuels, converting fuels to those with a lower flammability or isolating or breaking up large continuous bodies of fuels (*Ibid*).

While fire behavior would be modified in fuel treatment and salvage units, none of the action alternatives would significantly modify landscape level fire behavior. Treated areas may provide safe locations to anchor future fire suppression efforts and reduce the potential spread to private property adjacent to fuel treatment areas.

There is no support in the scientific literature that the probability for reburn is greater in post-fire tree retention areas than in salvage logged sites. The real question is not whether there is a greater probability for reburn, but if reburns occur would they be of greater intensity and more destructive to resources. The Beschta authors are correct that the intense reburn concept is not reported in the literature. It took time since fire suppression started (early 1900's) for forest tree density and cover to increase, and it took time for random ignitions to burn these altered sites (Entity Fire 1970, 107,000 acres; Dink Leman Fire 1989, 52,000 acres; Tee Fire 1994, 140,000 acres). Because of the timetables involved, the field-testing of the intense reburn concept started in the recent past and would continue into the future.

A precise evaluation of the effects of salvage logging and total tree retention on reburn fire intensity has not been accomplished. What is in the literature is that when dead and live tree biomass increase so does flame length, and fire line intensity (Rothermel 1983). The action alternatives would reduce dead tree biomass, which would reduce intensity and flame length in those areas treated. Fire intensity would be greater in untreated areas due to high amounts of dead biomass.

Wildland Fire Starts and Suppression

None of the alternatives have an influence on the time and place a natural fire may start. Wildland fire is a natural ongoing process whose time and location can never be precisely predicted by fire behavior science. Life, property, and resources are always at risk during wildland fire events. Human-caused fire is also unpredictable, but can be greatly diminished with ongoing educational fire prevention programs.

The risk of a large wildland fire threatening in the Moose Fire area would not be mitigated by the proposed action or its alternatives. The proposed action would reduce the fuel loadings, fuel continuity, and the availability of ladder fuels in the treated areas and would keep fire confined to the ground, reduce fire intensity, reduce firebrands, and afford a high probability of control through the use of engines, hand crews, and air tactical resources. Agee *et al.* (2000) state “Surface fuel management can limit fireline intensity and lower potential fire severity”.

The fuel reduction areas are designed to protect both private and government structures and improvements. A structure can be threatened by wildland fire in three ways: direct exposure from flames, radiated heat, and airborne firebrands. The treatments proposed are meant to decrease the probability that structures in the immediate area of the project are threatened from airborne firebrands. This would be of particular concern when viewing both long range and short range spotting potential of forested areas adjacent to developed areas.

The proposed treatment would also reduce direct exposure from flames and radiated heat, which can be done by creating a “defensible space” around a property or structure. This type of work was previously proposed in the Big Creek project, but was not implemented. Defensible space refers to that area between a structure and an oncoming wildfire, 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). This project proposes to treat stands burned by the Moose Fire. These stands would be managed to maintain fire resistant tree species, light surface fuels and no ladder fuels. This would provide a greater fuel reduction area and minimize the short range and long range spotting threat associated with those stands during wildland fire.

To reduce 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, threat from firebrands is greater the closer the fire is to the structures.

Reducing the threat from firebrands also involves using fire resistant building materials (particularly roofing materials) and providing a safe work environment for firefighters at the structure, in addition to the treatment of fuels within fire spotting distance of the structure. More in depth information on defensible space, building materials and the wildland/urban interface can be found at www.firewise.org.

All of the action alternatives would limit fire suppression vehicle access to portions of the Moose Fire area and surrounding National Forest System lands. Closing roads also minimizes the potential for person caused fires that may occur because of reduced travel along roadways. Early detection would continue to play a key role in preventing small fires from growing into large fires. The exception to this would be where fuel loadings are high due to fire exclusion or the fire regime. Access may be limited and may prevent rapid response time from ground personnel due to road closures. Where this becomes an issue, delivery of firefighting personnel would then be accomplished aerially with smokejumpers or helitack crews. Suppression costs during initial attack associated with aerial delivered personnel might be somewhat higher but may be more efficient and effective in limited access areas. In most instances response time to a fire is critical although rapid response may be secondary to environmental elements associated with fuel loadings, topographical features, and fire weather. These components play a very important role in fire behavior and fire growth and would determine what resources would be needed and how many.

