relative to the timber offer and the number of road construction and reconstruction miles planned for the alternative.

Water and Soil Resources, Alternative 4 – The elimination of timber offered for commodity or stewardship purposes further reduces the likelihood of effects on water and soil resources described for Alternatives 1, 2, and 3. However, some slight chance exists for increases in large fire activity in inventoried roadless areas. Should additional large fires occur, some additional effects might be detectible within the burned area for all of the water and soil parameters. Some incremental effects may be detectible downstream from the burned area onto other lands on the national forests and grasslands, primarily from accelerated soil loss, landslide activity (where applicable) and resultant changes to sediment yields, channel morphology, and water quality. Loss of vegetative cover may also elevate water yields and flood flows downstream off national forests and grasslands onto other ownerships. Increased BAER activity would be needed to minimize the effects on on-site and downstream resources, health, safety, and property.

Air Resources, Alternative 1 – Impacts on air quality from road construction, use, and timber sale activity would be detectable in inventoried roadless areas and adjacent national forests and grasslands. Poor air quality entering some Class I areas from non-national forests lands may make identification of effects difficult. Incremental additions to global climate change and carbon sequestration would not be detectable.

Air Resources, Alternative 2 – Substantial reductions in road construction and reconstruction and related timber harvest will result in reduced opportunities for an incremental change to air quality beyond the NFS lands level. Emissions from outside sources will make it difficult to detect impacts from the activities in inventoried roadless areas. Incremental additions to global climate change and carbon sequestration would not be detectable.

Air Resources, Alternative 3 – Further reduction in timber harvest levels decrease the likelihood of activities in inventoried roadless areas producing detectible impacts to air quality in inventoried roadless areas, on the surrounding national forest, or off the forest or grassland. Incremental additions to global climate change and carbon sequestration would not be detectable.

Air Resources, Alternative 4 – The slightly increased likelihood of large fires elevates the probability of smoke from wildland fires affecting air resources on-site in inventoried roadless areas as well as in the surrounding forest and off NFS lands. Incremental additions to global climate change and carbon sequestration would not be detectable.

Forest Health and Fire Ecology

Approximately one-third (747 million acres) of the total land area of the United States is covered by forest vegetation (USDA Forest Service 1999j). National forests account for 147 million acres of those forested lands. Forest health is the perceived condition of these forests based on age, **structure**, **composition**, function, vigor, level of insects or disease,

presence or absence of exotic organisms, and resilience to disturbance including wildland fire. Perception and interpretation of forest health are influenced by individual and cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of the stands that comprise the forest, and the appearance of the forest at a point in time (Helms 1998).

Diseases, insects, and abiotic agents, such as fire, wind, and drought, are the major natural disturbance agents that change forest ecosystems; anthropogenic air pollution also strongly influences forests (Edmonds and others 2000). Fire, wind, insects, and diseases strongly interact. For example, disease or insect killed trees are subject to fire, diseased trees may be windthrown or attacked by insects, and blown down or wind damaged trees may be susceptible to insects, diseases, and fire. These agents have always influenced natural forests, but in the past century, their patterns and influences have been changed by forest management practices including forest cutting and fire suppression.

Fire is an important ecological process in most ecosystems across North America. Before European settlement, fire occurred with characteristic patterns of frequency and severity that were controlled by climate, ecosystem conditions, and Native American burning. Human land use patterns since the late 19th Century, changes in climate, and organized fire suppression have resulted in alterations in fire regimes and in vegetative structure.

The concept of the "historic range of variability" helps us to understand how fire has determined the composition, structure, and function of vegetation over time, how wildland fire patterns have been altered by humans during the 19th and 20th Centuries, and when current fire patterns are characteristic or uncharacteristic of the system (Veblen and others 2000).

In the Sierra Nevada, the commonly expected consequences of decades of fire suppression—that large, infrequent fires are becoming larger and small, frequent fires smaller—is generally not confirmed by records for the 20th Century for Sierra forests (Sierra Nevada Ecosystem Project 1996). Some researchers have concluded that 20th Century attempts to exclude fire as a process have probably had little effect in forest types where natural fire intervals were long and where fire was historically stand-replacing (Brown 2000). However, in the Interior Columbia River Basin, assessment teams concluded that over all forest types, fires have become less frequent and more intense and **fire severity** has shifted from non-lethal to lethal (Hann and others 1997).

Factors Regulating Fire – Although there is conflicting evidence, wildland fires are generally considered to be increasing in size and severity since the first half of the 20th Century (Hann and others 1997; Sierra Nevada Ecosystem Project 1996; Swetnam 2000). Factors influencing fire regime, fire behavior, and fire ecology include the source and timing of ignition, fuel volumes and conditions, local weather, and climate. An understanding of the ecological consequences of fire, the risk of fire, and the implications to inventoried roadless areas involves sorting out the relative importance of these factors.

Human Ignitions – A potential factor in the increase in fire size and severity may be related to increased incidence of human-caused ignition. Human access is likely to be

increased by roads, a factor that will greatly increase the chances of both accidental and intentional human ignitions. These human ignitions may be an important source of ignition in many forests (Aber and others 2000). In an analysis of 20th Century fire patterns, the location of multiple-burn sites indicated that they were associated with busy roads (McKelvey and Busse 1996). The scientific assessments of the Interior Columbia River Basin also point out an increased probability of human-caused fire in roaded areas (Hann and others 1997). Further, while these assessments revealed that disturbance regimes were altered throughout the landscape, unroaded areas are among the least altered by management (Quigley and others 1996).

Changes in Fuels – Fire exclusion, forest management practices, and generally warmer and moister climatic conditions (Swetnam 2000) all contribute to altered stand structures and uncharacteristically high fuel accumulations in some ecosystems. In the Sierra Nevada, fire suppression and selective harvesting practices have produced forests that are denser, with generally smaller trees and more brush, and with higher proportions of certain species than were present historically. These increases in fuel have been associated with an increase in general fire severity (McKelvey and others 1996; Skinner and Chang 1996). In the Interior Columbia River Basin, model projections indicate that fire regimes have shifted, resulting in a 17% increase in lethal fires, a 3% decrease in mixed regimes, and a 22% decrease in non-lethal regimes. The increase in lethal fires is associated with altered stand and landscape conditions and fuel accumulations (Hann and others 1997).

Ecological Consequences – Fire exclusion has substantially altered the patterns of stand development, **succession** and disturbance regimes in systems formerly driven by frequent, low intensity fire. However, systems historically characterized by infrequent stand-replacing fire that operated at time scales of centuries are minimally affected. In these long-interval systems, current structures and patterns may be an expected result of the natural course of ecosystem change. Landscape and ecosystem patterns that are consistent with historical patterns are generally considered more resilient to natural and human-caused disturbances (Holling and Meffe 1996).

Fire Effects on Watersheds – Fire can have a wide array of effects on watersheds, ranging from very subtle to extreme and dramatic. The degree of effect depends on a variety of factors including physical site (slope, aspect, elevation, soil type, soil moisture content, humus and litter type and depth), vegetation (type, density, canopy levels), fuel (live vs. dead volume, arrangement, moisture content), and weather (wind speed and direction, relative humidity, temperature). These factors also determine the intensity of the fire (the amount and rate of surface fuel consumption, commonly reflected in flame length) and severity of the fire (a measure of the effects of the fire on ecosystem components, such as water, soil, vegetation, habitat). Intensity is a good measure of fire behavior, but it is a poor measure of fire effects on watershed resources. For example, a very intense fire moving quickly over a site may burn the aboveground fuel. However, this type of fire may remove little of the soil litter and humus component in a scattered **mosaic** pattern. A less intense fire may burn for an extended period over a large area, removing virtually all above-ground fuel and litter and humus layers, thereby, exposing bare mineral soil and

altering soil structural properties. Severity is the preferred measure to address the effects of fire on watershed resources.

While managers describe fires in two general categories (prescribed and wildland fire), the effects of fire on ecosystem resources is actually a continuum from very subtle effects to extreme effects. Some wildland fires can burn at low intensity and severity over large areas with few effects, while others burn at high intensity and severity with devastating effects. Some prescribed fires burn with few watershed effects, while others can cause serious disturbance over a portion of the burned area. In general, prescribed fires burn within carefully described conditions (fuel loads, fuel moisture, wind speed, fuel breaks or barriers), while wildland fires have no such constraints. Therefore, prescribed fires generally have fewer watershed effects, while wildland fires have greater impact.

Fire effects can be generally described in two categories: 1) on-site, and 2) downstream. Several authors have compiled excellent reviews of these effects (Tiedemann and others 1979; Wells and others 1979; Baker 1988; DeBano and others 1998). The following paragraphs highlight some of the known effects. The degree of these effects depends largely on the severity and extent of the fire at a watershed or multiple-watershed scale. Small fires with low severity will have few of these effects. Large fires over extensive areas may have many of these effects.

On-site effects:

- Precipitation interception – Fire consumes vegetation that normally intercepts rainfall, before it affects the ground and detaches soil particles, which results in surface erosion and eventual sedimentation.
- Transpiration – Fire can consume vegetation, reducing transpiration of water and make more water available for entry into soils or for runoff.
- Infiltration and overland flow – Fire burns the litter and humus layers of the soil, ash seals soil pores, chemical reactions make soils resistant to water entry (hydrophobic), which can result in water flowing across the soil rather than into it.
- Soil water storage – Water fails to enter the soil, reducing its capacity to store water for later use and increasing flow over the soil surface.
- Snowmelt and accumulation – Openings created by fire can increase snow accumulation on the surface and may increase the rate of spring melt.
- Surface erosion – Water running across exposed soil surface causes sheet, rill, and gully erosion.
- Landslides – In parts of the nation with high landslide risk, loss of ground cover and root strength can increase the number and size of landslides.

Downstream effects:

- Flow effects – Increased overland flow can increase flood flows in the elevation of the flood peak and in total volume of flow. Annual flow volumes may also increase if a large portion of a watershed is burned.
- Sediment – Sediment can be generated from surface erosion, and landslides can move great distances downstream, filling channels, floodplains, lakes, and wetlands, and damaging structures such as bridges, roads, and homes.

- Channel effects – Channels may fill with sediment, causing water to quickly overflow banks. Excess water may erode streambeds and banks or change channel shape.
- Chemical water quality – Fire can increase nutrients, such as nitrogen, in stream water, as well as phosphorous, potassium, calcium, magnesium, and other elements and chemicals.

The cumulative effects of fire on watershed are included in the discussion of the cumulative effects of the physical resources.

Fuel Management

The practice of fuel management incorporates the evaluation, planning, and implementation of treatments to restore and maintain forest and rangeland disturbance regimes and landscape patterns that contribute to sustainable ecosystems.

Primary objectives of fuel management are:

- Restore and improve ecosystem health through vegetation management, and
- Reduce the risk from uncharacteristic wildfire effects.

Healthy ecosystems have diverse and sustainable components and processes at the appropriate landscape scale. These include plant, wildlife, and aquatic species populations and habitat; watershed conditions (air, soil, water); human land uses; vegetation composition and structure; and disturbance (fire, insect/disease, grazing) regimes. Restoring fire as an ecological process in **fire-adapted ecosystems** can positively affect ecosystem health. Managing vegetation and fuel in areas where fire has been excluded will reduce the risk from uncharacteristic wildfire effects.

The assessment of fuel and vegetation treatments, including mechanical and hand **thinning**, prescribed fire and **wildland fire use**, to accomplish these results is an important consideration inside inventoried roadless areas.

Literally millions of acres of national forests are currently outside their historical fire regimes. Because of the cumulative effects of past wildland fire suppression, they have not experienced the natural occurrence of fire for years, sometimes decades, and past logging and grazing have added to this departure from the natural regime. This condition occurs most notably in the fire-adapted dry forests and associated rangelands of the Western United States where ecosystems historically experienced frequent, but low intensity, fires. Researchers confirm that forests and rangelands at most risk today developed under a historic cycle of high frequency, low-intensity wildland fire (Clark and Sampson 1995; Agee 1994; Mutch 1994; Hann 1997).

In the absence of natural fires, many of these lands have become overgrown with shrubs and smaller diameter trees creating a fuel profile that acts as a “fire ladder” to the crowns of the dominant overstory trees. The accumulation of **fine fuel**--dead needles, grass, and sticks on the forest floor--also contributes to increased fire spread. Many rangeland areas that were maintained in grass and shrub mosaics are now dominated by woody species that have shaded out the herbaceous cover that historically protected the soil from

erosion. These conditions diminish ecosystem vigor and resiliency, and increase the potential for unnatural, large fire outside the historical range of variability. Indeed, many wildland fires now occurring in Western ponderosa pine forests and associated rangelands are "larger, hotter, more lethal to vegetation, more damaging to top soils, and exceptionally dangerous to human settlement and property" (Clark and Sampson 1995).

Highlighting the need for fuel management, a recent U.S. General Accounting Office report (*Western National Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildland Fire Threats [GAO/RCED-99-65]*) concluded that:

> *"The most extensive and serious problem related to the health of national forests in the interior West is the over-accumulation of vegetation. This accumulation has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildland fires. These fires not only compromise the forests' ability to provide timber, outdoor recreation, clean water, and other resources, but they also pose increasingly grave risks to human health, safety, property, and infrastructure."*

Awareness of this fuel management issue is longstanding. This over-accumulation of fuel has also been a primary concern in recent regional environmental analyses.

> *"Wildland fire suppression activities, aided by improved technology for fire detection, prevention, and suppression, were generally successful in reducing the extent of wildland fires from the 1910s through 1960s. Fuel loadings have steadily increased as a result of suppression efforts and fire frequencies have declined (Agee 1993). As a result, fire size, intensity, and severity have increased…"*
>
> *Interior Columbia Basin Ecosystem Management Project Supplemental Draft Environmental Impact Statement*
> *March 2000*

> *"Current management strategies and those of the immediate past have contributed to forest conditions that encourage high-severity fires. The policy of excluding all fires has been successful in generally eliminating fires of low to moderate severity as a significant ecological process. However, current technology is not capable of eliminating the high-severity fires. Thus, the fires that affect significant portions of the landscape, which once varied considerably in severity, are now almost exclusively high-severity, large, stand-replacing fires."*
>
> *Sierra Nevada Forest Plan Amendment Draft Environmental Impact Statement*
> *April 2000*

> *"[The fires of 2000] reflect a longer-term disruption in the natural fire cycle that has increased the risk of catastrophic fires in our forests and rangelands… . Wildfires are on a pace to break decades-old records. …The intensity of this year's fires is the result of two primary factors: a severe drought accompanied by a series of storms that produced millions*

of lightning strikes and windy conditions, and the long-term effects of more than a century of aggressively suppressing all wildfires, which has led to an unnatural buildup of brush and small tress in our forest and rangelands."

Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000
September 8, 2000

Affected Environment

This over riding concept frames all of the fuel management effects analysis: in inventoried roadless areas, very little **fire hazard** reduction work has occurred in the past and little work is planned for the future. Regardless of whether there is a prohibition on road construction and reconstruction or a prohibition on timber harvest in inventoried roadless areas, the highest priorities for fuel management work will continue to be on NFS lands outside of roadless areas where natural resource values or potential threats to human communities are the highest. This point has been validated in two recent government reports. The first document, a Report to the President titled *Managing the Impact of Wildfires on Communities and the Environment* (White House 2000), notes that a top priority for reducing wildland fire risk is to reduce fuels in forests and rangelands adjacent to, and within communities. The second report, *Protecting People and Sustaining Resources in Fire-Adapted Ecosystems: A Cohesive Strategy* (Laverty and Williams 2000), addresses the need to restore roaded and managed landscapes in close proximity to communities. Specific Cohesive Strategy priorities are:

- Wildland-urban interface,
- Readily accessible municipal watersheds,
- Threatened and endangered species habitat, and
- Maintenance of existing low-risk Condition Class 1 areas.

Even though the majority of fuel management work is expected to occur outside inventoried roadless areas, if there was a threat to human life or property, threatened or endangered species, or community or domestic watersheds from a hazardous fuel situation in inventoried roadless areas, then agency personnel, working at the local level, could choose to work in these areas.

