3-7. Natural Disturbance Processes

3-7.1. Fire

3-7.1.1. Affected Environment

Historically, fire was a major force in shaping the composition and structure of the plant communities, and ecological processes within the Black Hills NF. In the Forest of today, vegetation composition and structure is more the product of human management activities (USDA Forest Service 1996a p. III-203). Fire exclusion, fire suppression, and resource management have influenced forest composition since permanent European settlement began in 1874. In some areas of the Forest, fire exclusion and land uses may have resulted in pine forests that apparently developed at the expense of meadows and hardwoods such as aspen. A comparison of 1874 with modern photographs shows that in nearly every case where Custer's expedition traveled many more trees are growing today. These trees tend to be smaller and growing closer together (Grafe and Horsted 2002).

To facilitate a fire-influence discussion, it is useful to review some terminology concepts commonly used in fire regimes and fire-severity literature. A "fire regime" is a summary description of the prominent characteristics of fire occurrence and fire effects within a specified area (**Table 3-41**). Variability in fire regimes is important in creating the structure, composition, and landscape character of the ecosystems.

Table 3-41. Components Of A Fire Regime (Modified From Romme et al. 2003a, 2003b)

Fire Frequency	Number of fires occurring within a specified area during a specified time period, e.g., number of fires in the Black Hills National Forest per year
Fire Size or Fire Extent	The size (acres or hectares) of an individual fire, or the statistical distribution of individual fire sizes, or the total area burned by all fires within a specified time period, e.g., total acres within the Black Hills National Forest that burned in 2002
Fire Interval (Or Fire Recurrence Interval)	The number of years between successive fires, either within a specified landscape or at any single point within the landscape
Fire Season	The time of year at which fires occur, e.g., spring and fall fires, when most plants are semi-dormant and relatively less vulnerable to fire injury, or summer fires when most plants are metabolically active and relatively more vulnerable to fire injury
Fire Intensity	Amount of heat energy released during a fire rarely measured directly, but sometimes inferred indirectly from *fire severity*
Fire Severity	Fire effects on organisms and the physical environment (see **Table 3-42**)

One of the most important aspects of a fire regime is the fire "severity" or impact of the fire on organisms and abiotic components of the ecosystem. The term "fire severity" may be used with many different meanings (see **Table 3-42**). The meanings differ depending on whether the focus is on fire effects on the forest canopy and understory or on the soil and soil surface. Note that the definitions may be inconsistent, e.g., a *high*-severity fire from the perspective of the forest canopy may be *low*-severity from the soil perspective. However, a high-severity canopy fire almost always accompanies high-severity soil effects. The definitions used in the BAER[1] process (burned area emergency rehabilitation) also are included (modified from Romme et al 2003a, 2003b).

1 BAER – Burned Area Emergency Response is a Forest Service assessment process used immediately after a wildfire to determine the need for and to prescribe and implement emergency treatments to minimize threats to life or property or to stabilize and prevent unacceptable degradation to natural and cultural resources resulting from the effects of a fire. (See Forest Service Manual 2523.)

Table 3-42. Commonly Used Synonyms And Definitions Of The Concept "Fire Severity."

Effects on the Forest Canopy and Understory Vegetation	**High severity** = **Lethal** = **Stand-replacing-** the fire kills all or most canopy and understory trees, and initiates a succession process that involves recruitment of a new cohort of canopy trees
	Low-severity = **Non-lethal** = **Non-stand-replacing-** the fire kills few or no canopy trees, plus a variable number of understory trees (from none to many), and does not result in recruitment of a new canopy cohort but creates or maintains an open, low-density forest structure
	Mixed-severity = **Intermediate severity-** used in two different ways: *Within-stand* – the fire kills an intermediate number of canopy trees (less than high-severity but more than low-severity), and may or may not lead to recruitment of a new canopy cohort *Among-stand* – the fire burns at high severity in some stands but at low or intermediate severity in others, creating a fire severity mosaic across the landscape
Effects on the Soil and Soil Organisms	**High severity-** the fire consumes all or nearly all organic matter on the soil surface, as well as soil organic matter in the upper soil layer, and kills all or nearly of the plant structures (e.g., roots and rhizomes) in the upper soil layer … results in possible water repellency and slow vegetative recovery
	Low-severity- the fire consumes little or no organic matter on the soil surface or in the upper soil layer, and kills few or no below ground plant parts … results in limited or no water repellency, and rapid vegetative recovery via re-sprouting
Definitions Used by BAER[1]	**High-severity-** areas of crown fire, i.e., leaves and small twigs consumed by the fire … always stand-replacing
	Moderate-severity- areas where the forest canopy was scorched by an intense surface fire, but the leaves and twigs were not consumed by the fire … may be stand-replacing or not, depending on how many canopy trees survive the scorching
	Low-severity- areas where the fire burned on the surface at such low intensity that little or no crown scorching occurred (may include small areas that did not burn at all) never or rarely stand replacing

Fire regimes varied greatly, both spatially and temporally, throughout the Black Hills during the historical period. The variation is a result of underlying differences in vegetation characteristics, local climate, and regional climate. Within this framework of natural variation in vegetation and climate, three general kinds of fire regimes are recognized as possibly occurring in the Black Hills (**Table 3-43**).

Table 3-43. Three General Types Of Fire Regimes In The Black Hills.

	General Characteristics	Major Controlling Variables	Distribution
Frequent, Low-Severity Fire Regimes	Fires recur within any stand at relatively short intervals (10 - 50 years), burning at low severity in the canopy and soil, and variable severity in the understory	***Weather*** (fires occur during dry periods), ***Climate*** (extensive fires tend to occur in dry years that follow 1- 3 wet years), and ***Fuels*** (fuels gradually accumulate during the intervals between successive fires)	Evidence of surface fire in ponderosa pine forests throughout the Black Hills, most frequent at the Prairie-Forest ecotone and less frequent in interior forests at mid to high elevations (Fisher et al. 1987, Brown and Sieg 1996, Brown and Sieg 1999, Brown et al. 2000, Wienk 2001, Brown 2003, Wienk et al. 2004).
Infrequent, High- Severity Fire Regimes	Fires recur within any stand at long intervals (100 – 500+ years), burning at high severity in the canopy and understory, and at variable severity to the soil	***Weather*** and ***Climate*** are the primary controllers (most ignitions extinguish by themselves because of wet conditions; extensive fires occur only in very dry summers; variability in fuels usually has little influence on fire frequency, extent, or severity)	Large areas of even-aged and dense forest and of closed canopy, mature or old-growth forest at the time of settlement are evidence of stand-replacing disturbance (Graves 1899, Shinneman and Baker 1997).
Mixed Severity Fire Regimes	These fire regimes are intermediate between the Frequent, Low- Severity and the Infrequent, High- Severity Fire Regimes. Fires occur at variable intervals (10 - >100 years), and burn at variable severity (patches of high severity intermingled with patches of low or intermediate severity)	***Weather***, ***Climate***, and ***Fuels*** all influence fire frequency, extent, and severity, in complex ways that are not well understood, with enormous variability over time and space	Proposed as the dominant model for fire regimes in ponderosa pine forests of the Black Hills. Under this model, surface fire forms the background process creating forest structure and landscape pattern. However, fires sometimes burn with mixed severity, with both a surface fire and a stand-replacing fire component, and may sometimes create large areas of high severity burns. Forest patches are variable in size and within patch structure (Lentile et al. in press)

3-7.1.1.1. Historic Fire Regimes And Forest Structure

Throughout the southern and central Rocky Mountain west, a prevalent understanding of fire regimes and the resulting characteristic structures in ponderosa pine forests is developed by a long tradition of research in the extensive ponderosa pine forests of the Southwest (e.g., Cooper 1960, Swetnam and Dieterich 1985, Baisan and Swetnam 1990, Savage 1991). In these southwestern forests, frequent, episodic surface fires, historically occurring at a frequency of 3 to 20 years, maintained open, low-density uneven-aged forests dominated by large, old trees (White 1985, Covington et al. 1994, Fule et al. 1997, 2002, Friederici 2003). Fire regimes of the Black Hills are often compared to the southwestern ponderosa pine forests. However, because of climatic and physiographic differences between the southwestern ecosystems and the Black Hills, the application of the southwestern model of frequent, low intensity surface fire is questionable.

Evidence For Infrequent, High Severity Fire In The Black Hills

Shinneman and Baker (1997) hypothesized that large areas of dense, even aged forest regenerating after large, stand-replacing fire events occurring at infrequent and irregular intervals were an important feature of the Black Hills landscape. They proposed that both low-intensity and stand-replacing fires are significant components of the disturbance regime of Black Hills forests and that large patches of continuous dense forest are a result of these large disturbances. Historical surveys document very dense young, post-fire forests and show photographs of forests burned in high-intensity crown fires (Graves 1899). Shinneman and Baker (1997) argue that the existence of large areas of closed forest conditions and anecdotal evidence of large historic fire supports the view that high severity fires were a feature of the forests before fire exclusion and suppression. There are proposed alternative explanations for large openings (e.g., disturbances other than fire) and recruitment resulting in dense forest conditions can be tied to favorable climatic conditions (Brown 2003). Regardless of the factors contributing to dense forest conditions, large, naturally dense forest stands did occur on the Black Hills landscape prior to Euro-American settlement (Graves 1899, McAdams 1995, Shinneman and Baker 1997, Brown 2003). Large stand-replacing fires have also occurred within the past 120 years. In the 1890s, a severe 20,000-acre fire near Deadwood and Lead was thought to be started by settlers, and in 1898, a 20,000-acre fire near Crow Peak was caused by lightning (Shepperd and Battaglia 2002). Throughout the 20th century, several fires burned areas from 7,400 to 22,000 acres. In 2000, the Jasper Fire burned approximately 83,500 acres.

Evidence For Frequent, Low Severity Fire In The Black Hills

Brown and others (2003) found no conclusive evidence that crown fire affected forest structure over large areas, and even-aged forest structure that has been cited as evidence of crown fires can be related to other historical processes. For example, large openings may be a result of tree mortality due to drought or mortality due to mountain pine beetle (Shepperd and Battaglia 2002, Brown 2003) and highly synchronous episodes of tree recruitment creating large, even aged stands that correspond temporally to wet periods (Brown 2003).

A number of recent tree ring studies attempted to characterize and quantify presettlement wildfire in ponderosa pine forests in the Black Hills and its effect on the landscape and the character of the forests. To date, six studies have documented the historical fire regime of different regions within the Black Hills. These studies looked at fire frequency in the context of factors that influence fire regimes: climate, elevation, topography, and fuel loads. Prior to fire exclusion, mean fire intervals ranged from a low of 10 to 12 years at the prairie/forest ecotone and generally the southern Black Hills to a high of 30 to 33 years at higher elevations generally in the northern Black Hills (Fisher et al. 1987, Brown and Sieg 1996, Brown and Sieg 1999, Brown et al. 2000, Wienk 2001, Brown 2003). Studies by Brown and others (1996, 1999, 2000, and 2003) cover the broadest area, representing the greatest geographic variability, and have resulted in the largest data set describing historical fire regimes.

Brown concluded that surface fire frequency in the Black Hills is less than ponderosa pine sites in the Southwestern United States. There are shorter fire seasons in the Black Hills, and there are large differences in precipitation patterns that contribute to variation in stand productivity and fuel dynamics between the two regions. Longer intervals between fires in the Black Hills contribute to greater fuel buildup and possibly more severe fire behavior than in the ponderosa pine forests of the Southwest. It is possible that canopy mortality during surface fires occurs more frequently and over larger areas than in the Southwest.

Brown's studies found that surface fires of varying frequency were common disturbances in Black Hills ponderosa pine forests prior to Euro-American settlement. The relative area burned in any single year was often extensive, with fires related to dry conditions, and dramatic changes in fire regime are coincident with the period of fire exclusion and fire suppression. Spatial heterogeneity is another important feature of the fire regime described in Brown's work.

Mixed Fire Regimes In Black Hills Forests

A consideration of the evidence for both infrequent severe fire and frequent surface fire suggests the possibility of an additional model for fire regimes in the Black Hills forested ecosystem. A detailed reconstruction of burn patterns and fire effects of the Jasper Fire and a comparison of retrospective information generated by the Jasper Fire with fire history reconstructions led to a conclusion that mixed-severity fire may have been common historically in the Black Hills (Lentile et al. in press). In this alternative model, moderately severe and infrequent severe fires, in conjunction with frequent surface fire, played an important role in shaping a spatially heterogeneous, multi-cohort ponderosa pine forest. Mixed-severity fire regimes are complex processes with a range of burn severity elements (surface, torching, and active crown fire), resulting in heterogeneous fire effects with mortality occurring in a wide range of patch sizes (Agee 1998, Arno 2000). Temporal and spatial variation in burn severity within a fire is related to weather, topography, and vegetation type (Eberhard and Woodward 1987, Turner et al. 1994) and variation among individual fires is influenced by climatic conditions (Lertzman et al. 1998, Heyerdahl 2001, Morgan et al. 2001). The severity of individual fires can vary both in time and space due to the combined influences of vegetation structure, terrain, short- and long-term weather and the location on the fire's perimeter (head versus flank versus rear) (Ryan 2002).

The mixed severity fire regime and associated variability in fire effects is consistent with the Black Hills fire history reconstructions that led to conclusions about the occurrence of frequent, low severity surface fire with infrequent, high severity stand-replacing fire (Brown and Sieg 1996, Shinneman and Baker 1997, Brown and Sieg 1999, Brown et al. 2000, Arno 2000, and Brown 2003). In summary, these studies would indicate that the *fire regime* in the forested areas of the Black Hills might be best described as a mixed severity fire regime.

Range Of Variation In Forest Structure And Landscape Pattern

The complex signature of fire effects of a mixed severity fire regime, coupled with the imprint of other forest disturbance processes and the strongly climatically driven recruitment episodes in Black Hills forests, would create a heterogeneous landscape with spatial and temporal variations in stand structures (**Table 3-44**). The predominant landscape of the 1800s was likely more diverse than the current forest. Much of the forest would have been maintained in an open condition due to the surface fire component of the fire regime. However, patches of dense forest, some of them quite large, are expected under the mixed severity fire regime and the influence of other disturbance processes particularly in the northern Black Hills.