None of the alternatives would affect firefighter safety during initial or extended attack. Firefighters are taught that escape routes and safety zones are dynamic based on their (the firefighters) location on the fire line. Escape routes are a short path through vegetation where access can be gained to safety zones in a matter of minutes. Safety zones are either natural (clean burn areas, rock areas or water) or human-made (constructed areas, clearcuts or roads) adjacent to the fire line. Safety zones must also be survivable without a fire shelter and be readily accessible.

Closing roads generally would not affect public safety. The precise location of a fire start cannot be predicted. Fire behavior of a start also cannot be predicted, because weather and fuels vary over time. If extreme fire conditions are predicted or exist restrictions and/or closures would be put into effect to limit public access to the forest. Generally, fire spread and intensity (based on typical fuels and weather within the Moose Fire area) would not impede exit access from a general fire area.

Escaped Prescribed Fire

There is a very low risk of escaped prescribed fire for all the action alternatives because the only burning prescribed involves machine piles, which are burned in late fall when soil and fuel moistures would prevent spread beyond the piles.

Direct and Indirect Effects Specific to Alternative 4

The effects of salvage logging would be slightly different in this alternative, due to the difference in treatment prescription. Additional snags and woody debris recruitment material would be retained in treated areas, thus retaining a greater dead fuel loading, and the potential for a greater downed dead fuel loading in comparison to the salvage prescription in other alternatives. Over time this would create potential for a slightly higher intensity fire, relative to other alternatives. This alternative treats 2493 acres with salvage logging.

This alternative treats 196 acres in fuel reduction areas adjacent to private property and the Big Creek Administrative Site. This alternative does not treat the Big Creek Campground. Not treating the fire-caused dead and down fuels may be a hazard to forest users of the campground caused by falling snags. The other areas proposed for treatment at the campground generally are dense stands of lodgepole pine, Douglas fir and spruce. Not treating these fuels would maintain a stagnant stand, susceptible to human-caused fire. Thinning trees within the area would open the stand, improve stand health, and reduce potential for a fire start to transition from the surface fuels into the ladder fuels and the crown. The risk of large wildfire within the Moose Fire project area would increase over time as vegetation continues to fill in the burned area.

Cumulative Effects

Cumulative Effects of Alternative 1

Change would occur as an inevitable and natural consequence of the working of ecosystem processes. The Moose Fire will begin immediately to re-vegetate beginning a natural succession eventually creating a forest much like the one that burned in 2001. The naturally occurring longer fire intervals and fire exclusion in combination with natural processes such as insect, disease and fire mortality, allow forests to grow and change through any existing stand structure diversity, typically leading to more uniform and more flammable conditions.

Over time, these natural increases in vegetation and downed woody debris increase the probability that any future fire would be a high intensity, lethal severity fire and involve large areas. The risk of this kind of wildland fire in the Moose Fire project area increases substantially over time under all Alternatives.

Cumulative Effects of Alternatives 2,3, 4 and 5

As with the no action alternative, change would occur as an inevitable and natural consequence of the working of ecosystem processes. Proposed treatments are of a scale that they would not substantially alter landscape level vegetation development over time, or the potential fire behavior when/if another fire occurs.

This project would modify fuels in key locations to protect private and government structures and improvement from a fire similar to Moose. The slashing and piling treatments would decrease the risk of a high intensity, lethal severity fire from occurring in the fuel reduction areas. Initial attack on any fire starts in those areas would likely be very effective. The risk of a fire escaping initial attack in these treated areas would be reduced.

4. Regulatory Framework and Consistency

All fuels and fire management activities considered in the action alternatives are consistent with direction in the Flathead Forest Plan Appendix G, Fire Management Direction, and the Federal Wildland and Prescribed Fire Management Policy.