In the fuel management effects analysis that follows, it is assumed that fire hazard reduction work would not begin in inventoried roadless areas for at least 20 years, the estimated time it would take to address the extremely hazardous fuel situations outside roadless areas. (Some agency personnel think the 20-year timeframe is overly optimistic, and that it would take a much longer period to correct the hazardous fuel situations in roaded landscapes.) The fuel management effects described in the following analysis pertain only to situations where fuel reduction work is potentially expected to be completed in inventoried roadless areas.

The fuel management trend analysis in the FEIS was based upon NFS fire occurrence data (see Fire Suppression section) and the following sources of information, strategic direction, and geographic information system mapping products:

- Coarse-scale fire regime and condition class assessment
- National fuel management restoration strategy
- Wildland-urban interface demographics
- Historical fuel management treatment costs

Coarse-Scale Fire Regime and Condition Class Assessment – A national fire regime-mapping process and coarse-scale assessment has identified acres at potential risk from uncharacteristic wildland fire effects (*Coarse-Scale Assessments for Wildland Fuel and Management*, Hardy, Bunnell, Menakis, Schmidt, and Long 1999). The coarse-scale data used in this analysis were developed for national-level planning. Summaries of the data were restricted to State or Forest Service regional scales. The data were not intended to be used at finer spatial scales.

The assessment developed three condition classes and five fire regime groups to categorize and describe vegetation composition and structure conditions that currently exist. They serve as generalized rankings – based on coarse-scale data – to be used only as approximations for strategic planning purposes at national, State, or regional scales. These fire regime groups and condition classes are shown in Tables 3-11 and 3-12, respectively.

Table 3-11. Fire regime grouping based on coarse-scale data.

Fire regime group	Frequency	Severity
I	0-35 years	Low severity
II	0-35 years	Stand replacement severity
III	35-100+ years	Mixed severity
IV	35-100+ years	Stand replacement severity
V	> 200 years	Stand replacement severity

(Hardy and others 2000)

A fire regime is a description of how fire functions as a process within an ecosystem. Fire regimes are characterized by **fire frequency**, predictability, seasonality, intensity, duration, and scale. Five combinations of fire frequency, which are based on **fire return interval** and fire severity, served as the basis for the five Fire Regimes in the *Coarse-Scale Assessment*.

Of the five Fire Regimes, Fire Regimes I and II demonstrate the most significant departure from historical fire occurrence. Fire Regime I includes western dry, pine forests and other long-needle pine species, as well as dry-site Douglas fir. Fire Regime II includes the drier grassland types, tall grass prairie, some chaparral ecosystems, and mountain brush communities. Generally these fire regimes occur in lower to mid-

elevation forest and rangelands types where people tend to dwell, and when not maintained in their natural condition, comprise the greatest risk to human health and safety, as well as potential loss of property, highly valued resources, and commodity interests.

Fire exclusion has substantially altered the patterns of stand development, succession and disturbance regimes in Fire Regimes I and II. Systems operating at longer time scales, characterized by mixed severity and less frequent stand-replacing fire (Fire Regimes III-V), have been less affected. Large, stand-replacing fires will still occur in these fire regimes.

The analysis for the FEIS also focuses on the three condition classes identified in the *Coarse Scale Assessment*. Condition class categorizes the current condition within each of the five fire regimes. Current condition defines the departure from the historic disturbance regime and the resulting vegetative structure and composition.

A qualitative risk ranking is assigned to each condition class – low, moderate, high. The chance of losing key ecosystem components in a wildland fire increases from **Condition Class 1** (lowest risk) to **Condition Class 3** (highest risk) as described in Table 3-12. The description of condition class "risk" (used to classify and rank the three condition classes) is not the probability of a fire occurring. Instead, it refers to the potential harmful effects to key ecosystem components and human communities that are occurring because of altered vegetation composition and structure and to the uncharacteristic wildfire effects that can occur once a wildland fire ignites and burns.

Figure 3-20 shows changes in fuel profile and vegetation composition and structure that have typically occurred in the dry, pine forests of the West. Grasslands, brushlands, and other vegetation types found throughout NFS lands have experienced similar changes in condition class resulting from changes in management emphasis or exclusion of fire. The sequence of photographs in Figure 3-20, taken in 1909, 1929, and 1980, shows how condition class changes from a low to a high rating. The 1909 photograph, representing Condition Class I, shows a ponderosa pine forest at the Fort Valley Experiment Station near Flagstaff, AZ. Regularly occurring forest fires would have kept this forest at a low risk from uncharacteristic wildland fire effects, but after years of fire exclusion, this forest became densely populated with small diameter trees. As time passed, the fire hazard and condition class both rose. The dense tree stocking seen in the 1929 and 1980 photographs, representing Condition Classes 2 and 3, would require some mechanical pretreatment before prescribed fire could be applied.

On the 170 million acres of NFS lands outside of Alaska, for Fire Regimes I-V, 66 million acres can be described as low risk, 57 million acres as moderate risk, and 38 million acres as high risk (Table 3-13).

The condition class and fire regime databases were developed using biophysical data, environmental modeling, and the knowledge of regional fire ecology experts. The

Table 3-12. Condition classes based on vegetation composition and structure conditions.

Condition class	Interpretation
1 Low risk to ecosystem health and from uncharacteristic wildfire effects	Fire regimes are within historical range of variability for fire frequency and intensity. Vegetation composition and structure is largely intact and functioning. Forests and rangelands within this class can be maintained by regular application of prescribed fire, or wildland fire use, and do not need pretreatment. As used in this analysis, if a wildland fire occurs in Fire Regimes I and II, it is generally non-lethal to vegetation and non-threatening to people and communities. However, some Condition Class 1 lands in Fire Regimes III, IV, and V, could produce intense, stand-replacing fires.
2 Moderate risk to ecosystem health and from uncharacteristic wildfire effects	Fire regimes and associated vegetation composition and structure are moderately altered. One or more fire cycles may have been missed, allowing denser stocking of sapling trees, woodlands or shrubs. Wildland fires on these lands produce a mixed severity burn pattern. Fifty percent of these forests and rangelands may need pretreatment (thinning, chipping, hand piling, dozer piling, yarding, helicopter logging, mastication, mowing, and crushing of fuels) before prescribed burning. Some inventoried roadless areas may need pretreatment before being managed with prescribed fire or wildland fire use.
3 High risk to ecosystem health and from uncharacteristic wildfire effects	Fire regimes and associated vegetation composition and structure are substantially altered. Multiple fire cycles have been excluded, representing a dramatic departure from historical conditions. Forests and rangelands that were once open and park-like are now densely stocked with trees, closed woodlands, or shrubs. Nearly 100% of this condition class may need pretreatment, especially along the perimeters, before prescribed fire can be successfully used. Wildland fires would be of high severity, killing most of the vegetation, damaging key ecosystem components, and possibly posing direct threats to people and communities.

(Laverty and Williams 2000)

condition class and fire regime databases were also reviewed and validated by local experts. As such, these national databases are the most accurate spatial data of their kind ever prepared for the **contiguous** United States. When viewed for entire States or regions, the databases accurately portray patterns of condition class and fire regime as they exist on the ground.

There is uncertainty associated with whether an individual pixel in the geospatial map is fire Condition Class 1, 2, or 3. This attribute uncertainty is mostly due to the scientific judgment used to integrate the biological and ecological data sets used to prepare the fire condition map. The scale of data sets (1 kilometer) contributes less to the uncertainty than does the scientific judgment. The Agency has been unable to quantify the extent to which this uncertainty exists. The Agency has also been unable to identify if errors associated with the data may be correlated with whether an area is roaded or unroaded, and therefore, the Agency has not eliminated the possibility that the data may be biased in this way.

1909 Photo – Condition Class 1

Regularly occurring, low-intensity fires could maintain vegetative conditions similar to those shown here. Analysis of fire-scarred trees indicates that fire burned these forests at 2 to 20 year intervals. The fires were "hot" enough to restrict most encroaching vegetation, but "cool" enough to avoid killing most of the older-aged trees.

1929 Photo – Condition Class 2

By 1929, because fire had been excluded for 2 to 3 cycles, the forest began to reveal changes in species composition and structure. The site had a higher percentage of small trees.

1980 Photo – Condition Class 3

By 1980, the vegetative composition and structure has changed from what existed in 1909. Over this 71-year period, grasses and herbs on the forest floor were replaced by dense thickets of small trees in the understory. During drought periods, the overabundance of vegetation stresses the site, pre-disposing it to insect infestations, disease outbreaks, and severe wildland fire.

Figure 3-20. Photos taken at the same location over 71 years illustrate changes in condition class and vegetative structure due to wildfire exclusion.

(USDA Forest Service and Ecological Restoration Institue 2000; 1909 and 1929 photographs courtesy: G.A. Pearson; 1980 photograph courtesy: Frank Ronco)

Because of this uncertainty, the Agency acknowledges that this fire-condition class data should not be used at a scale finer than an entire State. The data cannot be relied on to portray an accurate picture of geographic areas smaller than a State. Map overlay using a geographic information system was the process used to compare inventoried roadless

Table 3-13. Acres (in millions) at risk from uncharacteristic wildfire effects for Condition Classes 1 through 3 in Fire Regimes I through V, excluding Alaska.

	Fire Regimes I-V				
	Condition Class 1 low risk	Condition Class 2 moderate risk	Condition Class 3 high risk	Other land cover	Total
All National Forest System lands	66	57	38	9	**170**
Inventoried roadless areas	19	14	8	2	**43**

(Roadless Database 2000)

areas and other NFS lands outside of inventoried roadless areas with respect to condition class and fire regime. The inventoried roadless areas are mapped at a finer scale as compared to the broad scale condition class and fire regime data. The national scale and resolution of the condition class and fire regime databases limit the minimum size of areas that can be compared. Taken together, however, the inventoried roadless areas are large enough to allow comparisons to be made using State and regional summaries. The geographic information system methods used for this analysis are consistent with other assessments that used multi-scale geospatial data (USDA Forest Service and USDI Bureau of Land Management 2000). A detailed discussion of coarse-scale data sets and analysis procedures is in the Fire Management Specialist Report, which is available for review at **roadless.fs.fed.us/**.

Figure 3-21 displays the same information for inventoried roadless areas as Table 3-13 (Condition Classes 1-3, Fire Regimes I-V) for each Forest Service region. As the bar chart illustrates, the highest risk from uncharacteristic wildland fire effects in inventoried roadless areas occurs in the Western United States. The following Western regions contain the most high-risk acreage: Region 6 (Oregon and Washington), Region 1 (Montana and northern Idaho), Region 4 (southern Idaho, Utah, Nevada, and a small portion of western Wyoming), and Region 5 (California).

National Fuel Management Restoration Strategy – The Forest Service has prepared a national strategy, “Protecting People and Sustaining Resources in Fire-Adapted Ecosystems: A Cohesive Strategy” (Laverty and Williams 2000), for protecting communities and restoring and maintaining ecosystem health by reducing the over-accumulation of fuel. The Cohesive Strategy tiers from the national Coarse-Scale Assessment and is a broad-scale analysis that will be refined as finer-scale national forest data become available.

Table 3-14 displays, by individual State, potential treatment acres within inventoried roadless area boundaries. Many States have no lands needing treatment. Further prioritization of treatments will occur at the forest level, commensurate with forest and rangeland sustainability, watershed protection, conservation of species diversity, protection of property, reduction of wildland fire costs, and public and firefighter safety. Unless an imminent threat to public safety, private property, water quality, or T&E

species exists, inventoried roadless areas would be a low priority for fuel treatment over the next 20 years, primarily because higher priority areas are more common outside of roadless areas.

Table 3-14 presents National Forest System fire condition class data in inventoried roadless areas by State. This data use is at a finer scale than what the *Coarse-Scale Fire Regime and Condition Class Assessment* suggests is appropriate. The Agency acknowledges that as the size of the analysis areas are reduced, the attribute uncertainty associated with the data increases. The uncertainty associated with the actual condition class that is associated with these small areas may be significant. The Agency has not quantified the extent of this uncertainty nor identified whether the results of this analysis may be biased due to a correlation between attribute error and if an area is roaded or unroaded.

Condition Classes 1, 2, and 3 and Fire Regimes I and II were identified in the Cohesive Strategy as areas for fuel and vegetation treatment. For the purposes of this FEIS, these same condition classes and fire regimes were assumed to be potential fuel treatment priorities within inventoried roadless areas. As pointed out earlier, Fire Regimes III-V were not considered potential treatment areas for purposes of this analysis.

Table 3-15 is a subset of the coarse-scale information presented in Table 3-13. This table categorizes acres of NFS lands and inventoried roadless areas by Condition Classes 1 through 3, but only Fire Regimes I and II, both derived from the *Coarse Scale Assessment.* Because of the extremely low fire hazard in the temperate rain forest of Alaska (Region 10), condition class information is not included in either Table 3-15 or Figure 3-21.

Figure 3-21 displays the risk information by condition class, under all fire regimes, for inventoried roadless areas in each Forest Service region. As the bar chart illustrates, the greatest number of acres at risk from wildland fires within inventoried roadless areas occurs in the Western United States (Regions 1-6).

Condition Class 1, Low Risk to Ecosystem Health and from Uncharacteristic Wildfire Effects – Approximately 19 million acres of inventoried roadless areas are at low risk of experiencing uncharacteristic wildfire effects. 16 million of those acres are located at mid to high elevations in Fire Regimes III-V.

The remaining 3 million acres, in Fire Regimes I and II, are classified as potentially needing fuel treatment. Even though forest and shrublands within Condition Class 1 are rated at low risk to ecosystem health from wildland fire, they still require regular application of prescribed fire to remain at low risk. Of those 3 million acres, 556,000 acres are located in the East (Regions 8 and 9) and 2.45 million acres are located in the West (Regions 1-6.).

Condition Class 2, Moderate Risk to Ecosystem Health and from Uncharacteristic Wildfire Effects – Approximately 14 million acres of total inventoried roadless areas are at moderate risk of losing key ecosystem components from uncharacteristic wildfire

Table 3-14. Potential treatment areas, in thousands of acres, by State. States without National Forest System lands are not included.

			Fire Regimes I and II			
						Condition Classes 1, 2, 3
States	National Forest System lands total acres	Inventoried roadless areas total acres	Condition Class 1 low risk Acres	Condition Class 2 med risk Acres	Condition Class 3 high risk Acres	Percent of total inventoried roadless areas
AL	665	13	1	11	1	100
AZ	11,255	1,174	67	792	108	82
AR	2,586	95	71	14	7	97
CA	20,698	4,416	484	534	879	43
CO	14,509	4,433	34	598	554	27
FL	1,153	50	47	0	0	94
GA	865	63	29	29	4	98
ID	20,458	9,322	291	690	77	11
MO	1,493	25	21	1	2	96
MT	16,893	6,397	49	224	90	6
NV	5,833	3,186	551	1,074	483	66
NM	9,327	1,597	182	779	358	83
NC	1,244	172	105	55	6	97
ND	1,106	266	192	0	0	72
OK	397	13	2	11	0	100
OR	15,658	1,965	74	299	428	41
SD	2,012	80	22	53	5	100
TN	698	85	54	18	9	95
UT	8,179	4,013	477	1,119	247	46
VA	1,660	394	200	92	44	85
WA	9,214	2,015	12	250	345	30
WV	1,033	202	8	46	44	49
WY	9,238	3,257	16	115	7	4
Aggre-gate[a]	5,285	69	16	12	17	0.65
Total	**161,459**	**43,302**	**3,000[b]**	**7,000[b]**	**4,000[b]**	**31**

[a] Aggregate is composed of the following States: IL, IN, KY, LA, MS, NE, PA, TX, and SC with 10,000 acres or less of Condition Class 1 through 3 lands.
[b] Rounded to nearest million acres.
(Roadless Database 2000)

effects. Because wildland fire has been excluded in these forests for years, they reveal changes in species composition and structure. Vegetation is now denser in these forests and rangelands with fewer large trees, more small trees, and fuels that are more continuous. When a wildland fire occurs, it kills a majority of the smaller trees and occasionally burns into the crowns of the larger trees, also killing them.

Nearly 7 million acres have been identified as potentially needing treatment. Of the 7 million acres, 294,000 acres are located in the East (Regions 8 and 9) and 6.7 million acres are located in the West (Regions 1-6).