Regardless of whether fires prior to 1900 were surface fires, mixed-severity fires, or stand-replacing fires, they often covered large areas. Tree regeneration and mortality under a surface-fire regime occur over longer time spans and across a greater range of spatial scales than that resulting from immediate, extensive stand-replacing fires. Relatively frequent surface fires occurring over a majority of the landscape would have resulted in open, low-density forest stands and heterogeneous landscape patterns (Brown 2003). Where a mixed severity fire regime is important, the severity of the fire either causes selective mortality in dominant vegetation, depending on different tree species' susceptibility to fire, or varies between understory and stand-replacement fire (Brown and Smith 2000). Uneven burning patterns in mixed fire regimes are enhanced by mosaic patterns of stand structure and fuels resulting from previous mixed burning. Thus, past burn mosaics tend to increase the probability that subsequent fires will also burn in a mixed pattern. Complex mountainous topography also contributes to variable fuels and burning conditions, which favors non-uniform fire behavior (Brown and Smith 2000). A wide range of fire effects may be expected in a mixed severity regime, creating variability in patch sizes and patch densities and overall greater heterogeneity than even a surface fire regime.

The range of white spruce may have expanded in response to reduced fire frequencies, and, in some cases, from early silvicultural practices that selectively removed pine from mixed stands. In some places, hardwoods such as aspen, birch, and bur oak probably have declined in extent due to increased conifer dominance. Understory herbaceous and shrub vegetation diversity may have declined due to higher pine and spruce densities (USDA Forest Service 1996a p. III-130).

Management Implications And Restoration Needs

The term *condition class* (see Glossary) has been developed to describe the degree to which the composition and structure of plant communities has departed from the historic fire regime. The number of missed fire-return intervals determines it with respect to the historic fire-return interval, and the current structure and composition resulting from the alterations to the disturbance regime. An area that is *Condition Class I* is within a historic fire interval range and the risk of losing key ecosystem components is low. In a *Condition Class II* the fire regimes have been moderately altered from their historical range resulting in moderate risk of losing key ecosystem components from changes in the size, frequency, intensity and severity of fires. *Condition Class III* fire regimes have been significantly altered from their historical range resulting in significant changes in the size, frequency, intensity and severity of fires. Condition Class III lands are at high risk from uncharacteristically severe wildfires due to significant changes in the vegetation composition and structure. The coarse-scale national data (Schmidt et al. 2002) characterize the Black Hills as primarily Condition Class III.

A finer scale analysis of condition class for the Black Hills was not undertaken for this amendment. However forest conditions over much of the range of ponderosa pine in the Black Hills exhibit conditions (hazard), which may result in severe crown fire. A subjective classification of these conditions indicates that most forested landscapes would be characterized as Condition Class II or III depending on the relative abundance of the vegetation classes, landscape position (northern vs. southern Black Hills) and the mix of surface and stand-replacing severity fires for those landscapes. Under these conditions the goals and methods of fuel reduction and ecological restoration may converge. Restoration of open, low-density forest stands and surface fire regimes over portions of the Black Hills landscape is desirable to meet ecological objectives and to reduce fire hazard.

Table 3- 44. Generalized Forest Landscape And Stand Structural Patterns Associated With Three Potential Fire Regimes In Ponderosa Pine Forests Of The Black Hills.

Fire Regime	Fire Extent	Landscape Pattern	Patch Sizes	Tree Density	Age Structure	Impact on Forest Overstory	Impact on Forest Understory and Herbaceous Vegetation
Frequent, Low-Severity Fire Regimes	Small areas to large landscapes depending on vegetation and topographic discontinuities	Finely grained landscape with large areas characterized by open, uneven aged conditions dominated by old trees	Small patch sizes (<10 ha) created by the fine scale of processes creating openings	Low density; sometimes park-like stands	Stands are uneven-aged and dominated by large, old trees; in some cases, uneven aged stands are composed of small, even aged patches	Mortality of mature trees is rare due to thick bark and high crowns	Frequent fire reduces density of saplings and pole-sized trees and kills the majority of tree seedlings; open canopy allows for herbaceous vegetation
Infrequent, High-Severity Fire Regimes	Large landscapes of almost complete overstory mortality	Coarsely grained landscape with very large patches of dense, even-aged forests	Small to very large patches (10-50,000 ha) created by large disturbance events	Dense, closed canopy stands	Even-aged young stands and dense mature or old-growth forests	Large areas of tree mortality; within a fire perimeter, there may be remnant surviving trees	Fires are stand replacing so there is usually complete mortality in the understory; closed canopy limits herbaceous vegetation
Mixed Severity Fire Regimes	Large landscapes with variable patterns of burn severity controlled by local fuel patterns, topography, vegetation type, and weather; variable patterns of burn severity result in variable effects to landscape and stand structures and patterns	Heterogeneous patch mosaics due to variable patterns of fire severity resulting in patchy mortality and variation in scales of pattern; dense patches resulting from severe fires are interspersed with relatively open, multi-aged forests maintained by periodic low-severity fire	Patch sizes vary from small (10 ha) to large (5000 ha) depending on local effects and burn severity patterns	Dense patches of varying size occur in a larger landscape of low density forest	Dense patches are composed of multiple distinct cohorts (original cohorts plus cohorts regenerating after moderate severity fire); open forest conditions are uneven-aged over broader areas	Patchy mortality of the overstory depending on pattern of burn severity	Surface fire component will reduce density of saplings and pole-sized trees and may create recruitment space for multiple cohorts forming denser patches; variable burn patterns will result in variable patterns of sapling and seedling mortality and variable patterns of herbaceous vegetation

Forest management would benefit from the perspective that takes into account the combined effects from variable sizes of recurrent surface fires and the broad-scale effects of climatic changes (including droughts and wetter periods) affecting the forest structure. Historical structural patterns referenced in Brown and Cook (in review) and documented in historic photographs justify restoration and maintenance of large openings, woodlands and open forest stands, retention of existing large trees wherever they are found, as well as large patches of dense even-aged trees. Such a mosaic of age and structural classes would be expected to provide the most diverse habitats for a broad spectrum of understory plant and wildlife species, including species such as the northern goshawk and its prey (Long and Smith 2000). Patches of denser forest structure and smaller trees are present in the Black Hills, but what is missing from virtually all ponderosa pine forests are openings and mosaics of different spacing, especially those containing larger and older trees. Increasing the area burned in prescribed fires and mechanical thinning to change stand and landscape fuel structures should be considered as complementary means to maintain or restore structural characteristics that promote landscape and species diversity (Brown and Cook in review).

3-7.1.1.2. Fire Occurrence 1970-2003

Background information regarding wildfire on the Forest is presented in the Final EIS for the 1997 Revised LRMP starting on page III-203. The following section updates fire activity to the present.

An analysis of fire records for the period of 1970 to 2003 indicates the Forest averages 137 fires per year that burn approximately 8,275 acres (**Table 3-45**). The analysis period includes the 2000 to 2003 fire seasons that had fire activity well above the established average levels.

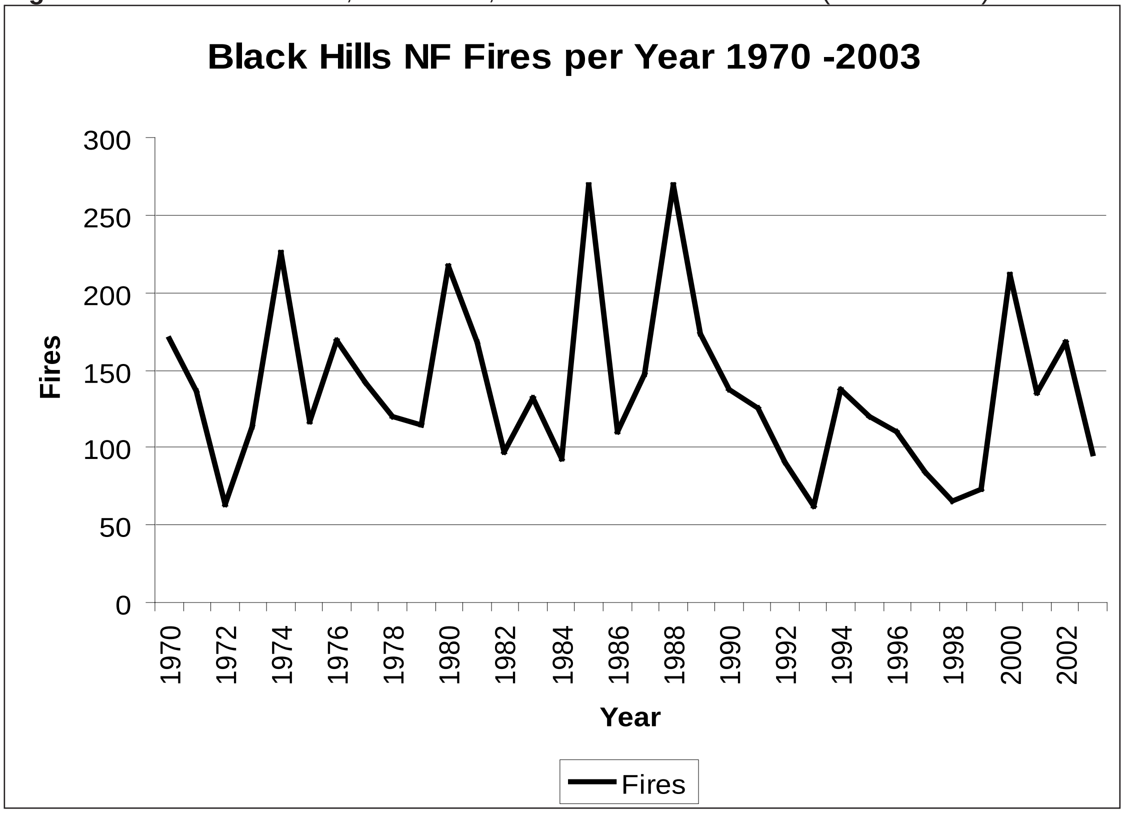
The majority of fires (97 percent) on the Forest are suppressed when small (less than 10 acres). Approximately 70 percent (96 fires per year) of all fires are caused by lightning but result in less than 40 percent of the acreage burned.

Table 3-45. Fire Occurrence By Size Class, 1970-2003, Black Hills National Forest (NWCG 2004)

Class	Size (Acres)	Annual Number of Fires	Annual Number of Acres	Percent of Fires	Percent of Acres
A	0 - 0.25	85.59	9.15	62.4%	0.1%
B	0.25 - 10	46.76	77.21	34.1%	0.9%
C	10.0 - 99	3.41	108.26	2.5%	1.3%
D	100 - 299	0.50	89.82	0.4%	1.1%
E	300 - 999	0.32	215.24	0.2%	2.6%
F	1000 - 4999	0.29	719.38	0.2%	8.7%
G	5000+	0.38	7,055.50	0.3%	85.3%
Total/Mean		137	8,274		

In the last 30 years there is a slight, although not statistically significant, downward trend in the number of fires per year. Persistent drought has caused fire intensity and size to increase dramatically since 2000. Prior to 2000, fires consumed an average of 2,400 acres annually. In the last 4 years, 35,000 acres have burned on the average (including the very large Jasper Fire). Very active fire seasons and extreme fire behavior coincide with periods of drought.

Figure 3-21 Fire Occurrence, 1970-2003, Black Hills National Forest (NWCG 2004)



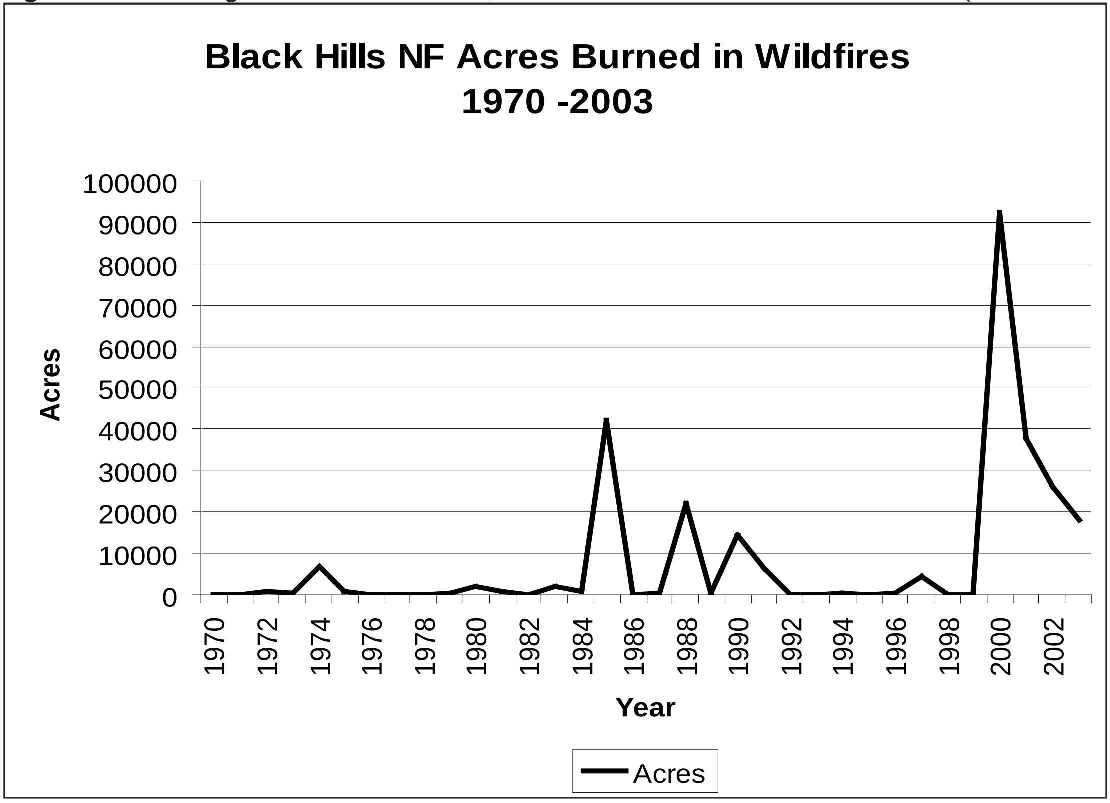
In 1998, 66 fires occurred, which is below average. Lightning caused 35 fires. Only 37 acres burned in these fires (USDA Forest Service 1999b). In 1999 168 acres burned in 73 fires, 22 of which were lightning caused (USDA Forest Service 2000a).