Table 3-15. Potential treatment acres (in millions) for Condition Classes 1 through 3 in Fire Regimes I and II on all National Forest System lands and in inventoried roadless areas, excluding Alaska.

	Fire Regimes I and II			
	Condition Class 1 low risk	**Condition Class 2 moderate risk**	**Condition Class 3 high risk**	**Total**
All National Forest System lands	22	38	29	**89**
Inventoried roadless areas	3	7	4	**14**

(Hardy and others, 2000, Roadless Database 2000)

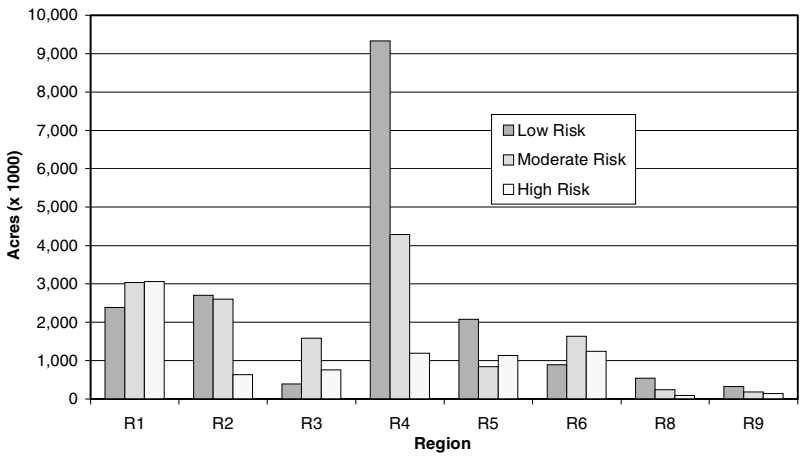

Figure 3-21. Potential risk from uncharacteristic wildland fire effects for inventoried roadless areas by Forest Service region [a] in Condition Classes 1-3 and Fire Regimes I-V.

(Hardy and others 2000, Roadless Database 2000)
[a] Because of the extremely low fire hazard in the temperate rain forest of Alaska (Region 10), condition class information is not included.

Condition Class 3, High Risk to Ecosystem Health and from Uncharacteristic Wildfire Effects – Approximately 8 million acres of inventoried roadless areas are at high risk of losing key ecosystem components. These forests and rangelands are overgrown and increasing in density. Because of this overabundance of vegetation, wildland fire can quickly move from the ground to the crowns of the larger trees, contributing to severe, high-intensity fires that result in complete overstory mortality. These "hot" wildland fires damage key ecosystem components, including the soil. In these forests and rangelands, a fire would be difficult to control. Of the 8 million acres rated at high risk, nearly 4 million acres are identified as potentially needing treatment. Of these 4 million acres of high priority treatment, 428,000 acres are in the East (Regions 8 and 9) and 3.5 million acres are located in the West (Regions 1-6).

While some Eastern and Southern forests are at moderate to high risk of losing key ecosystem components, from wildfires, fuel hazard in these geographical areas is not as

widespread as in the West. On these lands, prescribed burning can usually be accomplished without **mechanical pretreatment**. The goal for fuel treatment in these regions is to maintain ecosystems in the low risk classification. Specifically, the Eastern (R-9) and Southern (R-8) regions generally have more low-risk areas than other regions. There are isolated exceptions though. For example, adjacent to the Boundary Waters Canoe Area Wilderness (R-9), 6,000 acres of a 477,000-acre blowdown occur in inventoried roadless areas posing a serious fire hazard.

Even though Alaska has minimal fire hazard and major fuel management work is not planned, it should be noted that on Alaska's Kenai Peninsula on the Chugach National Forest, a spruce bark beetle epidemic has created 112,000 acres of forest that could burn in a severe wildland fire. Approximately 92,000 acres are in inventoried roadless areas

Wildland-Urban Interface Demographics – The wildland-urban interface demographics refer to the urban areas, dwellings, or other concentrations of people adjacent to NFS boundaries. For purposes of this analysis, the wildland-urban interface was classified into five categories based on **ambient population densities** near inventoried roadless area boundaries:

- Wildland – 0 to less than 2.6 people per square mile (e.g., Loma, ND and Boulder, UT)
- Rural – 2.6 to less than 26 people per square mile (e.g., Marysvale, UT and Owyhee, NV)
- Rural/Urban - 26 to less than 260 people per square mile (e.g., Cohutta, GA and Neihart, MT).
- Suburban - 260 to less than 1,300 people per square mile (e.g., Blackduck, MN and McCall, ID)
- Urban – 1,300 or more people per square mile (e.g., Missoula, MT and Bishop, CA).

Ambient population density class distributions for each Forest Service region were created by first placing both 1- and 5-mile buffer zones around each inventoried roadless area. Figure 3-22 shows how the 1- and 5-mile buffer zones were spatially mapped near Tucson, Arizona. A similar map was produced for each inventoried roadless area.

After the buffer zones were created, an ambient population density map was placed over them, producing the density class distributions shown in Tables 3-16 and 3-17. The information in Tables 3-16 and 3-17 does not locate each density class to a specific geographic area. Instead, these tables show the proportion of the total land area for each of the five population density classes (wildland, rural, rural/urban, suburban, and urban) compared to the total land area in each buffer zone. These proportions are expressed as percentages for each Forest Service region.

As expected, in most regions the ambient population density within 1- to 5-miles of inventoried roadless areas is very low, in fact, the ambient population density is less than 1%. Exceptions occur in the Southern and Eastern regions. In the Southern region, within the one-mile buffer zone, the rural ambient population density class becomes more prevalent (40% rural vs. 52% wildland) than in other regions. A similar pattern occurs in the Eastern region, with more than 22% in the rural ambient population density class and approximately 76% in the wildland class (Table 3-16).

Table 3-16. Percentage of land by ambient population density class within 1 mile of inventoried roadless area boundaries.

Region[a]	Wildland	Rural	Rural/Urban	Suburban	Urban
Northern (1)	98.0	1.8	0.3	0.0	0.0
Rocky Mountain (2)	93.7	4.7	1.6	0.1	0.0
Southwestern (3)	94.6	4.2	1.1	0.1	0.0
Intermountain (4)	96.0	2.7	0.9	0.2	0.1
Pacific Southwest (5)	88.8	8.6	2.3	0.2	0.0
Pacific Northwest (6)	94.3	5.1	0.6	0.0	0.0
Southern (8)	52.1	39.6	8.2	0.1	0.0
Eastern (9)	75.9	22.3	1.8	0.0	0.0
National average	**86.7**	**11.1**	**2.1**	**0.09**	**0.01**

[a] Region 10 is excluded because of the low fire occurrence on National Forest System lands in Alaska.
(U.S. Department of Energy 1998; Roadless Database 2000)

Table 3-17. Percentage of land by ambient population density class within 5 miles of inventoried roadless area boundaries. [a]

Region	Wildland	Rural	Rural/Urban	Suburban	Urban
Northern (1)	95.0	3.3	1.5	0.1	0.0
Rocky Mountain (2)	91.4	5.7	2.5	0.4	0.0
Southwestern (3)	91.6	5.2	2.5	0.5	0.1
Intermountain (4)	91.6	4.7	2.5	0.7	0.4
Pacific Southwest (5)	82.8	11.1	4.3	1.2	0.6
Pacific Northwest (6)	91.4	7.1	1.4	0.1	0.0
Southern (8)	38.1	42.0	18.1	1.7	0.1
Eastern (9)	65.9	29.0	5.0	0.2	0.0
National average	**81**	**13.5**	**4.7**	**0.6**	**0.2**

[a] Percent values are rounded to the nearest 1/10 and may exceed 100%.
(U.S. Department of Energy 1998; Roadless Database 2000)

Fuel Management Treatment Costs – The national budget for fuel management on NFS lands has averaged $60 million annually. Costs for individual fuel management projects can average from $15 to $150 per acre. If fuel treatment-reduction projects are located near high value areas, total treatment costs can range as high as $500 to $1800 per acre.

In 1999, 1.4 million acres of NFS lands received fuel treatments. Most of those acres were treated using prescribed fire, and 60% of the treated acres occurred in the Southern Region (R-8). The national average cost for using prescribed fire as a fuel treatment method was $43 per acre in 1999. The 7.5 million acres of high priority acres in inventoried roadless areas may require mechanical pretreatment to prepare a site for prescribed fire. Projected average costs to apply prescribed fire are expected to range from $176 to $276 per acre if mechanical pretreatment is required (Laverty and Williams 2000).

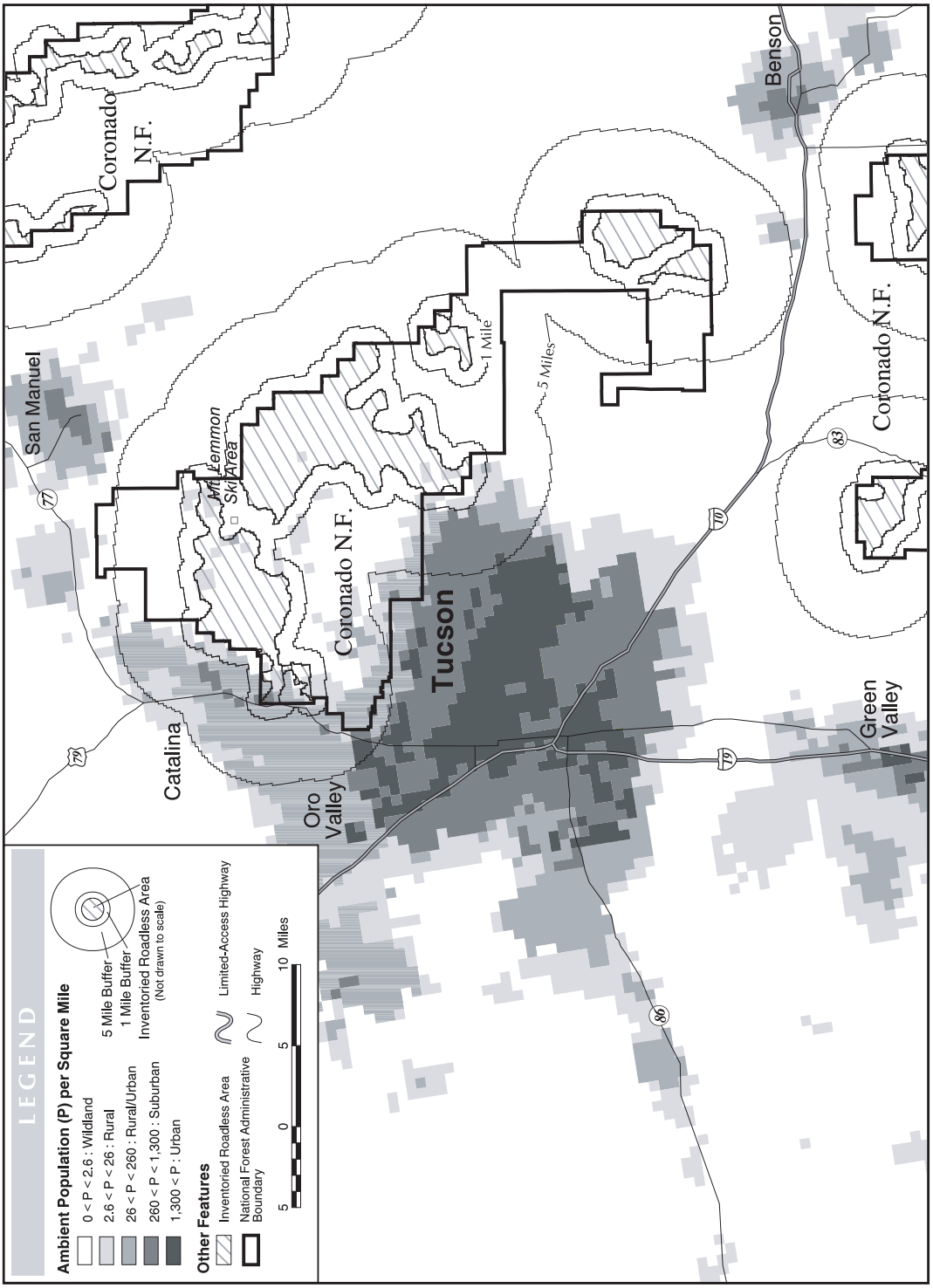

Figure 3-22. Map of inventoried roadless areas overlaid with ambient population density near Tucson, Arizona.

Historically, the Agency has not constructed roads solely for fuel management projects. Roads are constructed for other purposes and subsequently used to access fuel-treatment areas. If the costs of road construction and maintenance were added to the fuel treatment cost, the increase would likely be higher than the commodity value of the resources protected.

There are many factors limiting the amount of work completed in inventoried roadless areas, including funding, the number of personnel available to complete fuel treatment planning and implementation, and the fact that the highest priorities for fuel treatment are outside inventoried roadless areas.

Methodology – Condition class, fire regimes, wildland-urban interface demographics, and fire occurrence data (see Fire Suppression section) were used to determine the potential trends and effects of each alternative on fuel and vegetation management activities within inventoried roadless areas. In evaluating each alternative, four questions were considered:

Number of Large Wildland Fires – Will the number of large (1,000 acres or more) fires increase to such an extent that key ecological factors (water, soils, vegetation, air quality, T&E species), or human life and property are damaged?

Wildland-Urban Interface – Will fuel and vegetation management activities to ensure public safety and to protect property in the wildland-urban interface near inventoried roadless area boundaries be adversely affected?

Treatment of Potential Areas – Can an aggressive fuel and vegetation management program be implemented on the 14 million acres of inventoried roadless areas potentially needing treatment?

Fuel Management Costs – Will the costs to reduce the threat of uncharacteristic wildfire effects preclude reaching fuel and vegetation management objectives?

Design Elements Common to all Alternatives – Six key design elements along with the national coarse-scale assessment, fuel management strategy, fire occurrence data, and wildland-urban interface demographics were used to help frame the analysis.

- The primary purpose of fuel management is to maintain forest and ecosystem health and reduce the occurrence of large fire (Davis and Cooper 1963; Wood 1982; Van Wagtendonk 1996).
- Unless an imminent threat to public safety, private property, water quality, or T&E species exists, inventoried roadless areas would be a low priority for fuel treatment over the next 20 years because higher priority areas are more common outside roadless areas.
- Disposing of fine fuel reduces fire hazard and can be accomplished through mechanical treatment, prescribed burning, or combinations of both (Swetnam 2000).
- Among fuel management practitioners and researchers, uncertainty exists over how to spatially locate fuel management projects (particularly at the landscape level) to prevent large fires (Deeming 1990; Turner and Romme 1994; Pollett and Omi 2000; Miller and others 2000; Johnson 1994).

- Whether timber harvesting reduces the size and intensity of a wildland fire is disputed and uncertain. Both **commodity-purpose timber harvest** and stewardship-timber harvest can reduce **fire intensity**, the **resistance to control**, and fire spread provided the ladder fuels and unutilized coarse and **fine fuels** are removed from the site. Conversely, timber harvest can sometimes elevate fire hazard by increasing dead-ground fuel, removing larger fire resistant trees, and leaving an understory of ladder fuels (Graham and others 1999; Sacket and others 1996; Barrett 1994; Feeney and others 2000; Weatherspoon 2000).
- The costs of road construction and maintenance were not factored into this analysis as they vary widely depending on terrain, road design, and associated mitigation measures. Roads used for fuel treatment are often constructed for other purposes. This analysis focused on the direct cost of fuel treatment activities (Saveland 1987), and not on the costs of building a road just for fuel management purposes.

Alternative 1 – No Action

Numbers of Large Wildland Fires – Approximately 160,000 acres within inventoried roadless areas are projected to burn annually. More than 90% of this acreage will burn in an estimated 17 large (1,000 acres or more) wildland fires. Acreage and the number of large wildland fires are expected to increase over the next 20 years.

Wildland-Urban Interface – Minimal fuel reduction work is currently being conducted in the wildland-urban interface adjacent to inventoried roadless areas because few people live there (Tables 3-16 and 3-17). This alternative would provide the widest array of fuel treatment options to efficiently manage fuels in the wildland-urban interface.