In 2000, due to extended dry weather, fire occurrence was much above average. There were 212 fires, 134 of which were lightning caused. A record of 92,481 acres of NFS land burned. The 83,500-acre arson-caused Jasper Fire was the largest (USDA Forest Service 2001a).

In 2001 there were 135 fires, 67 of which were lightning caused. This is near the Forest average of 137 fires, but the number of lightning fires was below normal. The total of 37,788 acres burned is well above the Forest average acres. The three biggest fires were the 14,990-acre Elk Mountain Fire, the 11,770-acre Rogers Shack Fire, and the 10,547-acre West Hell Canyon Fire (USDA Forest Service 2002).

In 2002 168 fires burned about 26,059 acres. Lightning caused 135 of these fires. The Battle Creek Fire was the largest totaling 13,495 acres and was human caused (USDA Forest Service 2004a).

Figure 3-22. Acreage Burned In Wildfires, 1970-2003. Black Hills National Forest (NWCG, 2004)



In 2003, 96 fires burned 18,199 acres of NFS land. This is below the Forest average of 137 fires. Eighty-one were lightning caused and 15 human caused with both ignition sources well below the respective annual norms of 101 and 38. The only fire that exceeded initial attack capabilities on the Forest was the lightning-caused Red Point Fire that encompassed 17,500 acres (10,773 NFS acres) (USDA Forest Service 2004f).

There were 122 fires in 2004, which was below the Forest average of 139. Ninety-four were lightning and 28 were human caused. A total of 143 acres burned.

3-7.1.2. Resource Conservation Measures

Alternatives were developed to address species viability and reduce-fire hazard and insect risk. These alternatives differ by focus on species viability, minimizing human disturbance, or reducing fire hazard and insect risk. Alternatives also vary the fire-hazard rating objective in the WUI. For Forest-wide analysis planning purposes, the WUI is defined as 1.5 miles from ARCs in Alternatives 3, 4, and 6. Alternative 6 also includes an additional 300 feet from all non-federal lands to encompass structural and other improvements and values existing and expected in the future on private lands. See Appendix B for additional discussion of WUI and ARCs. Several Forest-wide and management area goals, objectives, standards, and guidelines are included in each alternative to address fire-and-insect management. Some goals, objectives, standards, and guidelines are common to all alternatives. Those that vary among alternatives are presented below.

- New Goal 10 is developed for Alternatives 3, 4, and 6. Goal 10 is designed to establish and maintain a mosaic of vegetation conditions to reduce the occurrence of severe wildfire, insect and disease events, and facilitate insect management and firefighting capability. Alternative 6 targets this emphasis near ARCs and non-federal land and across the Forest. Alternative 4 emphasizes treatments only adjacent to ARCs. Alternative 3 emphasizes treatments adjacent to ARCs and sensitive at-risk resources.

Specific objectives pursuant to Goal 10 include the following:

- In Alternatives 3 and 4, Objective 10-01 manages for a moderate-to-low fire-hazard rating on 50 percent of the WUI, except in certain management areas. Within the WUI, fuel treatment in proximity to structures will be guided by current National Fire Protection Association (NFPA) 1144 standards.
- In Alternative 6, Objective 10-01 strives for a moderate-to-low fire-hazard rating on 50 to 75 percent of the WUI, and 50 percent in all other areas of the Forest except in certain management areas. Within the WUI, fuel treatment in proximity to structures will be done to current NFPA 1144 standards.
- Objective 10-02 establishes timeframes for attaining scenic integrity objectives (SIO) following fire-hazard reduction treatments.
- Objective 10-03 would reduce fire hazard between RNAs and values at risk (ARCs and other resource values) to a moderate-to-low rating within 5 years after any RNA designations.
- Objective 10-04 (originally Objective 223) promotes the use of prescribed fire in Alternatives 1, 2, 3, and 4 to achieve desirable vegetation diversity and fuel profiles on 2,000 to 8,000 acres per year for the next decade. There is not a treatment acre objective in Alternative 6; it is incorporated into Objective 10-01.
- In Alternatives 3, 4, and 6, Objective 224 has been moved to Goal 10 to become Objective 10-05. It addresses fuel treatment and has not changed from the 1997 Revised Forest Plan under any of the alternatives.
- In Alternatives 3, 4, and 6, Objective 225 has been moved to Goal 10, Objective 10-06 (new). A management area for RNAs is added and terminology for the appropriate management response (AMR) is updated (see Table 3-46). There are no changes in the AMR shown in the 1997 Revised Forest Plan (page II-54). A project-specific wildland-fire use (WFU) plan would have to be prepared before using WFU. There is some indication that WFU may not be appropriate given proximity to non-NFS lands throughout the Black Hills and potential for very rapid increase in fire size.
- In Alternatives 3, 4, and 6, Objective 226 has not been changed from the 1997 Revised Plan, but is moved to Objective 10-07 (New).
- In Alternatives 3, 4, and 6, Objective 227 has been moved to Goal 10. Under Alternatives 3 and 4, Objective 10-08 (New) strives for treatment of 12,500 to 20,000 acres of activity and natural fuels each year during the next decade, consistent with the need to protect life, property, and natural resources from the threat of wildfire. This acreage includes acres specified in Objective 10-04. In Alternative 6, the treatment levels may vary as needed to achieve overall fire-hazard objectives in Objective 10-01.

Table 3-46. Fire Management Direction Summary

Fire Management Unit	Management Area Prescription		Appropriate Management Response (AMR)					Prescribed Fire Use
	Area	Primary Resource Emphasis	**Confine**	Contain	Control	Wildland Fire Use	Restrictions	
Wilderness	1.1A	Black Elk Wilderness *PL = 1 PL = 2 PL =/> 3 7,961 Acres	Yes Yes Yes	Yes Yes Yes	 Yes Yes	Yes	***SJ<10 Acres **Restrictions on Mechanical Equip. / Retardant	Yes
Research Natural Areas	2.2	Research and education.	Yes	Yes	Yes	No	Follow direction in establishment record. use minimum impact suppression techniques.	Yes, if provided for in establishment record for the RNA
Botanical	3.1	BAs PL=1 PL =/>2	Yes Yes	Yes Yes	 Yes	Yes	SJ<5 Acres	Yes
Wilderness	3.2A	Inyan Kara Mountain	Same as for Management Area 1.1A					Yes
General Resources	3.31	Back Country Motorized Recreation Emphasis	Yes	Yes	Yes	Yes	SJ<10 Acres	Yes
General Resources	3.32	Back Country Non-Motorized Recreation Emphasis	Yes	Yes	Yes	Yes	SJ<10 Acres	Yes
General Resources	3.7	Late Successional Forest Landscapes	Yes	Yes	Yes	Yes	SJ<10 Acres	Yes
General Resources	4.1	Limited Motorized Use and Forest Product Emphasis	Yes	Yes	Yes	No	SJ<10 Acres	Yes
High Use	4.2A	Spearfish Canyon	Yes	Yes	Yes	No	SJ<5 Acres	Yes
Experimental Forest and Scenic Byway	4.2B	Peter Norbeck Scenic Byway (Within Norbeck Scenic Byway)	Yes	Yes	Yes	No	SJ<10 Acres	Yes
High Use	5.1	Resource Production Emphasis	Yes	Yes	Yes	No	SJ<5 Acres	Yes

Table 3-46. Fire Management Direction Summary

Fire Management Unit	Management Area Prescription		Appropriate Management Response (AMR)					Prescribed Fire Use
	Area	Primary Resource Emphasis	**Confine**	Contain	Control	Wildland Fire Use	Restrictions	
Southern Hills	5.1A	Southern Hills Forest and Grassland Areas	Yes	Yes	Yes	No	SJ<15 Acres	Yes
High Use	5.2A	Fort Meade VA Hospital Watershed	Yes	Yes	Yes	No	SJ<5 Acres No Heavy Equip	Yes
Experimental Forest and Scenic Byway	5.3A	Black Hills Experimental Forest	Yes	Yes	Yes	No	SJ<10 acres	Yes
Experimental Forest and Scenic Byway	5.3B	Sturgis Experimental Watershed	Yes	Yes	Yes	No	SJ<10 acres	Yes
Wildlife	5.4	Big Game Winter Range Emphasis	Yes	Yes	Yes	Yes	SJ<15 Acres	Yes
Wildlife	5.4A	Norbeck Wildlife Preserve	Yes	Yes	Yes	Yes	SJ<15 Acres	Yes
General Resources	5.43	Big Game/ Resource Production	Yes	Yes	Yes	Yes	SJ<10 Acres	Yes
General Resources	5.6	Forest Products, Recreation and Big Game Emphasis	Yes	Yes	Yes	Yes	SJ<10 Acres	Yes
High Use	8.2	Developed Recreation Complexes	Yes	Yes	Yes	No	SJ<5 Acres	Yes

*PL = Preparedness Level as defined in the Forest Fire Management Plan (FMP)
** See Wilderness Fire Suppression in FMP for criteria for equipment use in wilderness
*** SJ = Suppression Object

The Fire Management Plan (FMP) provides implementation guidance. Suppression options range from monitoring with minimal on-the-ground actions to intense suppression actions on all or portions of the fire perimeter. The AMR is developed from analysis of the local situation, values to be protected, management objectives, external concerns, and land use. In Alternatives 3, 4, and 6, the range of suppression responses established in the Forest Plan at page II-54 is replaced with the menu of AMR options allowed for each Management Area displayed in **Table 3-46**. No substantial changes have been made.

- Goal 11 has been established for Alternatives 3, 4, and 6. Goal 11 is designed to enhance or maintain the natural rate of recovery after significant fire and other natural events while maintaining a mosaic of fuel-loading conditions to facilitate future fire-suppression activities. Alternative 4 adds the words “Outside of reserves,” to the beginning of the goal.

Objectives pursuant to Goal 11 include the following:

- In Alternatives 3, 4, and 6, Objective 11-01 targets achievement of non-emergency watershed condition as soon as possible after a fire event, but generally no later than 3 to 5 years.
- In Alternatives 3 and 6, Objective 11-02 is designed to achieve a fuel-loading mosaic within 3 to 5 years. Under this "mosaic" large material would be removed to reduce long-term fire severity, and downed woody material would be retained where needed for soil recovery.
- In Alternatives 3 and 6, Objective 11-03, all dead trees are available for value recovery except for 50 percent of the recent (0 to 5 years) stand-replacing fire acreage Forest-wide, up to 10,000 acres. Highest priority to retain is areas with greater than 70 percent pre-fire canopy closure. Under Alternative 4, Objective 11-03, no dead trees are available for value recovery.
- Alternatives 3, 4, and 6, Objective 11-04 encourages the establishment and protection of shrubs in moderate-to-high-intensity burn areas in the first 5 years following a wildfire.
- Standard 4101, MA 3.1 (BAs). In Alternatives 1 and 2, this standard requires the management of fire and fuels through control practices and prescribed fire consistent with BA values. In Alternatives 3, 4, and 6, this standard requires control practices and prescribed fire to protect the values for which the BA was designated and to use minimum impact suppression techniques during fire suppression.
- Standard 4101 for MA 4.2B (Peter Norbeck Scenic Byway) requires fire and fuel management, but changes to meet management area priorities. In Alternatives 1, 2, 3, and 4, this standard requires management of fire and fuels through control practices and prescribed fire to improve wildlife habitat and to protect the biological and scenic values of the area. In Alternative 6, this standard adds a priority in the WUI for fuel treatment.

3-7.1.3. Direct And Indirect Effects

3-7.1.3.1. Fire Hazard

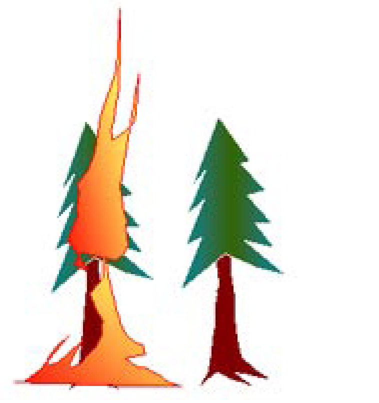
Fire hazard for any particular forest stand or landscape reflects the potential magnitude of fire behavior and effects as a function of fuel conditions. Crown fires are generally considered the primary threat to ecological and human values, and are the primary challenge for fire managers (Peterson et al. 2003).

Crown fires are more difficult to control than surface fires. Their rate of spread is several times faster than surface fires (Rothermel 1983). Spotting is frequent and can occur over long distances. Larger flames from crown fires dictate large firefighter safety zones (Butler and Cohen 1998). Spotting and increased radiation make structures more difficult to defend from crown fire than surface fire (Cohen and Butler 1998).

Van Wagner (1977) identified three types of crown fire (**Figure 3.23**):

- Passive – also called torching, is one where individual trees or small groups are ignited but rate of spread is controlled by the surface rate of spread.
- Active – is one that advances with a well-defined wall of solid flame extending from the surface to above the tree canopy
- Independent – is one that advances in the canopy fuel well ahead of (or in the absence of) the surface fire, requiring none of the surface fire's energy for sustained spread. They are not usually addressed because they rarely occur and no model of their behavior is available (Scott and Reinhardt 2001).

Figure 3-23. Three Types Of Crown Fire (Usda Forest Service 2005i)

Passive	Active	Independent
		
• Low wind speed; • Low crown bulk density and cover; • High crown base height.	• Higher wind speed; • High crown bulk density and cover; • Low crown base height.	• Very high wind speed; • Very high crown bulk density and cover.

Initiation and sustained spread of crown fires is dependent on surface fuels and crown fuels. The initiation of crown-fire behavior is a function of the surface-fire intensity and the canopy-fuel characteristics of Canopy Base Height2 (CBH) and Foliar Moisture Content (FMC). When the surface-fire intensity attains or exceeds the critical-surface intensity for crown combustion, fire can move vertically through the canopy. The ability of a crown fire to spread is a function of the surface rate of spread and the Canopy Bulk Density3 (CBD).

Control of wildland fire is directly related to fire behavior. Fire behavior is a primary consideration for public and firefighter safety. Factors that contribute to fire behavior that are unchangeable include weather, topography, and vegetation. The factor that can be changed is the fuels profile (ground, surface and canopy fuels). Other disturbance agents such as wind and snow damage, active in the Black Hills, can interact with insect populations (Ips spp.) in the creation of fuels profiles suitable for fire initiation and growth.

Fire behavior and severity depend on the properties of the various fuel (live and dead vegetation and detritus) strata and the continuity of those fuel strata horizontally and vertically (Graham et al. 2004). Fuels treatments alter the characteristics that influence crown-fire initiation and spread. Fuel treatments reduce the likelihood of crown fire and other fire behavior that would lead to undesirable future conditions, not guarantee the elimination of crown fires.

The primary stand attributes that influence crown-fire initiation and spread are surface-fuel loading, canopy-base height, and canopy-bulk density. These attributes can be directly managed by vegetation treatments. Silvicultural systems can be designed to reduce crown-fire hazard, but if desired stand attributes are not stated the desired stand structure or species composition may not be achieved (Graham et al. 1999). Treatments that reduce density and change the composition of stands will reduce the probability of crown fires, decrease severity of impacts, and enhance fire-suppression effectiveness and safety. Fuel treatments also can mitigate fire severity and reduce the threat to high-value areas (Pollett and Omi 2002). Where current landscape conditions exhibit a significant departure from historic conditions,

2 The terms Canopy Base Height and Crown Base Height are synonymous when used to describe this canopy fuel characteristic on a stand basis.

3 The terms Canopy Bulk Density and Crown Bulk Density are synonymous when used to describe this canopy fuel characteristic on a stand basis.

the goals and methods of fuels reduction and ecological restoration may converge depending on the management objectives for the treatment area and the treatment applied. When the goals and methods converge, fuel treatments will also most likely contribute to improving Condition Class.

Fire hazard was estimated using the Fire and Fuels Extension for the Forest Vegetation Simulator (FFE-FVS) and the *torching* (TI) and *crowning* (CI) indices. These methods are described in Appendix B. The TI and CI values obtained from FFE-FVS were used to assign a crown-fire-hazard rating of *low, moderate, high, very high or extreme* for each stratum. The fire-hazard rating increases as the amount and continuity of surface and canopy fuels increases. As the amount of fuel on a given landscape increases and fuel profiles become more horizontally and vertically continuous, the intensity of a wildfire in that landscape is expected to increase. Stands with low CI and TI are the least susceptible to crown-fire initiation and spread. Areas with an *extreme* fire-hazard rating (5) have the potential to exhibit more extreme fire behavior with more severe effects than those with a *low* hazard rating (1). Omi and Martinson (2002) found that the correlation between crown-fire hazard and fire severity is generally good.

3-7.1.3.2. Fuel Treatments

Fuel treatment priorities to achieve fire-behavior alteration are to reduce surface and ladder fuels, raise the bottom of the live canopy (CBH), reduce stand density (CBD) and reduce the continuity of the forest canopy as shown in **Table 3-47**.

Table 3-47. Fuel Treatment Priorities (Peterson et al. 2005)

Priority	Desired Result	Fire Behavior Effect
Reduce Surface Fuels	Reduce potential flame length	Control easier, less torching
Increase Canopy Base Height (CBH)	Increase flame length required to initiate torching	Reduces crown fire initiation potential with less torching
Decrease Crown Density (CBD)	Make active crown fire less probable.	Reduces crown fire potential

The term “thinning” is traditionally applied to stand treatments aimed at redistributing growth on remaining stems, but many kinds of partial cutting such as cleaning, weeding, liberation, preparatory, improvement, sanitation, and selection cuttings could be termed thinning as these treatments reduce the numbers of stems in a forest stand and stand structures. Thinning is applied to alter forest species composition and structure to meet management objectives such as creating disease and insect resistant stands, altering fire behavior and/or severity, producing forage, or producing timber products. Thinning can be accomplished with hand tools, machinery, fire, or combinations of techniques, all of which are effective in reducing fire hazard. Thinning followed by prescribed burning is particularly effective in reducing fire hazard. Tree thinning that adds to surface fuels may contribute to increased fire intensity, thus all fuels strata need to be managed to minimize the unwanted consequences of wildfires (Graham et al. 2004).

There are many different kinds of thinning, thinning regimes, reserve tree regeneration methods, and combinations that create a plethora of stand structures and compositions to meet various objectives. Thinning defines a set of intermediate treatments applied to forest stands to create varying compositions and structures, but there are other types of partial cuttings that remove trees. Regeneration methods (shelterwood, etc.) also create stands with various compositions and structures. Because there are many different stand compositions and structures possible from thinning and regeneration methods, there are at least as many ways these stands will respond to wildfire or prescribed fire (Graham et al. 1999). A series of forest treatments or a silvicultural system that maintains multiple forest canopies and high crown bulk densities is unlikely to decrease the potential for crown-fire behavior. Seed-tree and shelterwood regeneration methods and all of their variations have the potential to reduce the severity and intensity of wildfires. Open stands with low crown bulk densities would not likely support a crown fire when the regeneration was short. But if the regeneration were not pre-commercially thinned, the subsequent development of ladder fuels would increase potential for crown-fire behavior. The stand structures created by group shelterwood would likely be prone to crown-fire behavior depending on the density and spacing of the leave tree groups (Graham et al. 1999). Applying a thinning regime to the areas between the leave tree groups and regeneration established in the groups could reduce crown-fire potential depending on the density and stand structure achieved. Individual tree and group selection regeneration methods may not reduce crown-fire potential unless low crown densities are maintained by applying a relatively flat diameter distribution ($q<1.25$) that emphasizes larger trees with limited trees in the smaller diameter classes.

Fuel treatments that reduce canopy fuels can increase and decrease fire hazard simultaneously. Reducing densities exposes surface fuels to increased solar radiation, which would be expected to promote both the production of fine fuels and the drying of the surface fuels. Increased winds in thinned stands can promote dying of the surface fuels and increased surface-fire behavior. However, while surface-fire intensity is a critical factor in crown-fire initiation, height to crown and the vertical continuity between fuel strata are equally important, and reduction in crown fuels and crown-fire potential outweighs any increase in surface-fire hazard (Omi and Martinson 2002).

Fire behavior is typically described at the stand level, but the spatial arrangement of stands affects the growth of large fires across landscapes (Graham et al. 2004). The locations of treatments on the landscape can contribute to reducing the threat of crown fires to ARCs, or the successful implementation of fire-use actions. Significant reductions in fire growth and fire behavior can be achieved by treating as little as 20 percent of an area if the treatments are strategically placed across the landscape; however, with random fuel treatment placement a relatively high proportion (greater than 50 to 60 percent) of the landscape must be treated before similar reductions in fire growth and fire behavior can be realized (Finney 2003). Strategic placement of treatments on the landscape allows flexibility in achieving fire behavior reductions while accommodating management objectives and environmental and economic constraints

Landscape-level fuel treatment considerations include the creation of fuel breaks where fire-control efforts can be conducted safely, and strategically located strips or blocks of land where forest canopy and fuels, both living and dead, are modified to affect fire behavior, decreasing areas of contiguous high hazard fuels. The network of meadows, hardwood forest and rocky outcrops in the Black Hills help break-up the continuity of fuel patterns. Reduced surface fuels in addition to thinning can significantly limit fire spread under wildfire conditions (Graham et al. 2004).

Fuel-treatment projects around and within ARCs are performed to reduce fire hazard, and thus reduce the potential damage to community resources and increase the safety of the public and firefighters. Fires burning through a community can damage and destroy homes and other structures, and damage other public and private property, such as vehicles, fences, utility poles and wires and other urban infrastructure. Additional damage is done to the urban infrastructure by secondary fire impacts such as erosion moving soils into ditches, storm drainage systems, and onto roads. Finally, wildfires burning natural elements in and surrounding communities can cause the same kind of undesirable environmental impacts as in uninhabited natural areas: loss of habitat, damage to watershed conditions, negative aesthetic effects and damage to timber resources.

The amount of land to be treated around communities to reduce the threat to communities depends on the current structure of the vegetation, fuel loadings, topographic location, and firefighting concerns such as access. It is necessary to perform treatments at a range of distances from homes. Treatments at some distance from the developed portion of a community (a few to several miles) can reduce the direct threat to communities by being located in areas where the topography, wind conditions, and fuels would otherwise create the potential for wildfire spread to the community, or where a large or intense fire may cause indirect damage to the community (water sources or erosion hazard).

Treatments near developed portions of a community can reduce the threat to community infrastructure or local environmental resources. They can increase the safety of escape routes for residents and access routes for firefighters. Reducing spotting potential and production of fire brands in this zone can reduce the risk to structures, especially if the zones of treatment are wider than the spotting distances possible at critical weather levels (i.e., 97th percentile weather).

Fuels treatments in the WUI recognize that the ultimate success depends on several factors outside the control of the land managers. These factors are as follows:

- Clearance between the actual fuels and the residence or personal property is the responsibility of the property owner, in accordance with state law,
- Design and choice of construction materials for the residence or structure is the owner’s responsibility, and
- Even though all preventive measures to protect the structures are in place, the actual fire behavior under severe conditions that threaten the home or structure could still be outside the control of suppression forces.

Finally, research by Cohen (1999) has shown that structures with typical ignition characteristics (wood sided, wood framed, asphalt composition roof) are at risk of catching on fire from one of three sources. First is the direct exposure to intense flames from a nearby source, which could be intensely burning vegetation or another structure. His research shows that the structures may be at risk if the flame front is no more than 100 feet away. Second, constructions may be ignited from less intense sources against or very near the side of the structure. This can occur if a ground fire or firebrands ignite firewood or other flammable material next to the structure. Third, firebrands falling directly on roofs can ignite the structure if the roof is flammable or if flammable debris is present.

Implementation of treatments under each alternative affects the fire-hazard rating by changing the vegetation structure and fuels profile of individual stands and the forest. Alternatives that favor establishment, growth and an increased stand density of species such as ponderosa pine and white spruce, tend to increase the fire-hazard rating and the potential for fire spread. Conversely, alternatives that manage ponderosa pine and white spruce at reduced densities and increase hardwoods within the landscape would tend to reduce the fire-hazard rating and the opportunity for fire to spread. This would generally be characterized as improving the condition class. In the Black Hills, hardwoods do not provide fuel profiles that would support sustained crown fires (USDA Forest Service 1996a p. III-211).

3-7.1.4. ALTERNATIVE COMPARISON

Alternatives are compared by: fire-hazard or fuel-treatment objectives, treatment acres anticipated to meet the objectives, comparison to an average fire-return interval, and fire-hazard reduction from *high* or *very high* ratings.

As discussed above, tree ring studies indicate fire-return intervals from 10 to 33 years from the southern to the northern Black Hills with a simple arithmetic average of about 22 years between fires. So, it could be roughly anticipated that of the 1,036,000 acres of ponderosa pine (Draft EIS Appendix B-10) about 47,000 acres would burn annually, i.e., 1/22nd of total pine acreage (method described by Arno and Allison-Bunnell 2003 p. 33). This is an approximation and would vary in timing, size, and intensity characteristic of a mixed-severity fire regime.

Alternative 1 has a Forest-wide objectives (223 and 228) to manage 28,900 acres of activity fuels and 4,000 acres of natural fuels, including 8,000 acres of prescribed fire, annually. These two objectives are combined with many objectives in providing for biologically diverse ecosystems (Goal 2 of 1997 Revised Plan) and are primarily for treatment of activity fuels (mostly after timber harvest). “Forested land treatment” (harvest, thinning, hardwoods and prescribed fire) would total an estimated 34,000 acres (Appendix B **Table B-1**), which is less than the approximate 47,000 acres (+/-) that would have been disturbed historically by fire. Structural stages 4C and 5, rated very high fire danger (Appendix B **Table B-5**) remain at about the current level in Alternative 2.

Alternative 2 has a Forest-wide objectives (223 and 228) to manage 28,900 acres of activity fuels and 4,000 acres of natural fuels, including 8,000 acres of prescribed fire, annually. These two objectives are combined with many objectives in providing for biologically diverse ecosystems (Goal 2 of 1997 Revised Plan) and are primarily for treatment of activity fuels (mostly after timber harvest). “Forested land treatment” (harvest, thinning, hardwoods and prescribed fire) would total an estimated 24,000 acres (Appendix B **Table B-1**), which is considerably less than the approximate 47,000 acres that would have been disturbed historically by fire. Structural stages 4C and 5, rated very high fire danger (Appendix B **Table B-5**) would remain at about the current level.

Alternative 3 established a separate goal (Goal 10) for fire hazard. The Forest (including the WUI) would be managed to achieve a moderate-to-low fire-hazard rating on 50 percent, excluding specific management areas (see Appendix D Goal 10-01). Although dependent on funding, the estimated forested land treated of 41,000 acres annually (Appendix B **Table B-1**) is somewhat less than the presumed natural disturbance level. However, when projects are planned the newly created goal for fire-hazard reduction is presumably given more emphasis in comparison to other resource objectives so is more likely to be implemented. Vegetative structural stages 4B, 4C and 5 are rated high or very high (Appendix B **Table B-5**) and would be reduced in total acres to implement MA objectives 4.1-203, 5.1-204, 5.4-206, 5.43-204 and 5.6-204 (Appendix D). This is a reduction of overall fire hazard.