Potential Treatment Areas – Even though some inventoried roadless areas currently allow road construction, very little fuel management work is currently being completed in these areas. Treatment areas inside inventoried roadless areas would likely continue to be classified as low priority for work due to the large amounts of fuel treatment needs that have been identified in treatment areas outside inventoried roadless areas. Because this alternative permits road development and all forms of vegetative manipulation, a full range of hazardous fuel reduction techniques could be used.

Of the 14 million acres of inventoried roadless acres identified as potentially requiring fuel treatment under this analysis, all 3 million of the low risk acres and approximately 3.5 million (or 50%) of the moderate risk acres can be treated using prescribed fire without mechanical pretreatment. Approximately 3.5 million of the moderate risk acres and all 4 million of the high risk acres, totaling 7.5 million acres, may need some type of mechanical pretreatment before prescribed fire can be used to reduce the fire hazard.

An estimated 90,000 to 95,000 acres of forest rated as Condition Class 2 and 3 could be treated in the next 5 years by commodity-purpose and stewardship-timber harvest methods. This represents just more than 1% of the 7.5 million acres in inventoried roadless areas potentially needing treatment that could require mechanical pretreatment before prescribed burning.

Fuel Management Costs – This alternative will allow a full range of mechanical fuel treatments and pretreatments in preparation for prescribed burning including: mechanical and hand thinning, chipping, hand piling, dozer piling, mastication, mowing, crushing, as well as land-based and aerial timber harvesting and associated yarding of standing live and dead trees. The fuel treatment costs will vary by the treatment method selected, but should average $176 to $276 per acre. These fuel treatment costs do not reflect the cost of road construction and maintenance.

Other Indirect Effects – In inventoried roadless areas that allow road construction and reconstruction, substantially more fuel treatment could be accomplished through timber harvest (including thinning) and other mechanical treatments than Alternatives 2, 3, or 4.

Of the mechanical treatment options available, the effects of logging can be the most problematic. Historically, some of the fuel created through logging has been left to naturally decay on thousands of acres of NFS land. A scientific report (Franklin and others 2000) *Simplified Forest Management to Achieve Watershed and Forest Health: A Critique* states:

> *"Any logging that reduces average tree size, at either the stand or landscape scale – including clearcutting, shelterwoods, seed tree cuts, selective cutting of larger trees, or thinning that lowers average stand diameter- will increase the risk of stand-replacement fires rather than decrease it. Thinning only small and intermediate trees less than 100 years old could decrease fire risk, depending on how much new risk is introduced by logging slash (or its disposal). Under-thinning done carefully can be a useful tool to reduce fire risk in dry forest types."*

In the short term (3 to 7 years), the effect of timber harvest can be a reduced fire hazard assuming fine fuel and unutilized coarse fuel created by logging is removed. Over the long term (20 to 40+ years), however, the indirect effect of timber harvesting may actually make the site more flammable than before it was logged. Once a forest is opened-up through logging, increased sunlight, more available water, and less vegetative competition may create an environment that is more conducive to tree, shrub, grass, and forb growth. This early successional vegetative growth often forms into dense thickets that create a highly flammable situation. New tree growth, whether from natural regeneration or planted nursery stock, produces needles and twigs that become the fine fuel that contributes to wildland fire spread.

A fuel management problem in these logged forests becomes how to treat the biomass created 20 to 40 or more years after the initial timber harvest to make the site less flammable and to meet land management plan objectives. If the primary silvicultural objective were to increase tree growth and yield, for example, it would be necessary to thin these dense stands to reduce competition. This can be accomplished through **pre-commercial** or commercial thinning. The problem facing the fire manager becomes what to do with the woody debris (slash) created by these thinning operations. Post-harvest fuel conditions commonly found in some managed forests prompt many scientists to conclude that harvested forests have a higher propensity for large, severe wildland fires

than forests that have not been harvested. A recent report by the National Research Council (2000) speaks to the issue of post-harvest fuel management in Pacific Northwest forests.

> *"Logging has been proposed as a possible surrogate for fire in reducing fuel accumulation with the added benefit of economic return (Agee 1993), but logging and clearcutting do not necessarily reduce flammable fuels…rapid regeneration of early-successional shrubs and trees can create highly flammable fuel conditions within a few years of cutting. Without adequate treatment of small woody residues, logging may exacerbate fire risk rather than lower it (Agee 1993)…"*

Alternative 2

Number of Large Wildland Fires – As described in the Fire Suppression section, the prohibition on roads in this alternative would have little effect on the number of acres burned by wildland fire. Approximately 160,000 acres within inventoried roadless areas are projected to burn annually. More than 90% of this acreage will burn in an estimated 17 large (1,000 acres or more) wildland fires. Acreage and the number of large wildland fires are expected to increase over the next 20 years.

Wildland-Urban Interface – A prohibition on road construction and reconstruction would limit the array of treatment options available to treat the fire hazard in or near the wildland-urban interface, slightly restricting the amount of mechanical pretreatment that could be completed by timber harvesting. However, since relatively few populated areas occur on boundaries between inventoried roadless areas and private lands, the overall direct effect is expected to be slight.

Potential Treatment Areas – Compared to Alternative 1, a full array of fuel treatment options is still available, but because of fewer roads being constructed for other purposes, fuel treatments would be more expensive and less efficient to implement, which could result in fewer acres treated. Some fuel treatment techniques available in Alternative 1 would not be economically or logistically feasible. Treatments would continue to be a priority in areas that are already roaded, near communities, or that are at risk for fire.

On the 14 million acres of inventoried roadless areas identified as potentially requiring fuel treatment under this analysis (6.5 million can be prescribed burned without pretreatment and 7.5 million which need pretreatment before burning), it is still possible to reduce the overall fire hazard without roads. Fuel treatment techniques that do not require roads include: prescribed burning, thinning, and sawing and stacking fuel into small pieces for later burning. On slopes less than 35%, heavy equipment such as bulldozers, masticators, and rubber-tire **skidders** can be used to pile or rearrange fuels provided the equipment could access treatment areas without the use of roads.

Approximately 40,000 acres of forest rated as Condition Classes 2 and 3 could be treated in the next 5 years by traditional and timber stewardship harvest methods. This is less than 1% of the 7.5 million acres of inventoried roadless areas rated as high priority, which may require mechanical pretreatment before prescribed burning.

Fuel Management Costs – Compared to Alternative 1, the prohibition on road construction and reconstruction would make the planning and implementation of fuel reduction projects more time-consuming and more expensive as new roads built for other purposes would not be available for use. The current national average cost of $176 to $276 per acre (Laverty and Williams 2000) for fuel treatment could increase by as much as 100% in areas without road access. These fuel treatment costs do not reflect the cost of road construction and maintenance.

Other Indirect Effects –Mechanical pretreatment by timber harvest in preparation for prescribed burning may become economically or logistically impractical in roadless areas, because fire managers are uncertain about their ability to mechanically pretreat fuels over large landscapes that do not have roaded access.

The Cohesive Strategy identifies areas classified as Condition Class 2 and 3 in Fire Regimes I and II as potentially requiring fuel treatment and also needing some mechanical pretreatment before prescribed fire can be used. Limiting road construction in roadless areas will result in a reduction of timber harvest as a mechanical pretreatment, thus reducing the range of fuel treatment options available. Other fuel management options would have to be attempted; such as lightly thinning the forest and using repeated applications of low-intensity prescribed fires (two to four entries) until the overall potential for wildife is reduced.

Excluding the cost of road construction and reconstruction, total direct cost to treat the 7.5 million acres of inventoried roadless area under this alternative is expected to be twice as much as treatments under Alternative 1.

It may be more cost effective to develop plans for managing lightning ignitions as a "**wildland fire used for resource benefit**" (WFURB) than to attempt fuel treatment without roads. WFURB has been widely used in Wilderness Areas (Swetnam 2000) across the United States. A method that thins small diameter trees followed by prescribed burning also has been applied in Grand Canyon and Sequoia/Kings Canyon National Parks (Barrett 1999; Keifer and others 2000; USDI National Park Service 1999). However, there is no demonstrated evidence to suggest that either technique could be applied efficiently and economically over hundreds of thousands of acres. If these techniques could not be applied, the indirect effect would be an increased occurrence of more wildfires with uncharacteristic fire effects over a portion of the 7.5 million acres of inventoried roadless areas needing mechanical pretreatment.

Even if a wildland fire burned in an area that had not been mechanically pretreated or prescribe burned, not all the fire effects are expected to be adverse. In fact, only a portion of a forest that burns, even under the most severe fire behavior conditions, is expected to experience lethal effects. The Cerro Grande wildland fire near Los Alamos, New Mexico, in July 2000, burned more than 42,000 acres. An analysis of burn severity showed 34% of the area burned at high severity, 8% burned at moderate severity, and 58% of the acres were either unburned or burned at low severity (Interagency BAER Team 2000).

Alternative 3

Number of Large Wildland Fires – As described in the Fire Suppression section, the prohibition on roads in this alternative would have little effect on the number of acres burned by wildland fire. Approximately 160,000 acres within inventoried roadless areas is projected to burn annually. More than 90% of this acreage will burn in an estimated 17 large (1,000 acres or more) wildland fires. Acreage and the number of large wildland fires are expected to increase over the next 20 years.

Wildland-Urban Interface – A prohibition on road construction and reconstruction coupled with a prohibition on commodity-purpose timber harvest would limit the array of treatment options available to treat the fire hazard in or near the wildland-urban interface, slightly restricting the amount of mechanical pretreatment that could be completed. However, since relatively few populated areas occur on boundaries between inventoried roadless areas and private lands, the overall direct effect is expected to be slight.

Potential Treatment Areas – Compared to Alternative 1, a full array of fuel treatment options is still available, but because of restricted road access, treatments would be more expensive and less efficient to implement, which would result in fewer acres treated. Some fuel treatment techniques available in Alternative 1 would not be economically or logistically feasible.

On the 14 million acres of inventoried roadless areas identified as potentially requiring fuel treatment, 6.5 million could still be treated with prescribed fire without mechanical pretreatment and 7.5 million may need some pretreatment before prescribed burning.

For the next 5 years, forests in Condition Classes 2 and 3 needing mechanical pretreatment that could be treated by stewardship timber harvest would be 22,000 acres, a decrease of 18,000 acres from Alternative 2 and a decrease of 68,000 to 73,000 acres from Alternative 1. This total acreage represents less than 1% of all inventoried roadless lands that potentially require mechanical pretreatment.

Fuel Management Costs – Compared to Alternative 1, the prohibition on road construction and reconstruction would make the planning and implementation of fuel reduction projects more time-consuming and more expensive as roads constructed for other purposes would not be available for use. The current national average cost of $176 to $276 per acre for fuel treatment could increase by as much as 100%. These fuel treatment costs do not reflect the costs of road construction and maintenance.

Other Indirect Effects – Same as those under Alternatives 1 and 2.

Alternative 4

Number of Large Wildland Fires – The prohibition on road construction and reconstruction and the prohibition on timber harvesting and thinning associated with fuel pretreatment for prescribed fire use, moderately hinder the fire manager's ability to

manage fuel for fire hazard reduction. Compared to Alternative 1, the number of large wildland fires would increase slightly.

Wildland-Urban Interface – Compared to the other alternatives, this alternative limits the fuel management tools available to the fire manager to effectively treat hazardous fuels in the wildland-urban interface. The primary non-mechanical fuel treatment tool available in inventoried roadless areas adjacent to the wildland-urban interface would be prescribed fire. Without the ability to pretreat some areas next to the wildland-urban interface before prescribed burning, managers would be hesitant to use prescribed fire there because of the risk of the fire escaping onto private property.

Potential Treatment Areas – A prohibition on road construction and reconstruction coupled with a prohibition on timber harvesting and thinning associated with fuel pretreatment for prescribed fire use limits the array of fuel treatment options available to the fire manager. Compared to Alternative 1, fuel treatments would be more expensive and less efficient to implement, which would result in fewer acres treated.

On the 14 million acres of inventoried roadless areas identified as potentially requiring fuel treatment, 6.5 million acres could still be treated with prescribed fire without mechanical pretreatment. However, on the 7.5 million acres that may need mechanical pretreatment before burning, thinning would not be an option; but other mechanical fuel treatments such as crushing, piling, or limbing would be permitted, as would construction of firelines and fuelbreaks needed to implement effective fire use.

This alternative does not restrict the use of prescribed fire or lightning-caused wildland fires allowed to burn for resource benefit (WFURB). The implementation of WFURB as a primary fuel treatment tool to reduce the occurrence of large fires within inventoried roadless areas is feasible, especially in inventoried roadless areas that are large or are located adjacent to Wilderness. This perspective has been supported in a recent position paper in *Issues in Ecology* by a team of forest ecologists (Aber and others 2000) concludes:

> *"No evidence supports the view that natural forests or reserves are more vulnerable to disturbances such as wildland fire, windthrow, and pests than intensively managed forests. Indeed, there is evidence natural systems may be more resistant in many cases."*

Fuel Management Costs – Prescribed burning and mechanical pretreatment (crushing, piling, limbing) costs are expected to double as they did in Alternatives 2 and 3. The cost of managing fuel through WFURB is estimated to be $50 per acre. Even though the fuel management treatment cost for WFURB is much lower than using other fuel management tools, fewer total acres are expected to be treated by this method. This may also lead to an increase in burned-area emergency-rehabilitation projects to treat these burned areas. These fuel treatment costs do not reflect the costs of road construction and maintenance.

Other Indirect Effects – On the 7.5 million acres possibly requiring mechanical pretreatment before prescribed burning, thinning would not be an option. Although other

mechanical fuel treatments such as crushing, piling, or limbing would be permitted, it is unlikely they could be applied on a majority of the areas needing pretreatment. The ability to treat here is limited by steep, rugged topography. Without thinning to pretreat fuels for prescribed burning, vegetation becomes more susceptible to uncharacteristic wildfire effects (Della Sala and others 1995; Barrett 1994; Graham and others 1999). The indirect effect is that more acres of inventoried roadless area would become susceptible to uncharacteristic wildfire effects.

This alternative would have several temporal and spatial indirect effects involved with using WFURB as a primary fuel management technique. Few wildland fires will be managed as a WFURB where the threat of a fire burning from an inventoried roadless area across administrative boundaries is high. In time, the fire hazard would increase. Inventoried roadless areas near Wilderness, however, could expand the total land area where lightning-ignited fires are allowed to burn. Many respondents to the DEIS indicated a preference for using the WFURB as a more passive (natural) approach to managing fire in inventoried roadless areas as the best way to retain roadless area characteristics.

Fire Suppression

Fire suppression is the practice of controlling forest and rangeland fires in a safe, economical, and expedient fashion, while meeting the natural resource objectives outlined in land management plans. All fire suppression actions are governed by the Federal Wildland Fire Management Policy, approved by the Secretaries of Interior and Agriculture (Glickman and Babbitt 1995), which states, in part:

> *"No resource or property value is worth endangering people. All of our actions and our plans must reflect this commitment. Our second priority is to protect resources and property, based on the relative values to be protected. We must be realistic about our abilities to fight severe wildland fire. As natural resource managers, we must make prudent decisions based on sound assessments of all the risks. Good management reduces the likelihood of catastrophic fire by investing in risk-reduction measures. Good management also recognizes when nature must take its course."*

A fire that is not meeting land management objectives is considered an unwanted wildland fire and is suppressed. Suppression forces, either air delivered smokejumpers and helicopter-delivered crews or ground crews with engines, are immediately dispatched to control these fires. When suppressing wildland fires, the first priority is firefighter and public safety and protecting property. Other major suppression objectives can include protection of municipal watersheds and habitat for T&E species.

Fire suppression is a complex activity. Fire personnel must be skilled to quickly make decisions, establish priorities when resources are limited, and evaluate weather and fuel conditions to predict how hot the fire will burn, and how fast it will spread.

Thousands of wildland fires – ignited by humans and lightning – occur each year on NFS lands. Suppression of these wildland fires requires large fire organizations and the expenditure of millions of dollars. Tragically, firefighters are sometimes killed working to control these wildland fires. Zimmerman and Bunnell (1998) describe the status of modern fire management:

> *"Challenges and risks associated with wildland fire management are increasing in both complexity and extent. Threats from wildland fires grow each year as long-term effects from past land use and fire management actions become visible in natural vegetation communities. The escalating values to be protected associated with current land use practices are compounding protection concerns. Federal land management agencies' ability to respond to these challenges is rapidly becoming overextended."*

Affected Environment

At issue is whether a prohibition on road construction and reconstruction in inventoried roadless areas on NFS lands would hamper the ability of firefighters to quickly suppress wildland fires, and whether more small wildland fires (less than 1,000 acres) would become large (1,000 acres or more), thus posing a danger to communities and natural resources and incurring excessive control costs.