Alternative 4 would manage to a 50-percent moderate-to-low fire-hazard objective only within the WUI. Estimated treatment acreage is about 28,000 acres per year (Appendix B **Table B-1**) considering the relatively constraining standards and guidelines and priority placed on other resource values. It is much less than the presumed fire/disturbance return interval acreage of 47,000 acres. Alternative 4 increases the estimated acreage of structural stages 4C and 5, both with a very high fire-hazard rating (Appendix B **Table B-5**).

Alternative 6 provides greatest emphasis of the five alternatives with a new objective for 50 to 75 percent of the WUI and 50 percent of the remainder of the Forest in a moderate-to-low fire-hazard rating, with some excepted management areas. The estimated 53,000 acres of forested land treated annually (Appendix B **Table B-1**) is highest of the five alternatives and is a little above the 47,000 acres that may have occurred prior to settlement. This treatment level (thinning and burning) is above the constrained budget, but is included to use for analyzing other environmental effects. Vegetative structural stages 4B and 4C are rated high or very high (Appendix B **Table B-5**) and would be reduced the most in Alternatives 3 and 4 by reducing tree density under MA Objectives 4.1-203, 5.1-204, 5.4-206, 5.43-204, and 5.6-204 (Appendix D). This is a reduction of overall fire hazard. Structural stages 3B and 3C, rated high and very high respectively, increase in acreage under Alternatives 3 and 6.

All alternatives protect structures within the WUI (Guideline 4113 or Objective 10-01). Alternatives 3 and 6 provide for treatments between any designated RNA, special resource needs (e.g., habitat or sites with SOLC), and ARCs.

Fire-hazard reduction can also be viewed as a reduction in potential fire severity (how hot it burns, i.e., the effect on the environment). High hazard is the approximate threshold for the significant passive crown fire while extreme hazard corresponds with active crown fire. Very high hazard is transition from passive to active crown fire. Low and moderate hazards exhibit primarily surface fire behavior. Since Omi and Martinson (2002) found that the correlations between crown-fire hazard and fire severity were generally good, Alternative 6 would be expected to have the lowest potential fire severity, followed by Alternatives 3, 1, and 2. Alternative 4 would be expected to have the least reduction in potential fire severity.

Fire-hazard reduction does not necessarily reduce the fire risk (sources of ignition). However, lower hazard increases the probability of lower fire intensity (surface fire versus crown fire) and easier control or containment. Management for fire-hazard reduction may not reduce insect risk, but management for insect risk reduces fire hazard.

In summary, fire-hazard reduction is expected to be the greatest under Alternative 6 followed by Alternatives 3, 1, 4, and then 2. This is based on fire-hazard objectives in Goal 10, anticipated treatment acres, and an approximate comparison of treated (disturbed) acres to historically disturbed acres. There is anticipated to be a corresponding reduction in fire severity.

3-7.1.4.1. Effects Of Species-viability Management On Fire

Management for species viability on the Forest would be expected to affect fire-hazard rating primarily by restoring less flammable community types (hardwoods) and by altering the structure of ponderosa pine stands. Alternatives 3 and 6 have an objective (201) to create about 50,000 acres (about 100-percent increase; 5,000 acres/year) of hardwoods in 10 years (to about 104,000 acres) by converting from conifer. Alternative 1 would create about 5,000 acres (10-percent increase) and Alternative 4 would increase hardwoods by about 10,000 (20 percent) from 1995. Estimated treatment acres are shown in Appendix B Table B-1. Highest priority treatment includes pine encroachment and areas adjacent to riparian that once supported beaver colonies. These cover types are less flammable than pine and serve to reduce fire hazard.

Objective 205 will restore grasslands and meadows by removing conifers. Conifer, mostly ponderosa pine, has encroached on these areas and has increased the fire hazard and/or reduced the fuel breaks provided by grassy areas. This habitat improvement will reduce fire hazard (torching and crowning indices) and improve the ability for firefighters to stop advancing wildfire. Alternatives 3 and 6 would triple the meadow acreage from about 1,200 acres to about 3,600 acres Forest-wide, and will increase grassland acreage from about 110,000 acres to about 122,000 acres Forest-wide (11-percent increase). Alternatives 1, 2, and 4 would increase meadow and grasslands by about 10,400 acres (10 percent). The difference between Alternatives 3 and 6, and Alternatives 1, 2, and 4 is not significant in a fire ecology or suppression perspective. The 10- to 11-percent reduction in pine within grasslands and meadows may not be significant on a Forest-wide scale, but to project firefighters, the reduced-fire hazard may be very important in meeting suppression objectives and protecting resources on a specific individual fire.

Structural stage objectives established for MAs 4.1, 5.1, 5.4, 5.43, and 5.6 (Appendix D) are established to provide overall objectives for ponderosa pine. These objectives, while designed for wildlife, also provide overall reduction in fire hazard by reducing tree spacing and opening crown structure compared to current conditions. See above discussion regarding efficacy of thinning and fuel treatment. Thinning, fuel and other silvicultural treatments are used to meet structural stage objectives.

3-7.1.4.2. Effects Of Research Natural Area Management On Fire

RNAs would be designated in Alternatives 3, 4, or 6 (see Section 2-3, 3-6.2 and Appendix D). Alternatives 1 and 2 each have the existing Upper Pine Creek RNA. Alternative 3 would designate four new RNAs: Canyon City, Fanny Boles, Geis Springs and Sheep Nose Mountain. Alternative 6 designates four new RNAs: Canyon City, Fanny Boles, Geis Spring, and North Fork Castle Creek. Alternative 4 would add all nine candidate RNAs. The east boundary of the Canyon City candidate RNA was adjusted west to leave about 0.5-mile distance to Silver City to provide for fire suppression and fuels treatment.

RNA establishment would preclude harvest, fuel-reduction treatments, or other management disturbances except prescribed fire within the RNA boundary. Prescribed fire may be utilized if its application is consistent with the management of the RNA. The appropriate management response for RNAs includes confine, contain and control strategies, but not Wildland Fire Use (see Fire Management Direction table on preceding pages). Wildland fire use is precluded due to the size of the RNA's, current fuel conditions, experienced fire behavior, and limits on the full suite of fuels treatments available for pre-treatment. Minimum Impact Suppression Tactics will be used in any fire-suppression actions. RNA management plans are expected to include restoration of fire when applicable and within carefully prescribed conditions. In Alternatives 3 and 6, fire hazard between RNAs and ARCs would be reduced to moderate-to-low rating where the topography, wind conditions, and fuels would otherwise create the potential for wildfire spread to the ARC (Objective 10-03 Appendix D). On a Forest-wide scale, RNA acreage is relatively small and would not be expected to alter fire-suppression strategies. On a local scale around the RNAs, the boundaries follow natural topographic or vegetation breaks that facilitate fire containment and designation would not be expected to affect fire suppression markedly. The alternative with the highest RNA acres in comparison to the alternative with the least RNA acres would have the most limitations on fire-suppression actions. This difference compared among the alternatives is not very significant compared to the 1.2 million acres of NFS lands on the Forest.

Ponderosa pine community types within the RNA would be allowed to go through natural succession. In the absence of fire, forested areas within the RNA would tend toward a higher fire-hazard rating. Stand-replacing fires, not compatible with the RNA establishment goal, could result from this increased amount of forest fuels. In the event of natural periodic fire, it is reasonable to assume that vegetation communities within the RNAs would eventually return to conditions more like those that existed historically. Vegetation conditions historically supported fewer stand-replacing fires and more frequent low intensity burns.

3-7.1.4.3. Effects Of Insects, Diseases And Other Disturbances And Their Management On Fire

Insects, diseases, snow breakage, and other forest health issues can cause changes in fire behavior over time through their effects on forest structure. They can cause significant mortality contributing to heavy fuel loading as the trees fall. A heavy loading of surface fuels from these disturbances can increase fire hazard and severity. The long-term effect is that fuel loading could increase, which in turn, can affect fire spread, rate of energy release, and resulting fire severity.

The National Forest Fire Laboratory (NFFL) fuel model 10 best represents the fuel model in stands, which have experienced significant mortality. Fires burning in this surface and ground fuel exhibit much higher surface-fire intensity than the other timber litter models. Crowning, spotting, and torching of individual trees is more frequent in this fuel situation, leading to potential fire-control difficulties. Large scale insect outbreaks change the fuel profile across the landscape with impacts both immediate (tree mortality) and potential (high severity fire) on all ownerships.

Fire may interact with other disturbances in a synergistic manner. The effects of nature are a cycle of natural influences; one may be dependent or independent of another. By creating open landscapes when a fire burns intensely, fire may increase the magnitude of rain-on-snow events, and it can increase shallow soil-mass movements on the landscape by reducing fine root biomass (Swanson 1981). It can open a stand to increased wind throw by reducing crown resistance through tree mortality. It can encourage creation of infection courts of fungi (Gara et al. 1985) on roots that are scarred.

The effect of fire on trees can include excessive heat transmitted to roots, cambium, or crown. Each effect, separately or in combination, can reduce tree resistance to insect attack. The probability of successful insect attack increases with increasing fire damage (Fischer 1980). These effects depend on fire severity, which would be different under each alternative as described above.

Some effects are difficult to quantify (for example, root infection courts) or may be tied to even more complex disturbances, such as regional droughts in the case of insect attacks. If a stand is drought-stressed, insect damage to trees may be exacerbated. Added stress effects of fire may greatly increase the chance of an insect outbreak. High levels of tree mortality and a wildfire can indirectly result in loss of other forest values. Extreme fuel loads caused by insect-related tree mortality pose a significant threat to property and life depending on relative location.

Management actions that reduce stand density to increase resistance to insect attack also can reduce fire hazard. The amount of vegetation treatments anticipated under each alternative that will affect fire hazard and insect risk vary greatly. Alternative 4 anticipates the least amount of treatments while Alternative 6 estimates the highest level of treatments based on the objectives. Managing stand density has the added benefit of increasing available moisture within the treated stand and increasing resistance to insect attack.

3-7.1.5. Cumulative Effects

Fire exclusion, fire suppression, and resource management activities have influenced the vegetation composition and structure of the Forest and, as such, are encompassed in the existing conditions against which projected changes are measured for each alternative. Current public and private fire and fuels management programs exist and are expected to continue in the foreseeable future within the cumulative effects study area for the Phase II Amendment. For example, the Forest coordinates with other federal agencies in fire management and other fire-related federal programs. In addition, the Forest has interagency agreements with the States of South Dakota and Wyoming. The Forest and selected private lands are part of the Black Hills Fire Protection District as defined by the State of South Dakota. In Wyoming, the Forest Service coordinates with the State and with local county commissioners regarding fires on adjacent private lands. The coordination and cooperation of public and private entities regarding fire and fuels management in the region is expected to continue. The incremental effect of land development on private lands will continue to complicate and increase expenses of fuels management and fire suppression.

Wildfires will continue to occur in the future and have a cumulative effect along with planned management actions. The number of acres that may be burned in the future was predicted by using the fire probability analysis program PROBACRE (Wiitala 1999a) as explained in Appendix B.

Table 3-48 shows that during a 10-year period, under existing vegetation conditions, the probability that fires will cumulatively burn more than 25,000 acres is almost 100 percent (roughly 2,500 acres per year). The probability of burning more than 50,000 acres is approximately 78 percent. For a threshold greater than 100,000 acres the probability is about 30 percent. The probability for fires to cumulatively exceed 150,000 acres is less than 5 percent while the probability of fires burning more than 200,000 acres is less than 1 percent.

Table 3-48. Probability Of Acres Burned Exceeding Thresholds In Decade 1

Burned Area Threshold (acres)	Probability of Exceeding Threshold in 10 Years
5,000	0.99893
10,000	0.99110
25,000	0.96725
50,000	0.78454
100,000	0.30358
150,000	0.04240
200,000	0.00362
250,000	0.00113

The alternatives anticipate different level of vegetation treatment and fire-hazard reduction to meet fire-hazard objectives. These treatments can reduce the cumulative acreage burned. Alternative 6 provides the most potential reduction in acres severely burned followed by Alternative 3, Alternative 1, and Alternative 2. Alternative 4 provides the least potential reduction in acres burned because of the lowest anticipated treatments and objectives that do not emphasize fire-hazard reduction. Actual acreage burned is subject to broad scale climatic conditions and weather conditions at the time of ignition. The reduction in acreage and severity of burns will change the direct and indirect effects on resources and experiences such as air quality, visibility, soil, water quality and quantity, scenic quality, quality of visitor experience, fauna and flora.

3-7.2. Insects

3-7.2.1. Affected Environment

Insects in the Black Hills function as important decomposers, nutrient recyclers, and food sources for wildlife and fish, pollinators, and natural enemies of other organisms (USDA Forest Service 1996a p. III-225). Only a relatively few species of insects cause unacceptable, adverse effects and are considered pests in the Black Hills. Certainly damage from insects is undesirable under certain social and economic goals. Insects may be functioning in an ecologically undesirable way, particularly if they are operating differently than we would expect under the historic disturbance regime. Hence, management should clearly distinguish between insects as pests because of social or economic objectives and insects as expected disturbance agents in the historic ecosystem regime.

Mountain pine beetle is native to the Black Hills and has an important ecological role in the forest ecosystem. The mountain pine beetle is the most known insect on the Forest, and research on the beetle is ongoing. Although an aerial survey of insect damage was completed in 2003, the information on insect risk is based on data from the RIS 2004 database using structural stages. Refer to Table 2-5.

The mountain pine beetle is described fully in the 1997 Revised LRMP Final EIS (USDA Forest Service 1996a p. III-234 to III-237). Information regarding the susceptibility of forestland in relation to attacks by these insects has become available since the 1996 EIS. The Forest rates tree stands in the Black Hills for susceptibility to mountain pine beetle infestations using a system described in RM-529 (Schmid et al. 1994), RM-RN-531 (Eckberg et al. 1994) and RMRS-GTR-28 (Obedzinski et al. 1999). Between 1998 and 2002, the amount of land on the Forest with a high risk rating dropped from 15 percent to 9 percent (USDA Forest Service 1999b, 2000a, 2001a, 2004a). Areas with a moderate risk rating increased from 26 percent in 1998 to a high of 34 percent in 1999. In 2000, 2001, and 2002, 32 percent of the Forest had a moderate risk rating to mountain pine beetle susceptibility. More than half the Forest had a low risk rating of 59 percent in 1998, 2000, 2001, and 2002, and of 57 percent in 1999.