The Forest Service controls nearly 98% of wildland fires, inside and outside inventoried roadless areas, at a relatively small size while, a few large wildland fires have the potential to burn the most acres. For example, as of September 14, 2000, only 15 fires (0.15% of the 10,192 ignitions on NFS lands) were responsible for 40%, or 856,000 acres of the 2.12 million acres burned to date (USDI 2000; USDA Northern Rockies Coordinating Group; USDI Eastern Great Basin Coordination Center).

A coarse-scale analysis of fire occurrence data for inventoried roadless areas was developed using national fire occurrence data sets for an 11-year period (1986 to 1996) overlaid with geographic information system maps of inventoried roadless areas. This data set includes four of the last half of the 20th Century's most serious fire years: 1) 1987 in northern California and the Pacific Northwest, 2) 1988 in Yellowstone National Park and Montana, 3) 1994 in the West, and 4) 1996 in the Southwest and Intermountain West.

This coarse-scale analysis identified dominant characteristics and trends for wildland fire cause (human or lightning), all causes (combination of lightning and human), fire size (more than 1,000 acres), and **median** large fire size for wildland fires burning inside and outside inventoried roadless areas. These wildland fire occurrence attributes were studied within the context of three large NFS geographic areas: 1) the West (Regions 1 through 6), 2) Alaska (Region 10), and 3) the East (Regions 8 and 9). A further refinement of the wildland fire-occurrence data included dividing all NFS lands into three subcategories: 1) Wilderness, 2) inventoried roadless areas, and 3) lands outside of Wilderness and inventoried roadless areas.

For the purposes of this analysis, NFS lands inside Wilderness and inventoried roadless areas were classified as "essentially roadless," while NFS lands outside of Wilderness and inventoried roadless areas were classified **essentially roaded**. NFS lands were classified in this manner to compare fire occurrence data for areas that do not have roads (Wilderness and inventoried roadless areas) with other areas in the National Forest System, which includes a road network of more than 380,000 miles. The total NFS land area classified as essentially roadless is 93.2 million acres (72.7 million acres excluding Alaska). For essentially roaded areas, the figure is 99.1 million acres (97.5 million acres excluding Alaska).

The fire occurrence information derived from this analysis process was tabulated and formatted into tables. Data were further refined into probabilities and then used to describe and project the fire suppression environmental effects for all three-prohibition alternatives (Alternative 2 through 4).

The fire occurrence data should only be used at a coarse-scale at national, regional, or State levels. Local variations in the data could not be projected. Fire occurrence patterns change on both national and local scales. For example, individual national forests within the same geographic area will produce different sets of fire occurrence statistics. At the coarse-scale, these localized differences could not be analyzed. While this analysis formulates conclusions at the coarse-scale, it is, nonetheless, one of the first efforts to link and correlate fire occurrence data for areas that are essentially roaded and essentially roadless.

The primary purpose in defining the analysis area as essentially roaded or **essentially roadless** was to develop a trend for the two areas to determine whether building roads in inventoried roadless areas actually reduces the chance of large fire occurrence. It should be noted that portions of inventoried roadless areas already have existing roads. In addition, large areas outside of inventoried roadless areas could actually be called unroaded. This national-scale analysis did not address these finer-scale variations.

A literature review for this analysis produced few peer reviewed scientific articles dealing with the consequences of building a road solely for fire suppression purposes. Most of the available information is anecdotal, originating from interviews with experienced firefighters (Schuster and others 1997; USDA Forest Service 2000b). In addition, access by road to a wildland fire area does not necessarily mean firefighters will not have to walk long distances in steep, inaccessible terrain to reach the fire.

The 1999 General Accounting Office report *Western National Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildland Fire Threats (GAO 1999),* notes that total acres burned yearly by wildland fires and number of large wildland fires are increasing (Figures 3-23 and 3-24). The 2000 fire season, as of September 14, 2000, has surpassed all years on record except for the 1910 and 1919 fire seasons, with 2.12 million acres of NFS lands burned (Figure 3-23). Figures 3-23 and 3-24 establish a national trend for large fire occurrence and total annual acreage burned on NFS lands including inventoried roadless areas.

Data used in this analysis were historical. If complete fire occurrence data from the 2000 fire season could have been included in this analysis, the individual fire occurrence calculations, especially for fire size, would have changed. However, the coarse-scale trends established for fire size and location would not have changed under each alternative.

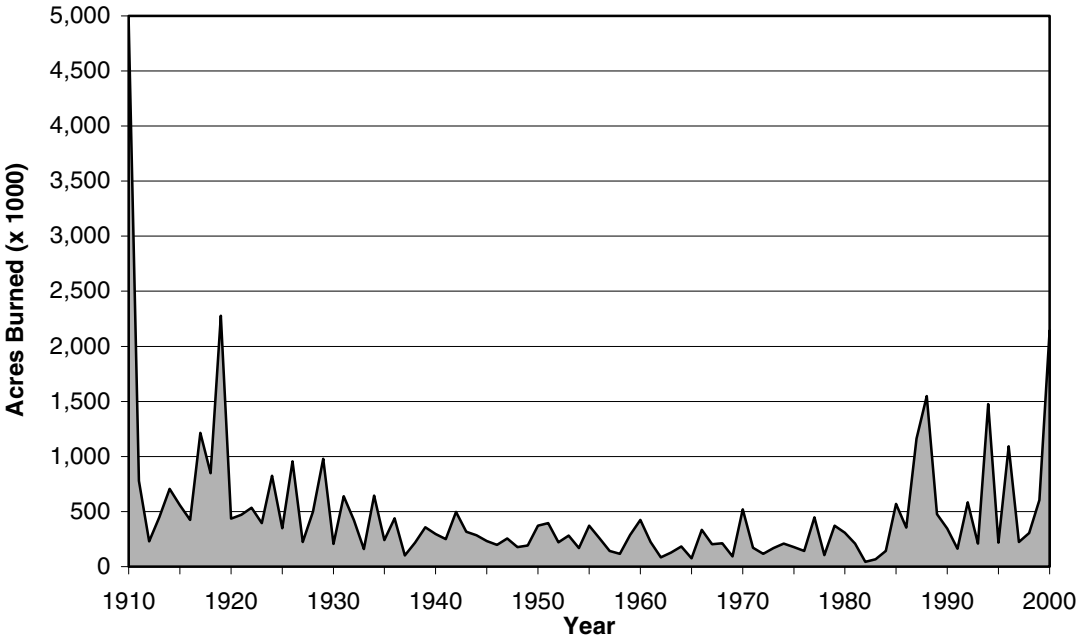

Figure 3-23. Acres burned by wildland fire on National Forest Systems lands, 1910 to September 14, 2000.

(USDA Forest Service and U.S. General Accouting Office 1999)

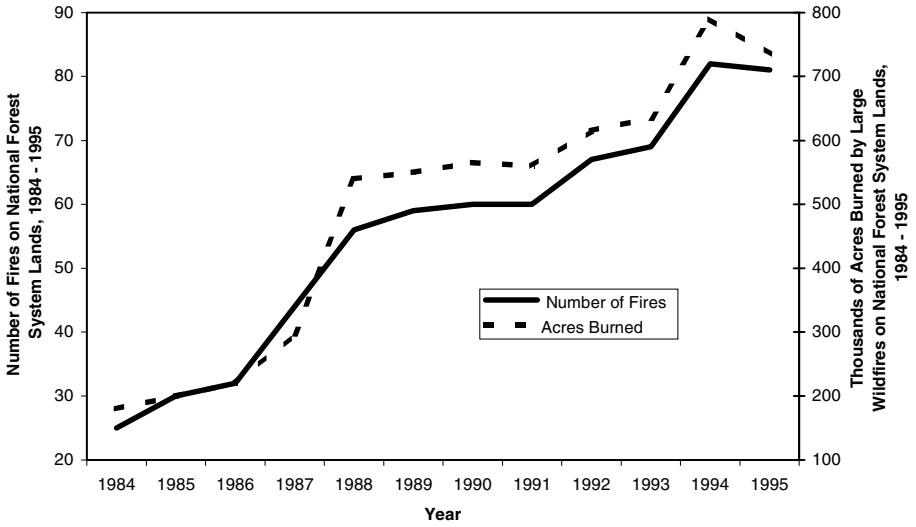

Figure 3-24. Number and acres burned by large wildland fires on National Forest System lands, 1984 to 1995.

(USDA Forest Service and U.S. General Accounting Office 1999)

Design Elements Common to all Alternatives – Four key assumptions common to all alternatives were developed to frame the discussion in the effects analysis.

- If an imminent threat of fire exists that, without intervention, would cause the loss of life or property, a road can be constructed for public health and safety.
- Congressional funding allocated to prepare for and suppress wildland fires would remain constant.
- Firefighter and public safety are always the highest priority. Regardless of the selected fire management strategy or the particular situation at the fire site, all high hazard threats affecting firefighter and public safety would be mitigated before a suppression action is taken.
- Two national trends identified in the 1999 General Accounting Office report apply to roaded and unroaded lands: 1) more wildland fires will continue to occur on NFS lands; and 2) more acreage will be burned by large wildland fires.

Four primary components, derived from extensive literature reviews and internal and external scoping processes, were developed. These components structured the fire suppression-effects analysis. The primary components became questions that were answered for each alternative.

Number of Large Wildland Fires – Will the number of wildland fires escaping **initial attack** and becoming large significantly change from current trends?

Annual Acreage Burned by Wildland Fire – Will the number of acres projected to burn annually from wildland fires significantly change from current trends?

Wildland-Urban Interface – Will the Forest Service's ability to manage wildland fires efficiently and safely in the wildland-urban interface be adversely affected?

Annual Expenditure for Fire Pre-Suppression and Emergency Fire Suppression – Will fire costs, both in preparing to fight a forest fire and in actually fighting it, significantly change from national historic averages?

Alternative 1 – No Action

Wildland fires that threaten human life and property or do not meet resource objectives are always suppressed. Suppression strategies can range from full control to allowing a portion of a fire's perimeter to burn. Human-caused fires are always suppressed. Some lightning-caused wildland fires that meet natural resource objectives are allowed to burn, mainly in designated Wilderness areas. If a fire is meeting land management plan objectives, some national forests do not suppress lightning-caused fires that occur on non-Wilderness lands. Research has shown that more than 98% of wildland fires are controlled by a local response unit while still small and that approximately 2% of wildland fires cannot be controlled by initial attack crews and become large (Strauss and others 1989).

Reviewing fire occurrence data for size of ignitions from all causes between 1986 and 1996, less than 1% (789) of 112,722 fire starts on NFS lands became large fires. For the same period, slightly more than 1% (190) of 16,611 fire starts in inventoried roadless areas burned more than 1,000 acres. While in areas classified as essentially roadless, during this period, just more than 1% (380) of 28,338 fire starts became large fires.

Before World War II (1946), most NFS roads were constructed primarily for fire suppression and conservation activities. From the mid-1940s until the mid- to late-1980s, the majority of NFS roads were constructed for timber harvest activities (Space 1979).

> *"Following the fire season of 1919, which ranks second to 1910 in area burned, the Forest Service appealed to Congress for money to build some roads . . .. The primary purpose of these roads was for fire protection and they were well worth the cost . . .. Following the war, all roads, except those in campgrounds, had been built either under contract or as part of a timber sale agreement."*
>
> *Ralph S. Space, Clearwater National Forest Supervisor 1954 to 1963*
> *"The Clearwater Story of the Clearwater National Forest" (Space 1979)*

Over the next 5 years, from 2000 through 2004, an estimated 1,160 miles of road would be constructed or reconstructed in inventoried roadless areas. Nearly 27% (363 miles) of this road construction is expected to occur in the low fire occurrence and low fire risk forests of Alaska where, because fires seldom occur on NFS lands, roads usually are not used for fire suppression purposes. In national forests outside Alaska, approximately 797 miles (or 159 miles per year) of road could potentially be constructed in the next 5 years and used for fire suppression purposes.

Number of Large Wildland Fires – Of the 1,500 total wildland fires that occur annually in inventoried roadless areas, 17 become large. These large fires account for 93% of all acres burned. This number is increasing, and this trend is expected to continue.

Annual Acreage Burned by Wildland Fire – Currently, an average of 160,000 acres of inventoried roadless areas burn annually. In the future, an increasing trend in burned acreage is expected. This increasing trend is expected to continue. More than 10,000 wildland fires occur on NFS lands each year, burning from 600,000 to 800,000 acres (General Accounting Office 1999). Approximately 96% of this burned acreage is in the West, where nearly 1,500 of these fires (14%) start in inventoried roadless areas.

Annually humans cause approximately 25% of these 1,500 fires in inventoried roadless areas. Lightning is the primary cause of forest fires in the West (Regions 1 through 6). Humans are responsible for a higher percentage of wildland fires in the South (Region 8), the Northeast (Region 9), and Alaska (Region 10).

Alaska's Chugach and Tongass National Forests experience a very low fire occurrence. From 1986 through 1996, 442 fires burned approximately 1,700 acres for an annual average of only 153 acres burned on NFS lands. Lightning accounted for only 1 of these

442 wildland fire ignitions. Because of this extremely low fire occurrence, Alaska was not included in this analysis.

Wildland-Urban Interface – As shown in Tables 3-16 and 3-17, few concentrated populations of either individuals or communities occur near inventoried roadless areas. Due to these population densities, a fire spreading from an inventoried roadless area would have little opportunity to endanger human life or property.

Annual Expenditure for Fire Pre-Suppression and Emergency Fire Suppression – The average cost of suppressing a wildland fire in inventoried roadless areas would continue to fluctuate around the averages identified in Figure 3-25. The annual average expenditure for emergency fire suppression is $304 million. In preparing and maintaining fire organizations, the fixed costs add, on average, an additional $326 million each year.

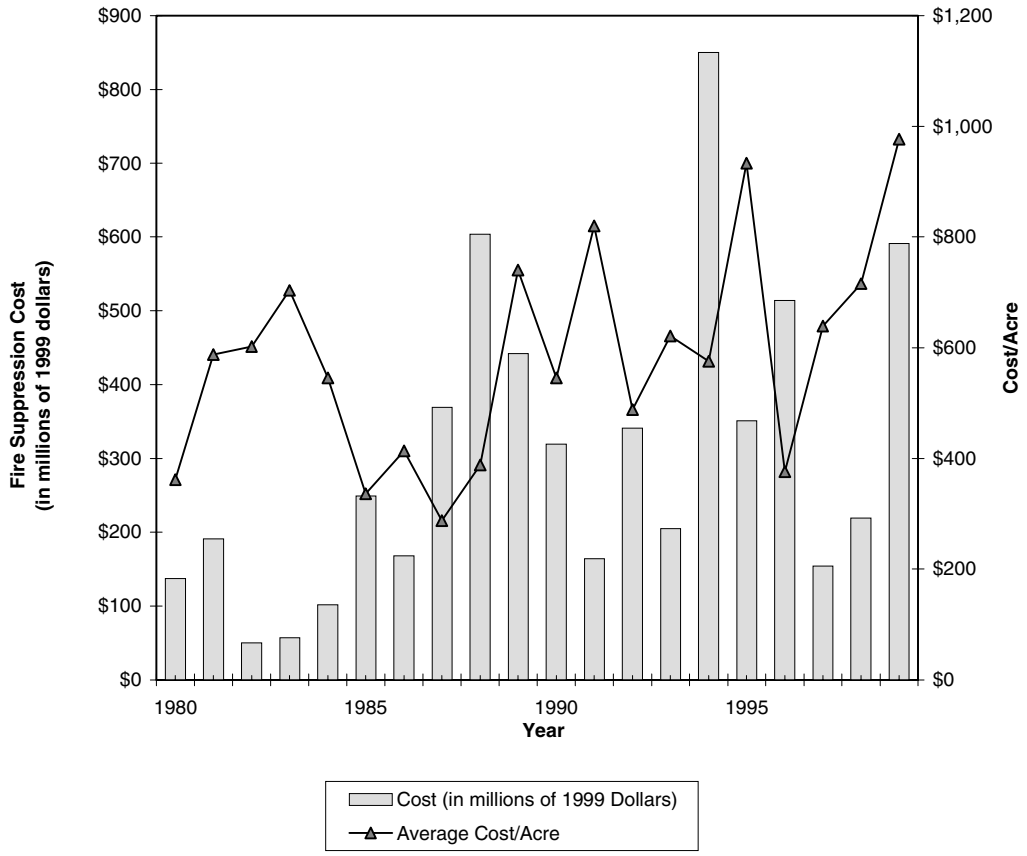

Figure 3-25. Historical fire suppression costs.
(USDA Forest Service 2000b)

Table 3-18 compares wildland fire occurrence for all causes (lightning and human-caused wildland fires) in areas classified as essentially roadless and essentially roaded. The fire occurrence (measured as the number of wildland fire ignitions per 10,000 acres) in Wilderness and inventoried roadless areas is nearly the same for all Forest Service

regions. This may be due to the limited human-use of these areas, lack of access (no roads), and nonexistence of permanent human communities.