In addition to the mountain pine beetle, other insects may cause occasional or future problems on the Forest including pine engraver beetle, red turpentine beetle, two species of pine tip moth, and gypsy moth. The pine engraver beetle typically attacks fresh cull logs and slash, scorched trees, and storm-damaged trees; it then moves into stressed green trees. Endemic levels kill individual trees and small groups of trees (USDA Forest Service 1996a p. III-228). The red turpentine beetle, native to the Black Hills, is not aggressive and is not generally the primary cause of ponderosa pine mortality (Shepperd and Battaglia 2002 p. 25). However, the red turpentine beetle is a secondary cause of ponderosa pine mortality, attacking trees already weakened by fire, drought, other insects, and lightning. Red turpentine beetle can damage wood products (USDA Forest Service 2004a p. 70). Two species of pine tip moth occur in the Black Hills—the Western pine tip moth and the Southwestern pine tip moth—and are of occasional concern on the Forest (USDA Forest Service 1996a p. III-228, Shepperd and Battaglia 2002 p. 27). These pine tip moths generally attack ponderosa pine seedlings that are shorter than 10 feet, bore into the new shoots, and feed on the tissues of the needles.

The gypsy moth is an exotic insect that is not yet established in the Black Hills. Detection surveys for gypsy moths were conducted each year on the Forest from 1997 through 2002 (USDA Forest Service 1999b, 2000a, 2001a, 2004a). No gypsy moths were caught in the traps during surveys. However, gypsy moths were caught in surrounding areas near the Forest including private campgrounds and at Mt. Rushmore National Memorial. If this species establishes itself in the Black Hills, it could affect riparian and aspen communities.

During the mid-1990s, beetle mortality was light and scattered throughout the Black Hills. In 1997, there was a noticeable increase in mortality detected. The 1999 survey showed a more than two-fold increase from 1998. Most of the mortality increases occurred in concentrated areas such as Beaver Park, Kirk Hill, areas south and west of Bear Mountain, around Ditch Creek, areas west of Deerfield, and the Boles Canyon area. In 2001, Beaver Park accounted for about 100,000 of the total trees killed by mountain pine beetle (USDA Forest Service 2001a p. 41). As noted in **Table 3-49**, there has been an exponential increase in bark beetle activity across the Forest the past few years. Also, during 2000 and 2001, hailstorms damaged more than 2000 acres of ponderosa pine, making these areas more susceptible to pine beetle attacks.

Table 3-49. Estimated Tree Mortality Caused by Bark Beetles in the Black Hills Since 1996

Year	Estimated Number of Dead Trees
1996	1,500
1997	5,200
1998	11,000
1999	26,000
2000	38,000
2001	299,000
2002	305,000
2003	395,000
2004	275,000

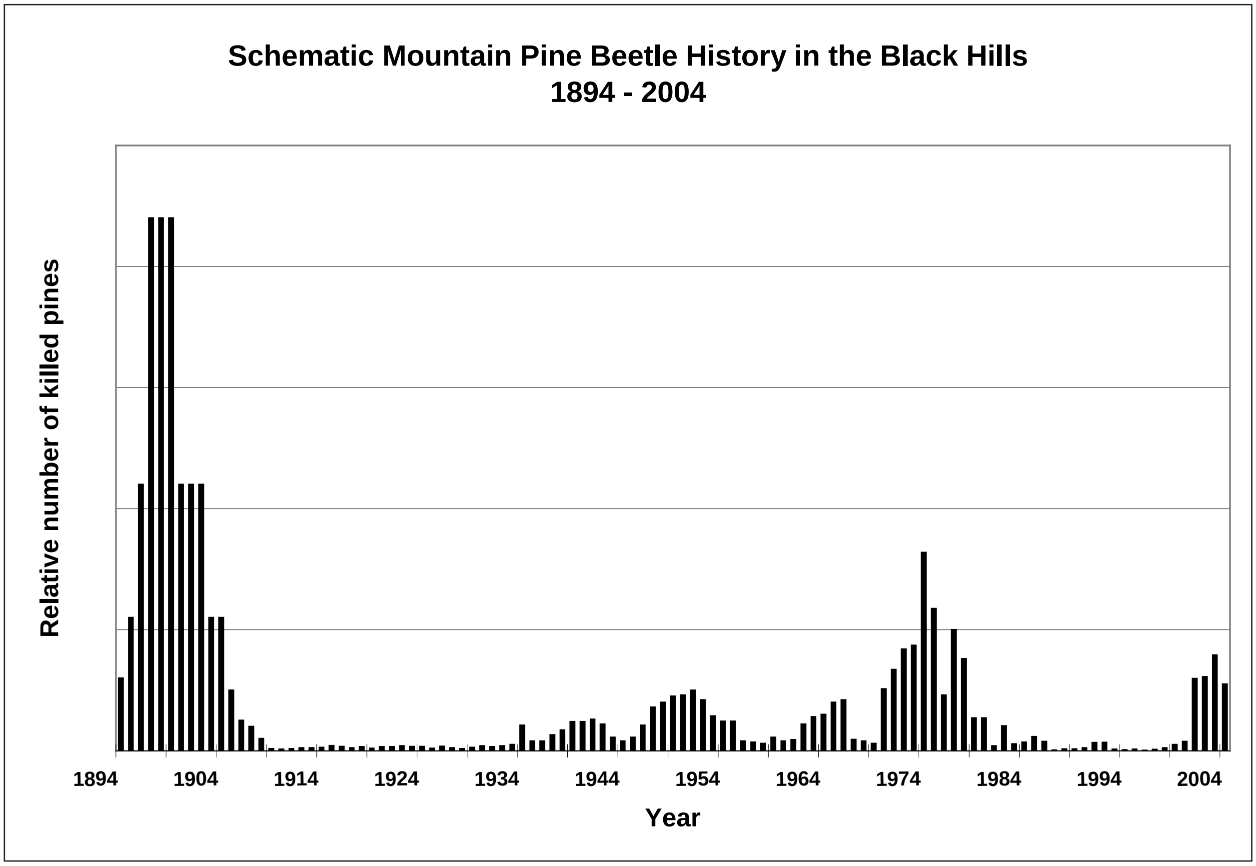
Biological evaluations of mountain pine beetle-caused mortality conducted in the Beaver Park, Deerfield, and Nemo areas found that mountain pine beetle populations are increasing in these areas (USDA Forest Service 2004a p. 69). As with any insect, the best defense against attack is to keep the trees growing vigorously (Shepperd and Battaglia 2002 p. 27).

Under historic disturbance regimes, tree mortality and stand replacement from insects is expected. These are important natural processes that create structure and diversity. Acceptable areas for insect occurrence are in research natural areas, botanical areas and late successional management areas. Given the management emphasis on value recovery for the Forest as in MAs 5.1 and 5.4, the insect occurrence is considered to be socially and economically unacceptable.

Hail damaged and caused defoliation of all tree species and all age classes on Kirk Hill in 1999 (USDA Forest Service 2000a p. 13). Evaluation of these trees in 2000 noted that most of the damaged trees had recovered, although some of the most heavily damaged trees had died (USDA Forest Service 2001a p. 27). These showed evidence of beetle attacks (USDA Forest Service 2001a p. 45). Monitoring plots were established in 2001 to monitor the potential insect influx.

The Black Hills ponderosa pine experiences the cyclical nature of increasing and decreasing insect populations. See historical graph **Figure 3-24**.

Figure 3-24. Historical Graph Of Mortality From Mountain Pine Beetle



Annual tree loss since 1997 has been compiled as shown in **Table 3-50**.

Table 3-50. Approximate Annual Tree Loss Black Hills National Forest

Year	Trees Killed	Acres Affected	Thousand Cubic Feet Lost Volume
1997	5,200	10,578	94
1998	11,000	10,062	190
1999	26,000	17,396	450
2000	38,000	17,630	664
2001	299,000	65,000	5,400
2002	305,000	80,000	5,500
2003	395,000	190,000	8,000
2004	275,000	114,000	5,000

Note: 1) acres affected are an estimate. Not every tree of every acre is dead. Acres affected are cumulative. Mapping tree mortality from insects is difficult. Mortality occurs from a single tree to large groups. It is evident that across the large-scale landscapes of the Forest that insect mortality is observed from the single tree to large acreages.

2) Aerial detection surveys are designed to detect and describe, not to quantify or exactly locate, forest insect and disease impacts. These surveys are used to locate new areas of infestation. numbers such as dead trees or acres affected are highly variable. These surveys record a picture in time of what is viewed on maps, while traveling at 100 miles per hour approximately 1,500 feet above the terrain looking out across a 1.5-mile swath. By timing the survey to occur during the appropriate biological window, the surveys record recent activity while trying to minimize remapping old mortality. For the Black Hills, aerial surveys are timed to see current faders (1 year old mortality) caused by mountain pine beetle.

The recent large wildfires across the Forest created various levels of fire intensity producing stress on tree growth. Stress from wildfires coupled with drought will invite insects and may lead to an expansion of pine engraver and wood-borer populations in these areas. Populations of pine engraver are killing green trees in larger numbers than has been seen in recent history. This is due in part to creation of large areas of habitat by fires and is being magnified by less than average moisture totals over the past few years. Wood-borer populations are also at high levels. Any trees that are killed are being rapidly attacked and infested by borers. Prompt salvage of dead trees is needed, as these insects are degrading lumber value quickly in killed trees. A study of beetle use of fire areas in the Black Hills is continuing. In addition, areas that have experienced heavy insect mortality over the past few years, such as Beaver Park, may no longer have enough live host material to sustain insect populations. However, monitoring indicates that insects are spreading out from these areas and infesting nearby stands. (USDA Forest Service 2004f).

Development from endemic to epidemic insect populations is addressed in Obedzinski et al. (1999). “Forest managers should also realize that although endemic MPB populations may kill a few trees and thereby reduce the overall basal area of a stand as well as the time to reach the critical susceptibility threshold in the short term, the long-term result may be development of relatively homogeneous stands containing microcosm stands of greater densities,” as described by Olsen et al. (1996). Such stands are highly conducive to mountain pine beetle epidemics. This situation is not likely to occur when trees are uniformly spaced. However, if the original marking tends to leave variable tree densities, as is evident in the C-C plot, the potential for the development of relatively homogeneous stands containing microcosm stands is greater. Overall, the GSL (growing stock level) may be below the susceptibility threshold but, within the microcosm stands, it may exceed the threshold. Thus, managers should not be lulled into thinking that because overall stocking is below the threshold, substantial time exists before MPB infestations may become evident."

Partial cutting to reduce beetle-caused mortality may be ineffective if the partially cut stands are surrounded by unmanaged susceptible stands. To increase the effectiveness of partial cutting, stands should be managed on a landscape basis. A 100-foot-wide strip with stand density of less than GSL 70 between unmanaged and managed stands may be sufficient to limit the spread of beetle-caused mortality from unmanaged stands to adjacent partially cut stands (Schmid and Mata RMRS in review 2005).

The Forest reviewed a paper critical of logging and the resulting reduction in insect hazard by Black (2005). The paper is not a peer reviewed work but a synthesis of selected literature which supports the author's conclusion. The Black paper was reviewed for Black Hills specific literature. The one Black Hills area paper found in the Black report is very much in line with insect risk objectives, which is to reduce stand density (basal area) to lower the susceptibility to mountain pine beetle. Considerable other Black Hills mountain pine beetle research that was not reviewed in the Black report exists that supports insect risk reduction through logging. Based on the current knowledge of the situation and review of the pertinent literature the Black paper does not provide compelling information that would change the Forest's scientific understanding that logging can reduce insect risk (Allen 2005).

3-7.2.2. Resource Conservation Measures

Standards, guidelines, goals, and objectives Forest-wide and for specific management areas have been developed and are used to manage insects on the Forest. The following examines the changes to insect management in the Revised LRMP that are being considered under the Phase II Amendment alternatives.

Goal 10 has been added to the Forest-wide goals and objectives under Alternatives 3, 4, and 6 to reduce occurrences of catastrophic insect infestations and to facilitate the management of insects. Under Alternative 4, Goal 10 emphasizes insect management adjacent to WUI. Objectives 228 and 229 under Goal 2 have been moved to Goal 10 under Alternatives 3, 4, and 6.

The following changes have been made to Forest-wide standards and guidelines relating to insects. Under Alternatives 3 and 6, Guideline 4201b has been changed to address structural stage objectives, and in Alternative 6 the basal area objective to minimize susceptibility to mountain pine beetle epidemics has been reduced from 80 to 70 to address the latest research. Guidelines 4201c and 4201d have been changed to remove old terminology (e.g., late successional habitat and thermal cover). In addition, conservation of R2 sensitive species and SOLC were added to the insect and protection measures for Guideline 4201c.

In MA 2.2, Standard 4201 requires the use of methods that minimize threats to native species. In MA 8.2, Goal 206 changes under Alternatives 3 and 6, emphasizing active monitoring while reducing the pest population potential. Goal 206 prioritizes using an insect control method instead of chemical pesticides at Cascade Creek because it is unknown if insecticides affect the pollinator for the stream orchid.

3-7.2.3. Direct And Indirect Effects

Management actions can directly affect the vegetation and environment upon which insects depend (USDA Forest Service 1996a p. III-233). For most insect populations, changes due to management actions may not be perceptible for many years. Management alternatives that change the mix of age classes and densities of forest stands generally limit insect effects on Black Hills environments (USDA Forest Service 1996a p. III-233).