However, when comparing inventoried roadless areas with areas that are essentially roaded, there is a significant difference in the coarse-scale fire occurrence data. In Forest Service Regions 1 through 9, fire occurs in essentially roaded areas twice as many times

Table 3-18. Lightning- and human-caused fire occurrence by Forest Service region in essentially roadless and essentially roaded National Forest System lands, 1986 to 1996.

		Essentially roadless areas[a]			Essentially roaded areas[b]
Regions[c]	**Total fire starts in National Forest System lands**	**Total fire starts in Wilderness[d]**	**Total fire starts in inventoried roadless areas[d]**	**Total fire starts in Wilderness and inventoried roadless areas[d]**	**Total fire starts in National Forest System lands outside Wilderness and inventoried roadless areas[d]**
Northern (1)	12,600	1,865 (3.7)	3,252 (3.6)	5,117 (3.7)	7,483 (6.6)
Rocky Mountain (2)	5,735	338 (0.7)	1,072 (1.7)	1410 (1.3)	4,325 (3.9)
Southwestern (3)	21,872	2,108 (7.8)	1,547 (5.6)	3,655 (6.7)	18,217 (12.0)
Intermountain (4)	12,279	1,641 (3.0)	5,050 (3.2)	6,691 (3.1)	5588 (5.2)
Pacific Southwest (5)	23,165	2,808 (6.6)	3,016 (7.2)	5,824 (6.9)	17,341 (14.9)
Pacific Northwest (6)	18,189	2,506 (5.3)	2,344 (5.9)	4,850 (5.5)	13,339 (8.4)
Southern (8)	13,614	249 (3.5)	245 (2.6)	494 (3.0)	13,120 (11.5)
Eastern (9)	5,268	212 (1.6)	85 (1.3)	297 (1.5)	4,971 (4.9)
Total	**112,722**	**11,727** **(4.1)**	**16,611** **(3.8)**	**28,338** **(3.9)**	**84,384** **(8.7)**

[a] 72.7 million acres of National Forest System lands inside Wilderness and inventoried roadless areas.
[b] 97.5 million acres of National Forest System lands outside of Wilderness and inventoried roadless areas.
[c] Region 10 (Alaska) is not included. Data unavailable for Alaska.
[d] Number in parenthesis is number of fire starts per 10,000 acres.
(Roadless Database 2000)

as in inventoried roadless areas. For the Western United States (Regions 1 through 6), the chance of a fire occurring is twice as likely in essentially roaded areas as in inventoried roadless areas. For the Eastern United States (Regions 8 and 9), the likelihood that fire will occur in essentially roaded areas is almost four-times greater than

in inventoried roadless areas. The net result is that there is a substantially increased level of fire occurrence outside inventoried roadless areas.

Table 3-19 represents a tabulation of human-caused (includes campfires, smoking, debris burning, incendiary devices, railroads, equipment use) fire occurrences using the same classifications as in Table 3-18. Similar to Table 3-18, the chance of a human-caused

Table 3-19. Fire occurrence for human-caused fires by Forest Service region in essentially roadless and essentially roaded National Forest System lands, 1986 to 1996.

		Essentially roadless areas [a]			Essentially roaded areas [b]
Regions [c]	**Total human caused fire starts in National Forest System lands**	**Total human caused fire starts in Wilderness[d]**	**Total human caused fire starts in inventoried roadless areas[d]**	**Total human caused fire starts in Wilderness and inventoried roadless areas[d]**	**Total human caused fire starts in National Forest System lands outside Wilderness and inventoried roadless areas[d]**
Northern (1)	2,755	189 (0.4)	477 (0.5)	666 (0.5)	2,089 (1.8)
Rocky Mountain (2)	2,219	177 (0.4)	382 (0.6)	559 (0.5)	1,660 (1.5)
Southwestern (3)	7,757	277 (1.0)	335 (1.2)	612 (1.1)	7,145 (4.7)
Intermountain (4)	2,977	327 (0.6)	1,025 (0.6)	1,352 (0.6)	1,625 (1.5)
Pacific Southwest (5)	10,655	662 (1.5)	1,210 (2.9)	1,872 (2.2)	8,783 (7.6)
Pacific Northwest (6)	5,428	549 (1.2)	541 (1.4)	1,090 (1.2)	4,338 (2.7)
Southern (8)	12,320	184 (2.6)	175 (1.8)	359 (2.2)	11,961 (10.5)
Eastern (9)	4,944	106 (0.8)	79 (1.2)	185 (0.9)	4,759 (4.7)
Total	**49,055**	**2,471** **(0.9)**	**4,224** **(0.7)**	**6,695** **(0.9)**	**42,360** **(4.4)**

[a] 72.7 million acres of National Forest System lands inside Wilderness and inventoried roadless areas.
[b] 97.5 million acres of National Forest System lands outside of Wilderness and inventoried roadless areas.
[c] Region 10 (Alaska) is not included. Data unavailable for Alaska.
[d] Number in parenthesis is number of fire starts per 10,000 acres.
(Roadless Database 2000)

wildland fire occurring in a Wilderness or inventoried roadless areas is nearly the same for all Forest Service regions.

In the West, the chance of a human-caused wildland fire occurring in an essentially roaded area is nearly three times more likely than in an essentially roadless area. In the East, the chances are nearly five times as likely.

In the West, 80% of human-caused fires start in essentially roaded areas. In the East, the figure is nearly 97%. Nationally (in all Forest Service regions), it is four times more likely that a human-caused wildland fire will occur in an area that is essentially roaded rather than an inventoried roadless area.

Table 3-20 shows lightning-caused fire occurrence only. Nationally (in all Forest Service regions), a lightning fire is twice as likely to occur in an area that is "essentially roaded" as in an inventoried roadless area. In the West, the chances of this occurring is 1.6 times as likely, and in the East it is 1.7 times as likely. Variation in these regional statistics is most likely due to: lightning occurrence patterns unique to specific locales, historical thunderstorm paths, the amount of precipitation with thunderstorms, and the ignitability of the forest or range where the lightning strikes.

Table 3-21 shows the large fire occurrence for both human and lightning occurrence. Nationally, (in all Forest Service regions) there is a two-times greater chance of a large forest fire burning in an area that is essentially roaded as in an inventoried roadless area. However, a comparison of the land areas classified as essentially roadless (Wilderness plus inventoried roadless areas), with areas that are essentially roaded shows that these numbers are almost equal. Approximately 50% of all large fires that ignite on NFS lands occur in essentially roadless areas.

The high number of large fires occurring in essentially roadless lands cannot be attributed to lack of access. If this were the case, then fewer large fires would occur in essentially roaded areas. Because many of the large fires originate where natural barriers would eventually slow their spread, they are a low priority for fire suppression resources.

Analysis of the fire occurrence data for all causes (Table 3-21) indicates that more large fires occur in inventoried roadless areas in Region 1 (Montana and Northern Idaho), Region 6 (Oregon and Washington), and Region 4 (Arizona and New Mexico). Again, priority setting is probably the main reason wildland fires are larger in these regions. During periods of high fire occurrence, drought, and high fire danger when thunderstorms ignite hundreds of fires within a geographic area, many wildland fires burning within the boundaries of inventoried roadless areas are a low priority for fire suppression resources. For example, in a wildland fire situation where crews and materials are limited, a fire burning in a remote section of an inventoried roadless area would be prioritized lower than a fire that was threatening private homes in the wildland-urban interface.

An example of how priority setting affected the final cost and size of wildland fires occurred during the 1999 fire season in northern California. The two largest and most costly fires, the Kirk Fire and Big Bar Fire, burned 227,000 acres and cost more than $176 million dollars to suppress. They both started in unroaded, remote, and extremely rugged Wilderness Areas. Outside the Wilderness Areas, other fires threatened private

Table 3-20. Fire occurrence for lightning-caused fires by Forest Service region in essentially roadless and essentially roaded National Forest System lands, 1986 to 1996.

		Essentially roadless areas [a]			Essentially roaded areas [b]
Regions[c]	**Total lightning caused fire starts in National Forest System lands**	**Total lightning caused fire starts in Wilderness[d]**	**Total lightning caused fire starts in inventoried roadless areas[d]**	**Total lightning caused fire starts in Wilderness and inventoried roadless areas[d]**	**Total lightning caused fire starts in National Forest System lands outside Wilderness and inventoried roadless areas[d]**
Northern (1)	9,845	1,676 (3.4)	2,775 (3.1)	4,451 (3.2)	5,394 (4.7)
Rocky Mountain (2)	3,516	161 (0.3)	690 (1.1)	851 (0.8)	2,665 (2.4)
Southwestern (3)	14,115	1,831 (6.8)	1,212 (4.4)	3,043 (5.6)	11,072 (7.3)
Intermountain (4)	9,302	1,314 (2.4)	4,025 (2.5)	5,339 (2.5)	3,963 (3.7)
Pacific Southwest (5)	12,510	2,146 (5.0)	1,806 (4.3)	3,952 (4.7)	8.558 (7.4)
Pacific Northwest (6)	12,761	1,957 (4.1)	1,803 (4.5)	3,760 (4.3)	9,001 (5.7)
Southern (8)	1,294	65 (0.9)	70 (0.7)	135 (0.8)	1,159 (1.0)
Eastern (9)	324	106 (0.8)	6 (0.1)	112 (0.6)	212 (0.2)
Total	**63,667**	**9,256** **(3.2)**	**12,387** **(2.1)**	**21,643** **(3.0)**	**42,024** **(4.3)**

[a] 72.7 million acres of National Forest System lands inside Wilderness and inventoried roadless areas.
[b] 97.5 million acres of National Forest System lands outside of Wilderness and inventoried roadless areas.
[c] Region 10 (Alaska) is not included. Data unavailable for Alaska.
[d] Number in parenthesis is number of fire starts per 10,000 acres.
(Roadless Database 2000)

property in less remote areas. An internal review of the fires (USDA Forest Service 2000b) stated that the Big Bar Fire "in terms of priority for resources was ranked last out of 8 fires in northern California." When firefighting resources were available to attack these fires, the fires were extremely large and were burning in such steep inaccessible terrain, that firefighters had difficulty in safely controlling them.

The 2000 fire season has provided additional examples of priority setting affecting fire size. The Flossie Fire, lightning ignited on July 31 in a Wilderness Area on the Payette National Forest, grew to 36,800 acres by August 18, with four people committed to staffing. Burning at the same time on the Lolo National Forest in Montana, the Thompson

Table 3-21. Fire occurrence, in starts per 100,000 acres, for large fires (more than 1,000 acres) by Forest Service region in essentially roadless and essentially roaded National Forest System lands, 1986 to 1996.

		Essentially roadless areas [a]			Essentially roaded areas [b]
Regions[c]	**Total large fire starts in National Forest System lands**	**Total large fire starts in Wilderness[d]**	**Total large fire starts in inventoried roadless areas[d]**	**Total large fire starts in Wilderness and inventoried roadless areas[d]**	**Total large fire starts in National Forest System lands outside Wilderness and inventoried roadless areas [d]**
Northern (1)	118	53 (1.1)	23 (0.3)	76 (0.5)	42 (0.4)
Rocky Mountain (2)	32	1 (0.0)	5 (0.1)	6 (0.1)	26 (0.2)
Southwestern (3)	142	40 (1.5)	28 (1.0)	68 (1.2)	74 (0.5)
Intermountain (4)	173	41 (0.8)	60 (0.4)	101 (0.5)	72 (0.7)
Pacific Southwest (5)	164	23 (0.5)	38 (0.9)	61 (0.7)	103 (0.9)
Pacific Northwest (6)	99	19 (0.4)	33 (0.8)	52 (0.6)	47 (0.3)
Southern (8)	44	7 (1.0)	3 (0.3)	10 (0.6)	34 (0.3)
Eastern (9)	17	6 (0.5)	0 (0.0)	6 (0.3)	11 (0.1)
Total	**789**	**190** **(0.7)**	**190** **(0.4)**	**380** **(0.5)**	**409** **(0.4)**

[a] 72.7 million acres of National Forest System lands inside Wilderness and inventoried roadless areas.
[b] 97.5 million acres of National Forest System lands outside of Wilderness and inventoried roadless areas.
[c] Region 10 (Alaska) is not included. Data unavailable for Alaska.
[d] Number in parenthesis is number of fire starts per 100,000 acres.
(Roadless Database 2000)

Flat Complex Fires, a group of fires threatening two communities, was at 9,300 acres on August 18, with 452 people committed to suppression (USDI 2000).

Table 3-22 indicates that the median size of large wildland fires for all causes is greater outside inventoried roadless areas in Regions 1, 2, 4, 5, 8, and 9. In Regions 3 and 6, this trend is reversed, the median size of large fires in inventoried roadless areas is greater than those outside roadless areas.

Table 3-22. Median size in acres of large fires by Forest Service region on National Forest System lands, 1986-1996. Fires are displayed by cause and location.

	Lightning caused			Human caused			All Causes		
Regions [a]	**Inventoried roadless areas**	**Wilderness areas**	**Outside Wilderness and inventoried roadless areas**	**Inventoried roadless areas**	**Wilderness areas**	**Outside Wilderness and inventoried roadless areas**	**Inventoried roadless areas**	**Wilderness areas**	**Outside Wilderness and inventoried roadless areas**
Northern (1)	2,470	3,250	3,680	5,710	5,864	2,230	3,245	3,507	3,336
Rocky Mountain (2)	3,190	13,100	4,034	1,572	0	2,152	1,906	13,100	2,983
Southwestern (3)	2,910	4,200	2,315	13,000	1,237	2,950	3,080	4,050	2,450
Intermountain (4)	3,087	3,530	4,068	2,147	4,160	5,169	2,865	3,549	4,585
Pacific Southwest (5)	4,840	2,598	6,830	2,298	2,559	2,516	2,550	2,990	3,460
Pacific Northwest (6)	4,115	4,725	3,690	9,200	2,201	2,119	4,730	3,648	2,800
Southern (8)	1,115	2,015	1,225	3,400	1,964	1,649	1,180	2,015	1,564
Eastern (9)	0	3,048	1,210	0	12,600	1,234	0	3,589	1,226
National median	3,094	3,600	3,660	2,550	3,125	2,230	3,069	3,509	2,800

[a] Region 10 (Alaska) is not included. Data unavailable for Alaska.
(Roadless Database 2000)

Fire Occurrence Summary Information – On a national basis:

- Ninety-eight point nine percent of all wildland fires in inventoried roadless areas are controlled at less than 1,000 acres.
- The median size of a large fire for all fire occurrence causes is greater inside than outside inventoried roadless areas (Table 3-22).
- The median size of a large wildland fire started by humans is greater on lands inside inventoried roadless areas (Table 3-22).
- A wildland fire ignition (regardless of the cause) is nearly two times more likely to occur in an essentially roaded area than in an essentially roadless area (calculation is based on number of fire starts per 10,000 acres) (Table 3-18).
- Human-ignited wildland fire is nearly five times as likely to occur in an essentially roaded area than in an essentially roadless area (calculation is based on number of fire starts per 10,000 acres) (Table 3-19).
- A lightning-caused fire is nearly one and one half times as likely to occur in an essentially roaded area than in essentially roadless area (calculation is based on number of fire starts per 10,000 acres) (Table 3-20).
- A large fire is one and one-quarter times more likely to occur in essentially roadless areas (calculation is based on number of fire starts per 100,000 acres) (Table 3-21).

Alternatives 2 and 3

Primary wildland fire trends as outlined under Alternative 1 would be projected to continue under these two alternatives including the number of fires escaping initial attack, the annual acres burned, the effect on fire suppression actions in the wildland-urban interface, and the pre-suppression and emergency suppression costs.

Uncertainty exists among fire researchers concerning whether the number of acres burned annually by wildland fires is reduced by timber harvest (Stephens 1998) or thinning (Weatherspoon and Skinner 1996; Alexander and Yancik 1977; Fahnestock 1966). It can be said, with some certainty, that removal of large fuels substantially reduces fire intensity, and its potential to become large. However, whether timber harvesting also reduces the final size of large wildland fires is debatable. Timber harvesting "opens" a forest (Countryman 1955), which allows more sunlight to penetrate to the forest floor causing the fine fuels, needles, and small sticks to dry faster and to stay dry longer. In addition, wind is able to penetrate into an open forest, which can sometimes cause fires to spread faster and become larger.

Number of Large Wildland Fires – Same effects as those under Alternative 1.

Annual Acreage Burned by Wildland Fire – Same effects as those under Alternative 1.

Wildland-Urban Interface: Same effects as those under Alternative 1. After 20 years, however, the potential threat from wildland fire at the wildland-urban interface is expected to increase as the population at increases in this area.

Annual Expenditure for Fire Pre-Suppression and Emergency Fire Suppression – Same effects as those under Alternative 1.

Alternative 4

Number of Large Wildland Fires – Over the next 20 years the number of large wildland fires in inventoried roadless areas is not expected to differ appreciably from those under Alternative 1.

Annual Acreage Burned by Wildland Fire – Over the next 20 years, the average acreage burned by large wildland fires is not expected to differ from those under Alternative 1.

Wildland-Urban Interface – Over the next 20 years, the potential threat of a wildland fire burning inside an inventoried roadless area toward a wildland-urban interface is expected to be the same as that under Alternative 1. After 20 years, however, the potential threat from wildland fire at the wildland-urban interface is expected to increase as the population at the wildland-urban interface increases.

Annual Expenditure for Fire Pre-Suppression and Emergency Fire Suppression – Same effects as those under Alternative 1.

Other Indirect and Cumulative Effects on Fuel Management

Table 3-23 is a comparative summary of each alternative compared to each primary component. Information from the Fire Suppression section was combined with information from the Fuel Management analysis to summarize the effects in this table.

Since the total land area covered by the proposed Roadless Rule encompasses approximately 31% of the NFS, affecting nearly every section of the United States, the cumulative effects analysis, like the effects portrayed for each alternative, will be described on a national basis as coarse-scale trends.

A significant increase in the amount of Federal land treated for high fire hazard is expected in the near future. In a recent report to President Clinton – *Managing the Impact of Wildland fires on Communities and the Environment* (White House 2000) – it was noted that it would take "significant investments to treat landscapes through thinning and prescribed fire" to address the fuel accumulation of past wildland fire suppression. The report went on to note that "since 1994, the Forest Service and the Bureau of Land Management have increased the number of acres treated to reduce fuel build-up from fewer than 500,000 acres in 1994 to more than 2.4 million acres" in 2000.

States and private landowners also actively treat the fire hazard on their lands. The annual acreage treated by States is unknown, but it would be substantially less than what is done on Federal lands.

The Forest Service Cohesive Strategy estimates that nearly 59 million acres of the 192 million acres of NFS land will require fuel treatment to reduce the risk of uncharacteristic wildland fire effects, either by prescribed fire alone or by mechanical pretreatment followed by prescribed fire. Approximately 32 million acres could be treated by

prescribed fire alone, and 27 million acres would need mechanical pretreatment before applying prescribed fire. Even though 16% percent of the NFS lands identified as potentially needing fuel treatment are within inventoried roadless areas; very few high priority areas (wildland-urban interface, municipal watersheds, and threatened and endangered species habitat) are found in inventoried roadless areas.

Fuel treatment acreage for fire hazard reduction is expected to increase on all Federal and some State lands in the in next 5 to 20 years. Most of this fuel treatment will occur in the high priority watersheds outside inventoried roadless areas where the overall values at risk are highest. The total acreage of high priority fuel treatment lands within inventoried roadless areas is small when compared to the total acreage that requires treatment on all Federal and State lands.

Approximately 14 million acres of short interval fire-adapted NFS lands are identified as potentially needing fuel treatment within inventoried roadless areas (Table 3-14). Approximately one million acres are in the East, (Regions 8 and 9) and nearly 13 million acres are in the West (Regions 1-6).

Treatment of these 14 million acres will be deferred for at least 20 years, however, because areas with higher values at risk from uncharacteristic wildfire effects (wildland-urban interface or high valued natural resources or community watersheds) that occur outside inventoried roadless areas are the highest priority for treatment. Full fire suppression is expected to continue on most of these 14 million acres until at least 2020, when a gradual implementation of the Cohesive Strategy is expected to begin inside inventoried roadless areas.

The cumulative effect of fully suppressing wildland fires within inventoried roadless areas for the next 20 years would be the continued exclusion of an additional two to three natural fire cycles. This would result in a greater accumulation of fine, dead ground fuel (twigs, sticks, branches) and further encroachment of thickets of small trees and other vegetation beneath the dominant canopy. When a forest or rangeland fire does occur, especially during periods of high fire danger (drought, low fuel moisture, high winds), there will be a greater chance of severe fire behavior that creates negative effects within the ecosystem and, based on projected population increases, threatens increasing numbers of people and communities.

When the 14 million acres within inventoried roadless areas are compared to all Federal, State, and private lands potentially needing fuel reduction to prevent the occurrence of uncharacteristic wildfire effects, the overall cumulative effect is very small. This fact is underscored since nearly all high priority treatment areas (wildland-urban interface, municipal watershed, and threatened and endangered species habitat) occur outside inventoried roadless areas.

Wildland-urban interface – Of the 10 fastest growing States in the United States, eight are in the West (Riebsame and others 1997) where more forest and rangelands are at risk from uncharacteristic wildfire effects. The national average yearly population growth is about 1%, while the growth rate for the West ranges from 2.5% to 13%. For example, the

population of Nevada is expected to grow from roughly 1.9 million in 2000 to nearly 2.8 million in 2025. The population of Montana is currently more than 900,000 and is expected to grow to 1.2 million by 2025. The current population of Idaho is more than 1 million and is expected to grow to nearly 2 million by 2025.

Because few people currently live on the boundary between inventoried roadless areas and the wildland-urban interface, the problem of a wildland fire burning from inside an inventoried roadless area into this interface is relatively rare. The human population density at or near the wildland-urban interface will increase if current national population trends continue. In time, the cumulative effect will be more people living in close proximity to inventoried roadless areas. In the future, however, the expected increase in interface population density will make the risk of severe wildland fires at the wildland-urban interface more likely.

Interior Columbia River Basin - The cumulative impact of implementing both the Cohesive Strategy and the Interior Columbia Basin Ecosystem Management Project (ICBEMP) was analyzed. Maps displaying areas with the highest priority for fuel treatment were overlain with two maps from the ICBEMP that identify ecosystem restoration-priority areas. Cumulatively, few major conflicts would occur from implementing these two national assessments within inventoried roadless areas.

Transportation Policy Rule - As noted in the Forest Service Road System section of the FEIS, “the combined effect of implementing the road policy, proposed roadless conservation policy, and individual land management plans – all within the planning framework in the planning regulations – would create additional acres of unroaded areas.” In the future, acres of unroaded NFS lands are likely to increase by 5% to 10%.

Roads outside inventoried roadless areas would not be decommissioned if a compelling fire management need exists to keep them open. Currently, however, no scientific process has been developed to determine the consequences to the fire suppression and fuel management programs of either closing or obliterating existing roads. The cumulative effect associated with this uncertainty is that some roads might be closed that, in the future, are necessary for reducing fire hazard. Conversely, some roads that should have been closed might inadvertently remain open.

Other Indirect and Cumulative Effects on Fire Suppression

On Federal lands managed by the Bureau of Land Management, Forest Service, Bureau of Indian Affairs, Fish and Wildlife Service, National Park Service, and on lands managed by States, hereafter called “Federal and State land”, a comparison was made of annual wildland fire occurrence for human and lightning ignitions and total acres burned (Table 3-24).

As can be seen in Table 3-24, nearly 99% of all human-caused ignitions and nearly 92% of all lightning-ignited wildland fires occur on land outside of inventoried roadless areas.

Table 3-23. Comparative summary of direct and cumulative effects on fuel management under all alternatives by primary components.

Component	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of large wildland fires	Acres burned by large wildland fires expected to increase in next 20 years, then a gradual decrease is expected as the treatment of priority areas begins	Acres burned by large wildland fires expected to increase in next 20 years, then a gradual decrease is expected as the treatment of priority areas begins	Acres burned by large wildland fires expected to increase in next 20 years, then a gradual decrease is expected as the treatment of priority areas begins	Acres burned by large wildland fires expected to increase in next 20 years, a few more large fires than under Alternatives 1 through 3
Wildland-urban interface (WUI)	Little threat to WUI now; in 40 years number of people living in WUI is expected to increase	Little threat to WUI now; in 40 years number of people living in WUI is expected to increase	Little threat to WUI now; in 40 years number of people living in WUI is expected to increase	Little threat to WUI now; in 40 years number of people living in WUI is expected to increase
Potential ability to treat areas by:				
Prescribed fire without mechanical pretreatment	Few areas treated now, potential increase in the future	Few areas treated now, potential increase in the future	Few areas treated now, potential increase in the future	Few areas treated now, potential increase in the future
Timber harvest [a]	90,000 to 95,000 acres could be treated in next 5 years; potential increase in 40 years	40,000 acres could be treated in next 5 years; potential increase in 40 years	22,000 acres could be treated in next 5 years; potential increase over 40 years	No acres treated by this method
Mechanical pretreatment with prescribed fire	Few acres being treated now; potential increase in future	Few acres being treated now; potential increase in future	Few acres being treated now; potential increase in future	Few acres being treated now; potential increase in future
WFURB [b]	None now; potential increase in future	None now; potential increase in future	None now; potential increase in future	None now; potential increase in future
Cost	$176 to $276/acre future	$352 to $552/acre future	$352 to $552/acre future	Less than $50/acre future if WFURB used

[a] The acres of fuel treatment that could be accomplished through timber harvest if one choose to work in an inventoried roadless area. In the future, most high-priority fire-hazard reduction work will continue to be outside inventoried roadless areas.
[b] Wildland Fire Used for Resource Benefit

Because a majority of the fire suppression activities will continue to take place outside of inventoried roadless areas, the cumulative effect of applying the Roadless Rule to them is negligible.

Table 3-24. Comparison between Federal land, State land, and inventoried roadless areas of annual average fire occurrence and annual acres burned.

Protection area	Number human-caused fires	Acres human-caused fires	Number lightning-caused fires	Acres lightning-caused fires
Federal and State land	102,000	1,900,000	13,000	2,000,000
National Forest System lands	4,400 (4)[a]	250,000 (13)[a]	5,800 (45)[a]	481,000 (24)[a]
Inventoried roadless areas	384 (<1)[a]	3,800 (<1)[a]	1100 (>8)[a]	130,000 (>7)[a]

[a] Percentage of all fires occurring and all acres burned on Federal and State lands.
(National Interagency Fire Center 2000; Roadless Database 2000)

In comparing Alternatives 2 and 3 with Alternative 1, the fire occurrence data indicate, at a national coarse-scale, that prohibiting road construction and reconstruction in inventoried roadless areas would not cause an increase in the number of acres burned by wildland fires or cause an increase in the number of large fires. The data further reveal that building roads into inventoried roadless areas would likely increase the chance for human-caused fires. Conversely, in areas that are already roaded, fire occurrence data for all causes, human and lightning, indicates that the number of large fires are dramatically higher than in inventoried roadless areas.

Using such suppression resources as smokejumpers and fire crews delivered by helicopters, the current fire suppression organization has been effective in suppressing at a small size approximately 98% of wildland fire starts in inventoried roadless areas. The Agency has a long history of successfully suppressing fires in inventoried roadless areas. This high level of suppression performance is expected to continue.

Over time, Alternative 4, when coupled with the effects described in the Fuel Management section of this analysis, would produce a fire environment in which larger fires occurred and the total acreage burned annually would rise. Under this alternative, any form of timber cutting, including thinning, would be prohibited. Therefore, forests would become thicker and denser with vegetation, resulting in an increase in fuel loading and associated potential increase in large forest fires.

After evaluating all fire occurrence data, the conclusion of this analysis is that overall fire potential is greater on NFS lands outside inventoried roadless areas than on lands inside inventoried roadless areas. Other national assessments have reached the same conclusion. “Wildland areas with complex terrain or a moderate or high road density have a moderate or higher risk of wildland fires” (USDA 1996b).

Once a fire becomes large, road access allows firefighting materials and personnel to quickly enter an area, resulting in lower suppression costs. It is doubtful, however, that a fire manager would know where to place a road before a large fire occurs, or how to pre-design a road for an effective access route to a future, potentially large fire.

During the 2000 fire season in the West, when conditions of high fire danger and drought were coupled with high fire occurrence, wildland fires became uncontrollable in roaded and inventoried roadless areas. To limit the size and number of forest and rangeland fires, fire managers must address the high fuel loads common to most of these ecosystems.

In public response to the DEIS, hundreds of respondents suggested that a direct link exists between the presence of roads and the occurrence of large fires. Without roads, one respondent explained, "you raise the probability of catastrophic fires." Another person wrote that without road access "fire control will be out of the question."

If building a road into an area where a uncharacteristic wildfire could potentially occur would limit the size, number, and intensity of future wildland fires, the following issues exist:

- To strategically locate a NFS road for fire control before the fire occurred would be a complex task of predicting the future. A fire manager would have to accurately predict all possible combinations of weather, fuel loadings, fire occurrence patterns, drought cycles, and seasonal weather events before road construction.
- The location of the current NFS road was based more on the extraction of commodities for commercial use than on creating a route for the speedy delivery of firefighters to forests that are at risk from uncharacteristic wildfire effects. In the past, road construction was paid for by the use that benefited most from the initial access (mainly timber harvesting). Therefore, if roads were built to prevent large fires, a new method of financing the construction would be necessary.
- Building a road into a forest at high risk from uncharacteristic wildfire effects could increase the incidence of human-caused fires. A human-caused wildland fire is nearly five times more likely to occur on essentially roaded lands than on **essentially unroaded** lands.
- Even in essentially roaded areas, firefighters must often walk long distances, negotiating steep mountainsides and thick brush to reach a fire area. The presence of a road, does not guarantee firefighters will have direct access to where a wildland fire is burning.
- Because of the rugged terrain, in most inventoried roadless areas it is not feasible to build roads into all areas at high risk from uncharacteristic wildfire effect. The inaccessibility of inventoried roadless areas helps to explain why roads do not currently exist in these areas.
- In many cases, even if one knew where a future large fire would occur, the environmental and economic cost of building a road into this high fire risk area would be higher than the value of the resource protected. Many inventoried roadless area forests are low in economic timber harvest value, which often is why these areas have not been logged.
- Even if roads were constructed into all inventoried roadless areas that are rated as moderate to high risk from large forest fires, a wildland fire burning there could still be given a low priority for fire suppression resources. (This occurred many times during the 2000 fire season.)
- In most cases, the highest priority for suppression resources would be where NFS land road networks currently exist, and where overall resource values are high (private property, for example, or timber stands that have been logged and replanted), not in inventoried roadless areas.
- Forest managers would concentrate their fire hazard reduction efforts on currently roaded areas where the fire hazard and threat to high value resources exists. Many fire ecologists

(USDA Forest Service 1996b; Agee, per. comm., Wildland Resources Center 1996) believe that many areas with roads have a higher fire hazard and the potential for more severe wildland fires than exists in inventoried roadless areas.