Mountain pine beetle generally affects stands with high densities (e.g., structural stage 3C, 4B, 4C, and 5) (USDA Forest Service 2003c). Extensive areas of forested habitat in these structural stages are at greater risk of an epidemic than are forested areas that include a mixture of structural stages, densities, and species diversity. Once an outbreak has started, any stands containing suitable host material are at risk (USDA Forest Service 2003c). Management alternatives that increase the amount, extent, or density of structural stage 3C, 4B, 4C or 5 of ponderosa pine would result in an increased risk of attack by mountain pine beetle (USDA Forest Service 1996a p. III-233). Those structural stages with low-to-moderate risk of mountain pine beetle infestation are structural stages 1, 2, 3A, 3B, and 4A (see Appendix B, Table B-5). Landscapes with denser structural stage conditions or older stands have increased insect risk. Species inhabiting the Forest evolved with a range of structural stage conditions, including the late successional stands, so the diversity required by species will carry with it some component of insect risk.

Insect hazard-rating scheme is documented in the 1997 Forest Plan Appendix B – Description of Analysis Process. The rating scheme is tiered to the 1997 Forest Plan Appendix B-44 Mountain Pine Beetle Analysis.

The insect hazard rating used variables from the corporate RMRIS database and was supported by research to calculate ratings. These ratings were linked to structural stage codes (see Appendix B, Table B-5).

3-7.2.3.1. Effects On Insects From Species-viability Management

Managing for species viability seeks a diversity of ponderosa pine structural stages and vegetation types across the Forest. Changes in the structural diversity of ponderosa pine, the predominant cover type on the Forest, will have the greatest effect on insects particularly the mountain pine beetle.

Revising Guideline 4201b under Alternatives 3 and 6 would have no impact on insects and disease, other than the lower basal area objective in Alternative 6, because the structural stage objectives for these alternatives would have essentially the same effect. Wording changes to remove old terminology for Guidelines 4201c and 4201d under Alternatives 3 and 6 would have no impact on insects.

In MA 2.2, the addition of Guideline 4201 under Alternatives 3, 4, and 6 would not impact insects because control measures could still be used in the management area. In MA 8.2, the change in Goal 206 under Alternatives 3 and 6 would not impact insects because insect control methods (other than insecticides) would still be utilized at Cascade Creek.

Structural stage 4C and 5 stands retained for late successional species are a high risk for insect infestation.

3-7.2.3.2. Effects On Insects From Research Natural Area Management

The effects of designation of a candidate RNA on insects would be minimal, but may include the implementation of control measures on insects where these disturbances threaten native species within a designated RNA. The relatively small number of acres within RNAs (a total of 9,639 acres if all candidate RNAs are designated) on the Forest would have little impact on insects on the Forest as a whole. Those candidate RNAs in which the vegetation type is predominantly grasslands and/or shrublands (e.g., Lemming Draw, Fanny/Boles) may provide buffers between areas at risk of insect infestation (e.g., areas with generally dense stands of weakened trees), thus limiting the spread of insects.

Cranberry Springs and Canyon City candidate RNAs could both be designated under Alternative 4, and Canyon City could also be designated under Alternatives 3 and 6. These two candidate RNAs adjoin management areas that focus on late successional forest landscapes. If these RNAs are designated and insects threaten species for which these RNAs were designated, occurrence of insects would not be suppressed by management. Candidate RNAs with a mosaic of vegetation types, and healthy, vigorous trees would have less probability of insect spread.

No additional RNAs would be designated under Alternatives 1 and 2. Under Alternatives 3, 4, and 6, those candidate RNAs with extensive and/or dense ponderosa pine stands may have a higher risk of insects than those candidate RNAs with a mosaic of vegetation types.

3-7.2.3.3. Effects On Insects From Fire-hazard And Insect-risk Management

All alternatives manage for reducing fire hazard and insect risk. Alternatives 1, 3, and 6 are estimated to have the same level of commercial timber harvest acres followed by Alternatives 4 and 2. There is an estimated range of precommercial or small diameter tree thinning among the alternatives. Alternatives 1 and 2 have the same level as the 1997 Forest Plan chosen alternative. Alternative 6 has the highest estimated thinning acres. As described above, the more thinning acres the more influence on reducing the probability of insect attack.

Silvicultural treatments that produce diverse forests also produce forests that have a lower probability of fire and insects. Thus, the insect risk described under species viability is also in part, attributable to fire-hazard management.

Alternatives that decrease the amount, extent, or the density of structural stage 3C, 4B, 4C, and 5 ponderosa pine will result in a decreased risk of attack by insects. Alternative 6 emphasizes more treatment acres reducing fire hazard and insect risk across the Forest.

3-7.2.3.4. Effects From Timber Management

Timber harvesting and timber stand improvement provide an opportunity to reduce insect outbreaks. Harvesting trees provides an opportunity to remove diseased and high-risk trees. Clear cuts, thinning and other final harvest methods provide opportunities for long-term protection and reduction of insect and disease outbreaks. Stands most susceptible to insect damage, such as high-density stands, can be harvested and replaced with healthier stands (Obedzinski et al. 1999, Olsen et al. 1996, Schmid et al. 1994, Schmid and Mata 1992). In stands scheduled for overstory removal, shelterwood, or uneven-aged management, individual suppressed or dying trees can be removed, increasing the overall growth and vigor of remaining trees. In commercial and precommercial thinning operations, increasing the growth and vigor of the remaining trees will decrease susceptibility to insects and disease.

Alternatives that increase the amount, extent, or density of structural stage 3C, 4B, 4C, and 5 of ponderosa pine stands will generally increase the risk of insects. Large-scale disturbances caused by insects can change stand structure, effect species changes or change successional trends. Large disturbances can also have the effect of regenerating expansive areas to basically a single age class, reducing diversity.

Under all alternatives, the potential exists for salvage and/or sanitation cuts to harvest dead or damaged timber and to attempt to slow or impede infestations from spreading. The degree to which these harvests are undertaken will largely depend upon the risks associated with the potential infestation spread into healthy stands, public safety, the presence of high value resources, and the resource emphasis of the infected or adjoining area.

Timber management can go a long way in creating forests that have a range of age classes and species diversity. The more diversity and healthier, vigorous trees present in an area, the less likely that large-scale insect epidemics will occur.

Timber sales showing evidence from insects should be sanitized as soon as possible to lessen the advance of insects.

3-7.2.4. Cumulative Effects

Cumulative effects for insect infestations from the incremental impact (direct and indirect effects) are associated with the alternatives when added to past, present, and reasonably foreseeable actions. The current insect situation describes past actions. The foreseeable cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Eco-region as defined by Bailey (1995).

Overall, past, present, and future activities that promote a mix of structural stages and species diversity across the Forest would lower the risk of insect infestations and epidemics. Activities that manage for more mature forested areas would likely result in some damage from insects, especially mountain pine beetle. Lowering the risk of insects would make the Forest less susceptible to insects invading the Forest from other ownership lands. Where forests outside the Forest are left to grow into mature, dense stands, the risk of insects increases in these areas, while increasing the risk to the Forest. Alternative 6 would have the least insect hazard followed by Alternatives 3 and 1. Alternative 4 would have the greatest insect hazard due to its emphasis on maintaining all structural stage 4C, and Alternative 2 would have the second greatest fire hazard due to its estimated low timber production level.

3-7.3. Noxious Weeds

Noxious weeds are typically non-native plants that adversely affect native plant communities by aggressively competing for nutrients, water, and sunlight. As a result, sensitive plants, forage quantity and quality, and soil stability are negatively impacted.

Background information regarding the status of noxious weeds on the Forest is presented in the 1997 Revised LRMP 1996 Final EIS (USDA Forest Service 1996a) on page III-189.

The Forest has implemented a Noxious Weed Management Plan (USDA Forest Service 2002b) to increase the scope of noxious-weed management. The weed-management plan directs the Forest to implement prevention, education, administration, planning, and integrated control in the Forest weed-management effort. The Noxious Weed Environmental Assessment (USDA Forest Service 2002b) was prepared to describe direct, indirect, and cumulative impacts concerning the weed-management plan. This section summarizes information from that document.

3-7.3.1. Affected Environment

Forest personnel have identified approximately 100,000 acres of existing noxious-weed infestations (USDA Forest Service 2004h). The Forest has been treating or retreating approximately 3,500 acres annually on a historic basis. Many treatments have occurred in association with scheduled timber-management projects. Under the Forest Noxious Weed Management Plan, treatment was increasing to at least 6,000 acres per year.

Future infestations on 22,300 acres could occur from implementation of scheduled Forest management activities through the year 2010 in the absence of weed treatment. These activities include timber management, road construction/maintenance, grazing, and prescribed fire. An additional 8,100 acres of potential infestation associated with scheduled land exchanges and campground and trail management could occur (USDA Forest Service 2002b).

Road construction and maintenance activities are expected to increase weed spread. Prescribed fire and mechanical-restoration activities can also increase the establishment and spread of noxious weeds. Motorized-vehicle use, a vector for spread, as well as domestic livestock and wildlife, can spread weeds. These factors and others not listed are expected to affect approximately 7,700 acres of spread (USDA Forest Service 2002b).

Wildfire is another disturbance that creates conditions conducive to the establishment and spread of noxious weeds. During the summers of 2000 and 2001, approximately 105,510 acres of Forest land burned from wildfires: Jasper (83,510 acres) and Elk Mountain (25,000 acres). Other large wildfires have burned since 2001. Forest personnel have documented increased noxious-weed establishment within the burned areas and predict additional weed establishment and spread in the absence of long-term (5 to 10 years) treatment and monitoring.

3-7.3.2. Resource Conservation Measures

Several goals, objectives, standards, and guidelines, both Forest-wide and specific to selected MAs, are included in each alternative to prevent, manage, and control noxious weeds. A number of these goals, objectives, standards, and guidelines are common to all alternatives and are contained in the 1997 Revised LRMP (USDA Forest Service 1997a). Guidelines specific to some MAs (1.1A-2505) where Region 2 sensitive species occur, address livestock use in relation to noxious-weed control; these do not differ among alternatives. Goals, objectives, standards, and guidelines that vary among alternatives are presented below.

Forest-wide Objective 231 is intended to prevent new infestations and reduce established noxious-weed infestations. In Alternatives 1 and 2, based on the 1997 LRMP, the objective would be to treat 3,600 acres per year, which represents a continuation of existing program accomplishment. In Alternatives 3, and 4, Objective 231 was changed to treat at least 6,000 acres per year during the next 10 years in accordance with the weed-management plan. Alternative 6 increases that to at least 8000 acres.

Forest-wide Guideline 1110 recommends initiation of re-vegetation and weed-free material, which is unchanged in Alternatives 1 and 2. In Alternatives 3, 4, and 6, the guideline has been made a standard and clarified.

Forest-wide Standard 4301 requires managers to determine noxious-weed introduction or spread risk and implement appropriate mitigation measures for all proposed projects or activities. This standard remains unchanged in Alternatives 1, 2, and 4. In Alternatives 3 and 6, treatment also would be required.

Forest-wide Guideline 4303 recommends the development of a noxious-weed management program that addresses the following components: awareness, prevention, inventory, planning, treatment, monitoring, reporting, and management objectives (USDA Forest Service 2002b). Noxious-weed control is given the following priority:

- New invaders- early detection and eradication
- New areas of infestation;
- Spreading or expanding infestations; and
- Existing infestations.

This guideline remains unchanged in Alternatives 1 and 2. Under Alternatives 3, 4, and 6, the guideline would be revised to change the priority to the following:

- Region 2 sensitive and SOLC occurrences of snails and plants;
- RNAs;
- BAs;
- New invaders;
- New areas of infestation;
- Spreading or expanding infestations; and
- Existing infestations.

The change-in-priority order rationale is that one of the primary risks for most sensitive species and SOLC is noxious weeds and treatment methods.

Forest-wide Guideline 4304 requires treatment of individual plants or groups of plants instead of broadcast chemical treatments where practical. This guideline would remain unchanged in Alternatives 1 and 2. In Alternatives 3, 4, and 6, the guideline would be changed to a standard and would “treat individual plant or group of plants in areas where Region 2 Sensitive or SOLC plants occur. Use a treatment method that is the least risk to the species being protected.” The rationale for the change is the same as for Guideline 4303. The guideline became a standard to enhance protection of sensitive species.

Forest-wide Standard 4306 requires the use of certified noxious-weed-free seed, feed, and mulch. This standard would remain unchanged in Alternatives 1 and 2. In Alternatives 3, 4, and 6, use of certified noxious-weed-free seed, feed, and mulch would be required along with Forest seed testing for noxious weeds. The additional testing and the certified noxious-weed-free seed meet a higher standard of purity. This meets or exceeds the Region 2 “Weed Free Forage Products Order” number R2-2005-01.

Forest-wide Guideline 4307 requires the use of certified noxious-weed-free feed when feeding recreational livestock and other ungulates. This guideline would remain unchanged in Alternatives 1, 2, and 4. The guideline would be deleted in Alternatives 3 and 6 because it is covered in Standard 4306.

MA Guideline 2.2-4201, new in Alternatives 3 and 4 recommends controlling invasive non-native plant and wildlife populations using measures that minimize threats to native species. In Alternative 6 this becomes a standard.

3-7.3.3. Direct And Indirect Effects

Management efforts to contain existing noxious-weed infestations and prevent spread to new areas directly affect noxious weeds on the Forest. Noxious weeds result from soil and vegetation disturbance where a seed source is available (e.g., timber harvesting, road construction and maintenance, mining, off-road vehicle recreation, new recreational developments), as well as range and wildlife improvements that create opportunities for noxious-weed establishment in new areas or increasing population size in existing infestation areas. Road building materials (gravel) can be a source for the movement of noxious-weed seed. Wildfire and prescribed burns and large-scale insect outbreaks directly affect noxious weeds with the disturbance they cause and indirectly by altering habitats in ways that can favor noxious-weed establishment and spread.

3-7.3.3.1. Species-Viability Management

Noxious weeds pose a threat to Region 2 sensitive plants and other native plants by competing more aggressively for soil moisture, light, and space, and sometimes by releasing chemicals in the soil inhibitory to other species. Species-viability management is thus hindered when invasive plant infestations occur.