Burned Area Emergency Rehabilitation

Affected Environment

Severe impacts may occur on portions of watersheds that experience large wildland fires, activating a special program designed to handle these emergencies. The Burned Area Emergency Rehabilitation (BAER) program was developed in 1974 to assess severely burned areas and to implement treatments to prevent watershed emergencies (severe erosion, flooding, landslides, etc.) on the burned area and downstream. Teams of specially trained professionals evaluate fire effects, design and install treatments, and monitor the effectiveness of those treatments. Typical treatments include, but are not limited to, building sediment retention structures in stream channels, improving drainage on roads and trails, seeding to improve vegetative cover, mulching bare soils, placing burned trees or other materials on the slope contour to slow runoff and capture eroded soil, and similar measures (Robichaud and others 2000).

Burned areas are evaluated for treatment needs regardless of their location (Wilderness, inventoried roadless area, roaded areas, etc.). Decisions to treat areas are based upon predicted potential damages to life, property, and resources. The range of treatments may vary, however, depending on terrain or management restrictions (such as in Wilderness), or treatment costs may vary depending on accessibility or other factors.

The vast majority of BAER activities take place in Regions 1 through 6 although Regions 8 and 9 have used the BAER program on occasion. The level of BAER activities varies widely from year to year, depending on the severity of the fire season and the number of large and damaging fires that occur. BAER activity shifts between regions of the country. For example, the 1996 season saw considerable activity in the Southwest, intermountain West, and California. The 2000 fire season is very active in most regions except the Pacific Northwest. California always seems to have a busy fire year with significant BAER projects.

The number of BAER projects and funding varies widely between years. A very active fire season occurred in 1996, with 58 projects at a cost of more than $10 million. In 1997, which was considered a modest year, there were 10 BAER projects that cost about $1.1 million. A relatively quiet year was in 1998, with only four projects at a cost totaling about $1.0 million. A significant increase occurred in 1999, with 18 projects totaling more than $6.7 million.

The 2000 fire year will be a record fire year and a record BAER year both in terms of projects initiated and total funds spent. As of September 16, 2000, the Forest Service has approved 57 projects with more than 12 remaining to be submitted for approval. Total approved funding to date is more than $25 million. Projects have treated more than 200,000 severely burned acres. Treatments so far include seeding on 78,000 acres (this includes 14,000 acres of treatment to prevent the spread of non-native invasive species),

4000 acres of mulch, 11,000 acres of contour erosion barriers, 390 miles of road maintenance and culvert improvement, and 71 miles of trail maintenance (Copenhagen 2000).

Alternatives 1-3

Since the number of large wildland fires is expected to increase during the next 20 years, additional BAER activities would be required to assess conditions, design and install treatments, and monitor effectiveness. This expected rate of increase should slowly diminish as **fuels treatments** in priority areas become effective over larger landscapes. These alternatives would have no short- or long-term effect on the amount of BAER activity required by the Agency.

Alternative 4

Effects would be similar to Alternatives 1 through 3 except the number of large fires is likely to continue to increase slightly after 20 years due to expected lower rates of fuel treatments. Increased BAER activity is expected as follow-up to these fires to protect water, soil, and air resources and life and property on-site and downstream.

The indirect and cumulative effects of the alternatives on Burned Area Emergency Rehabilitation are discussed with the indirect and cumulative effects on physical resources.

Insects and Disease

Affected Environment

Many forestlands across the country are at risk of serious insect attack and disease infection. In the inland Western United States, trees across wide areas of the landscape are dying faster than they are growing or being replaced (Mutch and others 1993). Because of this, tree mortality conditions exist that almost guarantee large and severe wildland fires. Other forest resources, aquatic, wildlife, watershed and other values, are also affected. Managers of public and private forests are being challenged to take rapid preventative action to restore these forests to conditions more similar to their historic range of variability or at least to a socially desired condition (Edmonds and others 2000).

In 1996, the Forest Service initiated a mapping effort to evaluate forest health risk on all forested lands in the United States. A geographic information system database was created that displays NFS lands most at risk of mortality from insects and diseases. This database is still under development, in its current form, it is recommended for use only at the national scale. It will be used in combination with other layers (fire, T&E species, and wildland-urban interface), still under development, to help set priorities for addressing forest health problems (Lewis 2000).

Information from the insect and disease geographic information system layer has been used at a broad national scale to identify acres at risk from substantial tree mortality and

growth loss from insects and disease. The **endemic** insect and disease rate is approximately 5% mortality. Areas are at risk if 25% or more tree mortality or growth loss (beyond the endemic level) can be expected over the next 15 years. Gypsy moth, root diseases in the West, mountain pine beetle, and southern pine beetle accounted for more than two-thirds of the acres at risk of tree mortality. Dwarf mistletoes and heart rot accounted for nearly three-fourths of the acres at risk of growth loss (Lewis 2000).

Nationally, approximately 58 million acres of all ownerships are at risk of tree mortality, and 24 million of those acres are NFS lands. About 3 million of these acres on national forests occur inside inventoried roadless areas where road construction is not currently allowed by land management plans. In inventoried roadless areas, another 4 million acres at risk are in areas where road construction and reconstruction are currently permitted by the land management plans. The percent of area at risk in inventoried roadless areas is about the same as the percent of area at risk for all NFS lands.

The majority of the areas at risk from root disease are in large, highly concentrated areas in Western Montana and northern Idaho. Mountain pine beetle high-risk areas are found throughout the West but are concentrated in Washington, Oregon, and Montana. Growth-loss risk projections identified approximately 48 million acres across the country. Dwarf mistletoe infestations across the West accounted for slightly more than a third of those acres, and heart rot in Alaska made up slightly more than a third (Lewis 2000).

Geographic information system data for insect and disease risk of mortality was combined with fire risk data to identify, at a coarse national scale only, joint areas of concern. Table 3-25 below identifies the combined risk by Forest Service region.

Table 3-25. Acres (in thousands) of inventoried roadless areas at combined risk of insect, disease, and fire.

Region [a]	Inventoried roadless areas	Inventoried roadless areas at combined risk of insect, disease, and fire
Northern (1)	9,005	246
Rocky Mountain (2)	6,183	43
Southwestern (3)	2,771	35
Intermountain (4)	15,960	221
Pacific Southwest (5)	4,200	93
Pacific Northwest (6)	4,002	102
Southern (8)	954	106
Eastern (9)	664	24
Total	**43,739**	**870**

[a] Region 10 (Alaska) is not included. Data unavailable.
(Roadless Database 2000)

While these combined at-risk acres have a critical need for forest health treatments, such as thinning and fuels reduction, it should be noted that the percentage of these acres in inventoried roadless areas is slightly lower than that of the combined at-risk acres for all NFS lands.

Given the scope of the forest health problem, the controversy associated with roadless areas, and the cost of building new roads, it is likely that higher priority for treatment to reduce the impacts of insects and disease would be assigned to roaded areas than to inventoried roadless areas.

Alternative 1- No Action

Road construction and timber harvest would continue to be used, consistent with land management plan direction, to treat a portion of high-priority stands within inventoried roadless areas at risk of insect or disease mortality where stand location and other factors make timber harvest economically feasible.

Under this alternative, timber harvest could be used to improve forest health conditions (e.g., suppressing insect infestation, thinning to improve stand vigor, or fuels reduction) on an estimated 18,000 to 19,000 acres per year in inventoried roadless areas during the first 5 years following rule implementation.

New road construction or reconstruction would reduce the cost of mechanical treatment needed to achieve the resource objectives or desired conditions. New road construction or reconstruction would provide closer access for equipment and vehicles to carry out timber harvest, fuels reduction, or other stand treatment activities. Depending on the distance from the nearest road and the size and quantity of material removed, per-acre costs for stand treatments are likely to be higher in unroaded areas than in roaded areas. This is due to lower production rates in unroaded areas for moving logs, whole trees, or bundles of trees from the stump to the landing. Roads are further from where the trees are removed or where the work is actually done. Skidders must travel longer distances, other equipment must travel further from the road to the job site, and work crews must walk farther. Total management costs of multiple treatments over time, when road construction is prohibited, may be higher than comparable situations where road construction is permitted. This includes consideration of road construction and maintenance costs.

It is unlikely that national forest managers would have any substantive impact on insect and disease condition over the next 5 years. Over the next 20 to 40 years, though, this alternative is likely to be substantially more effective in reducing insect and disease problems than any of the other alternatives. In this longer term, we would expect an average of 13,000 to 15,500 acres of timber harvest per year within inventoried roadless areas that would help improve forest health. However, the Agency may still be unable to treat all of these acres because of limited budgets, resource concerns, the high cost of road construction, and increasing levels of public controversy over roadless area management.

Alternative 1 would allow a higher level of timber harvest in inventoried roadless areas than the other alternatives. This would produce higher revenues, resulting in more funds for Brush Disposal (BD) and Knutson-Vandenberg (K-V) collections. These funds are collected from timber sale receipts and could be used for fuel reduction and thinning that otherwise would require appropriated funds.

Alternative 2

Under this alternative, timber harvest not requiring new road construction or reconstruction would be used to accomplish forest health improvement objectives (e.g., suppressing insect infestation, thinning to improve stand vigor, fuels reduction) on an estimated 8,000 acres per year in inventoried roadless areas during the first 5 years following rule implementation. Fewer acres of forest health treatment would be accomplished under this alternative (compared to Alternative 1) because road construction is prohibited.

Timber harvest could be used in the following areas:

- Adjacent to roads.
- Where logging equipment (**forwarders**, skidders, etc.) could move products long distances to roads.
- Where logging equipment could move products to off-road landings or where skyline **yarders** or helicopters could swing the logs or trees to the nearest roads.
- Where standard helicopter or skyline yarding is feasible.

Depending on the value of the product being removed, helicopter yarding is economically feasible up to 1 mile from the nearest road. Since this alternative allows timber harvest for commodity purposes, the larger and higher-value trees removed would generate more revenue and offset higher logging costs. In the Pacific Northwest, timber-harvesting costs for skyline yarding are approximately twice that for ground-based equipment, and helicopter costs can range from 3 to 5 times the ground-based equipment costs (Reutebuch 2000).

In the long term, beyond the first 5 years, 3,000 to 4,000 acres per year may be accomplished by timber harvest to improve forest health, reflecting higher costs over time as forest lands nearest to existing roads are treated.

Alternative 3

Under this alternative, types of forest-health-treatment activities would be similar to those in Alternative 2. Timber harvest for stewardship purposes only would be used to accomplish forest-health improvement objectives (e.g., suppressing insect infestation, reducing the spread of disease, thinning to improve stand vigor, and fuels reduction) on an estimated average of 4,400 acres per year in inventoried roadless areas during the first 5 years following rule implementation. Fewer acres of forest health treatment would be accomplished under this alternative (compared to Alternatives 1 and 2) because treatment cost/acre would be substantially higher due to the road construction prohibition and lower harvest volumes/acre.

Less work would be done using timber sale contracts because the smaller-diameter, lower-value trees would likely result in fewer economically viable timber sales. More forest health objectives would have to be accomplished using **service contracts** or means other than timber sale contracts, which would require more appropriated funds. In the long term, beyond the first 5 years, 1,200 to 1,400 acres per year may be accomplished by

timber harvest to improve forest health, reflecting higher cost over time as forest lands nearest to existing roads are treated.

Alternative 4

With timber harvest and road construction prohibited in inventoried roadless areas, this alternative would provide little opportunity to improve forest health conditions within inventoried roadless areas. Insect infestation and disease epidemics would run their course. None of the acres treated under the other alternatives would be treated under Alternative 4. It is not an option to use mechanical timber harvest or other silvicultural treatments for fuel reduction before a prescribed burn.

Other Indirect and Cumulative Effects on Insects and Disease

Past Actions – Combined incremental effects of wildland fire suppression and reductions in timber harvest from Federal lands has led to change in vegetation structure and species composition and an increasing accumulation of forest fuels over large landscapes of most of the interior West, including inventoried roadless areas. Removals of timber from NFS lands in 1996 were approximately 20% of growth that year (USDA Forest Service 1999j). While the 1996 rate of removal is not a current annual average, it indicates an ongoing and substantial net increase in volume of wood fiber on NFS lands.

Present Actions – The primary cumulative impact of Alternatives 2, 3 and 4, when added to other past, present and reasonably foreseeable future actions, is the continuing change in vegetation structure and species composition, and the accumulation of this vegetation and forest fuels. Prohibition of road construction and reconstruction within inventoried roadless areas would result in a large proportion of inventoried roadless area acres remaining largely inaccessible (from an economic feasibility standpoint) to equipment necessary to carry out vegetation management. Some of these lands are not suitable for timber production; on other lands, road construction is not economically feasible now. Most lands within one-quarter to one-half mile of an existing road would continue to be managed using timber harvest or other methods of treatment where appropriate. However, cost per acre would increase substantially and proportionally with distance of the project from the nearest road. Total acres treated within inventoried roadless areas are likely to be less than if road construction is permitted. Trees inside these economically inaccessible (under Alternatives 2 and 3) portions of inventoried roadless areas that are killed by insects, disease, windthrow, or fire would deteriorate and add to fuel loading. Wildland fires that subsequently burn these areas may cause severe impacts to soil and water resources because higher concentrations of natural fuels would cause the fire to burn hotter. However, even if road construction and reconstruction in inventoried roadless areas were permitted, it may not be possible to treat these acres because of resource concerns, the high cost of road construction, or public controversy.

Other agency and Federal proposals will continue to affect the Forest Service timber program at both the national and local levels. Current emphasis such as that found in the

Interior Columbia Basin Ecosystem Management Project, the Sierra Nevada Framework, and the Cohesive Fire Strategy calls for a mix of longer rotation periods to increase old-growth characteristics, and thinning treatments that would continue the removal of small diameter trees. Other strategies such as the Lynx Conservation Assessment and Strategy call for preservation of early seral stage habitat that would preclude some future thinning activities.

Reasonably Foreseeable Future Actions – Natural disasters such as wildland fires, windstorms, and insect outbreaks will continue to occur, and the Agency is likely to continue salvaging a portion of the dead and dying trees. These **salvage** sales will continue to be designated as high priority for harvest due to biological and economic factors. The biological factor is the need to control secondary insect outbreaks, like Ips beetle, southern pine beetle and spruce bark beetle, whose populations would increase rapidly by attacking damaged trees and then spreading into the surrounding healthy trees. The economic factor is the rapid deterioration of the dead material due to insect damage, stains, rots, and checking. If dead or dying trees are not salvaged quickly, there will be nothing to salvage.

Timber salvage sales generate vegetation management work completed on the ground and receipts to the Federal treasury from the sale of usable trees. A portion of the money collected from the resulting timber salvage sales is used to help cover the costs of essential rehabilitation work and reforestation. If the Agency elects to reduce the use of timber salvage sales because of continuing public controversy, the use of service contracts funded by appropriations must increase to accomplish fuels reduction or other desired vegetative treatments. Net cost per acre to achieve desired conditions rises substantially over that associated with use of timber salvage. The higher cost may be a disincentive to achieving desired conditions within inventoried roadless areas.

Wildland fires and other natural disasters, especially during a wildland fire season like the one experienced in 2000 in the West, will also eliminate or devalue the timber on some timber sales currently under contract and some that were planned but not offered for sale. However, it is anticipated that the acres of vegetation management that otherwise would have been accomplished through timber harvest will be recovered or slightly increased due to restoration and salvage operations over the next 2 years.

Biodiversity

Biodiversity is the variety and abundance of species, their genetic composition, their communities, and the ecosystems and landscapes of which they are a part (Wilson 1988; Adams and others 2000). The United States has a rich heritage of biodiversity, due in large part to its great topographic and climatic diversity. Extending north to south approximately 50° latitude and east to west more than 120° in longitude, this country contains 21 of 28 globally defined ecoregions and supports at least 4,500 distinct vegetative communities. Nearly 16,000 species of the world's vascular plants are found within the United States, and about 10% of freshwater fish species and 9% of mammal species (Adams and others 2000). Natural disturbance processes have been and continue to be instrumental in the development and maintenance of this biodiversity (Noss 1994).