The abundance and extent of noxious weeds on the Forest would be expected to increase less over the next 10 years if Alternatives 3, 4, or 6 were implemented.. Forest-wide Objective 231 for Alternatives 1 and 2 specify treatment of 3,600 acres, but Alternatives 3, and 4 would treat at least 6,000 acres per year and Alternative 6 would treat the most, treating at least 8000 acres. The potential for noxious weeds to become established following ground-disturbing activities would be reduced if Alternatives 3, 4, or 6 were implemented because the guideline outlining re-vegetation protocols (Forest-wide Guideline 1110) would become a standard, and only non-aggressive, non-native annuals would be used to stabilize soil if native species were not available. Although all management activities are to be analyzed for risk of noxious-weed introduction or spread (Forest-wide Standard 4301), only Alternatives 3 and 6 require implementing conservation measures and treatment; for Alternatives 1, 2, and 4, only conservation measures are required. Alternatives 3 and 6 would be expected to result in greater control of introduction and spread of noxious weeds on the Forest.

Considering species viability, Forest-wide Guideline 4303 in Alternatives 3, 4, or 6 would reduce the distribution of noxious weeds in the vicinity of Region 2 sensitive and SOLC because of the treatment priority given these areas. Conservation of those species would be improved.

3-7.3.3.2. Research Natural Area Management

All alternatives would include the existing Pine Creek RNA. The greatest number of RNAs (nine) would be established under Alternative 4. Alternatives 3 and 6 are intermediate, providing for four each. Alternatives 3, 4, and 6 alter Forest-wide Guideline 4303 for RNAs to have a high priority in efforts to control and contain noxious-weed infestations. Under these alternatives noxious weeds will be treated. Alternatives 1 and 2 do not provide special consideration to RNA noxious-weed management.

The land designated as RNAs would have less potential for noxious-weed spread because no significant ground-disturbing management activities would occur in these areas. Wildfires within RNAs could lead to increased noxious-weed infestations. Noxious-weed treatment in the RNAs would result in higher costs per acre. These off-setting concerns are minimal considering the total number of acres involved.

3-7.3.3.3. Fire-hazard And Insect-risk Management

Insects can kill trees often over large areas, removing the canopy and thus increasing amount of light on the forest floor, which in turn provides opportunities for noxious-weed invasion, particularly where mature, closed canopy stands have been killed because the supply of naturally occurring native grass and forb seed for re-vegetation is limited. The acres of Forest at high risk for insect damage over the next decade differ by alternative. Alternatives 1, 2, and 3 are comparable for high risk; Alternative 6 is slightly lower. Alternative 4 has the highest risk of insect damage during the next decade.

Higher fire hazard means more potential for high-intensity fires, causing more disturbances from high-intensity fires and a greater likelihood of weed spread. Alternatives 1 and 2 do not have fire-hazard objectives and may or may not reduce fire hazard are similar to 4 in fire hazard in the WUI due to national fire-hazard direction. Alternative 3 would reduce fire hazard in some interior portions of the Forest and would have a slightly lower fire hazard. Acreage for high-risk fire hazard would be less in Alternative 6 because Alternative 6 provides the greatest emphasis of the alternatives with an objective for 50 to 75 percent of the WUI and 50 percent of the remainder of the Forest in a moderate-to-low fire-hazard rating. Some of this fire-hazard reduction would likely be offset by fire-hazard-reduction actions taken, including silvicultural treatments such as cutting and prescribed burning. These management actions result in soil disturbance and the potential establishment and spread of noxious weeds.

3-7.3.4. Cumulative Effects

Cumulative effects for weeds result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Each Phase II Amendment alternative would result in beneficial and adverse effects; however, the nature, extent, duration, and intensity of these effects would likely vary across alternatives. Alternative 6 would directly disturb the most acres and thus have the largest cumulative affect on weeds; it is possible that much of this could be offset by the indirect effect of the disturbance by fires and should be reduced. Alternative 4 would likely be the reverse. The incremental effects of natural disturbances and resource-management practices on private and public lands on noxious weeds are expected to continue. The additional treatment acres in Alternatives 3, 4, and 6 are not anticipated to exceed acceptable thresholds to the environment or to result in long-term adverse impacts (USDA Forest Service 2002b).

Historic resource-management activities have influenced the vegetation composition and structure of the Forest and, as such, are encompassed in the existing conditions against which projected changes are measured for each alternative. Current public and private noxious-weed management programs exist and are expected to continue in the foreseeable future for areas within and adjacent to the Forest

3-7.4. Storm Events

3-7.4.1. Affected Environment

Storm events are natural occurrences on the Forest. Fire and insects are major disturbances addressed in other sections of this amendment and referenced in the 1997 Forest Plan. There are other storm events such as wind, snow, ice, hail, flooding, and winter kill (excessively cold temperatures). These storm events contribute to the fuel loadings, creation of snags, and the changing structure of the forest. The diversity of disturbance pathways, primarily timber harvest history, influences the forest-vegetation structure and number of snags (Lundquist 1995).

Wind damage is common in the Black Hills ranging from a single tree to large landscapes. Many documents state the damage to the forest from wind events. These documents are briefly summarized in RMRS-GTR-97 (Shepperd and Battaglia 2002). There are several things to keep in mind if minimizing wind damage is an objective. Although ponderosa pine is considered a wind-firm species (Alexander 1987), Graves (1899) noted that trees on exposed ridges of micaceous schist or limestone formations were typically toppled. Blow downs typically occur in higher elevations in exposed stands. Wind damage most often occurs on hillsides directly exposed to west winds or at the edge of high clearings where wind can be funneled down a valley (Raventon 1994, Shepperd and Battaglia 2002).

Ratios of tree height to diameter have been shown to predict ponderosa-pine susceptibility to wind and snow damage in the Northern Rocky Mountains (Wonn and O'Hara 2001). Ponderosa pine trees that have height:diameter ratios greater than 80:1 (units in feet) are more prone to damage than trees with lower ratios. Height:diameter ratios below the threshold level can be maintained with thinning during early stand development. If stands are older and have borderline height:diameter ratios, a series of low-intensity thinnings is preferable to allow greater diameter growth while maintaining stand stability (Wonn and O'Hara 2001). If the density of a stand is dramatically reduced, then the residual trees will not utilize the available growing space to the full potential. Furthermore, dense stands typically have high height: diameter ratios due to competition. These trees do not have the bole and root systems to withstand the wind when opened up, and many of the residual trees are likely to be uprooted, broken, or bent (Boldt and Van Deusen 1974, Shepperd and Battaglia 2002).

Ponderosa pine is also frequently damaged by snow in the Black Hills. Damage to the forest from snow has been recorded in many historical publications. Snow bend and breakage occur more often in sapling and small pole-sized trees (Boldt and Van Deusen 1974). Small saplings often fail to return to their original form. Pole-sized trees are in the highest danger of breakage. Snow damage affects tree mortality, susceptibility to insect attacks, and fuel loadings. It is also a factor in the creation of gaps in the forest canopy, provides for recruitment of new tree-age classes, and provides for habitat for insects and small mammals that are prey for other species. Early thinning of dense stands will strengthen the residual trees and prevent losses from heavy snow (Schubert 1974). Maintaining tree height:diameter ratios of less than 80:1 significantly decreases the susceptibility of snow damage in ponderosa pine trees (Wonn and O'Hara 2001) (Shepperd and Battaglia 2002).

Storm events may result in large rainfall amounts in localized areas that saturate soils, increase surface runoff, and cause flooding. Forest geology, topography, and climatic conditions play an important role in flood frequency and severity. The majority (59 percent) of annual precipitation in the Black Hills occurs in the months of April through July, with May and June being the wettest months (Carter et al. 2002). Principle damage from flooding is to roads, stream channels, recreation facilities, and dams. Additional information regarding past floods is disclosed in the 1996 Final EIS (USDA Forest Service 1996a) and is incorporated by reference.

All natural disturbances are looked upon as opportunities to improve the forest. Often the salvage of timber is pursued in efforts to improve forest conditions. Timber salvage has a narrow window of product removal due to deterioration of the wood from insects and fungi (K.Allen 2001). Timber resource products can be available in the balancing of all resource needs in managing the land (for salvage from wildfire see Section 3.7.1 Fire). For other natural disturbance events, salvage for forest products can be realized if done before wood deterioration. This salvage is permissible within the goals, objectives, standards and guidelines of the amended Forest Plan.

3-7.4.2. Direct And Indirect Effects

Storm events are natural disturbances in the forest. Storm events such as wind, snow, ice, hail, flooding, and winter kill (excessively cold temperatures) will always occur regardless of alternative choices. The 1996 Final EIS (USDA Forest Service 1996a) disclosed the effects of management activities on floods and floodplains and is incorporated by reference.

3-7.4.2.1. Effects Of Species-viability Management On Storm Events

Storm events provide the cycle of a changing ecosystem condition and are a random source of snag and down dead woody habitat. Managing for dense stands (3C and 4C) tends to produce trees with the greater height/diameter ratio and subject to greater breakage. Alternative 4 would provide the most 4C stands followed by Alternatives 3 and 6. Alternatives 1 and 2 do not have objectives for 3C and 4C stands and it is uncertain how much would exist under these alternatives although some would certainly exit. Similarly Alternative 4 does not have objectives for 3C. Alternatives 3 and 6 have identical objectives for 3C at 49,000 acres, a 7,000-acre increase over current conditions.

Floods and large runoff events may realign stream channels and contribute additional sediment into aquatic habitat in a short period of time. These flood events may also transport large woody debris and other materials that create aquatic habitat diversity. Species-viability management will maintain and/or enhance riparian and aquatic habitat conditions to moderate the effects of flooding and to speed habitat recovery following a flood. All alternatives maintain stream health to improve the resiliency of watersheds to recover from large runoff events. Alternatives 3 and 6 strive to rehabilitate five stream reaches as compared to three stream reaches in Alternatives 1, 2, and 4. Alternatives 3 and 6 promote increased hardwood restoration to increase beaver populations. All alternatives strive to restore riparian shrub communities. Alternatives 1, 2, 4, and 6 restore 500 acres, and Alternative 3 restores 1,000 acres. Riparian shrub communities stabilize stream banks and support beaver populations. Beaver and their associated dams serve as storage facilities to reduce peak flows.

3-7.4.2.2. Effects Of Research Natural Area Management On Storm Events

Storm events may occur in RNAs as well as the rest of the Forest. However, storm events in RNAs are the natural disturbances that historically influenced these RNAs and for which research is designed to observe and monitor the effects on the natural ecosystem. The effects of RNA management are anticipated to be negligible across the range of alternatives.

3-7.4.2.3. Effects Of Fire-hazard And Insect-risk Management On Storm Events

Storm events usually result in forest conditions that heighten fire hazard and insect risk. See the Fire and Insect secctions. Fire-hazard and insect-risk management tend to favor larger more wide-spaced trees that tend to be more wind firm and resistant to storm damage. Alternative 6 would have the greatest probability of reducing the extent and severity of storm damage, and Alternative 4 the least. Alternatives 1 and 2 do not have fire-hazard and insect-risk reduction objectives and their effect on storm damage is unknown.

Timber harvest, as related to fire-hazard or insect-risk reduction, has little effect on the amount of runoff from large rainstorm events (USDA Forest Service 1996a). A fire's potential to increase peak flows causing flood damage depends on the severity of the fire. Acreage for high-risk fire hazard would be the least in Alternative 6 and the most in Alternative 4.

3-7.4.2. Cumulative Effects

The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Storm events promote the changing mix of structural stages at various scales across the Forest that provides the species habitat. Regardless of alternative, storm events will provide a random source of snags, down woody material, and increased fire hazard and insect risk. The amount of resource enhancement, improvement and commodity realization from storm events is contingent upon the prompt action of documentation, decision, and funding.

Storm damage on adjoining lands (federal and state) can add to the habitat provided in an area as well as the overall fire hazard and insect risk. Large amounts of unmanaged storm damage over numerous ownerships can present the starting point for an insect epidemic or a stand-replacing fire.

The cumulative effects from storm damage are similar across the range of alternatives because the effects resulting from these events can simply overwhelm the effects of management activities, especially on a localized scale.

3-8. Use of the Forest

3-8.1. Recreation and Travel Opportunities

3-8.1.1. Affected Environment

The Final EIS of the Black Hills National Forest 1997 Revised LRMP (USDA Forest Service 1996a) presented information on the affected environment for recreation and travel opportunities in two separate sections under Use and Occupation of the Forest (refer to pages III-417 through III-428). The EIS sections presented information on recreational opportunities, dispersed recreation capacity and use, and associated travel opportunities, including summary information regarding the NFS roads. Most of the information provided in these sections is still relevant; however, the following presents recently collected data.

The Forest continues to provide an abundance of recreational opportunities in both dispersed areas and at developed sites. The Forest collects data regarding the use and quality of these opportunities. **Table 3-51** presents the number of recreation visitor days and the principal recreation activities in 2002.

Table 3-51. Recreational Activity and Visitor Days for 2002

Recreation Activity	Recreation Visitor Days
Vehicular travel	2,215,300
Interpretation, viewing, and picnicking	335,600
Trail use (hiking, horseback riding, biking)	252,300
Camping	241,700
Fishing	173,400
Lodging	97,500
Hunting	45,800
Water Activities (Nonmotorized)	26,700
Gathering Forest Products	21,100
Water Activities (Motorized)	13,000
Winter Activities (Nonmotorized)	7,900
Mountain Climbing	3,100

Source: USDA Forest Service no date (a)

As presented in **Table 3-52**, there are currently just over 5,200 miles of National Forest System roads within the Forest boundary. These roads fall under multiple jurisdictions.

Table 3-52. Miles of Roads by Jurisdiction

Jurisdiction	Miles of Road
USDA Forest Service	4,863
County, State, and Federal	380
Local and Private	13
Total	5,238

Source: USDA Forest Service no date (a)

There are five road maintenance levels (ML) used by the USDA Forest Service. These ML are described in the Transportation System Maintenance Handbook (FSH 7709.58). **Table 3-53** presents miles of NFS roads by ML.

Table 3-53. Forest Roads by Maintenance Level

Maintenance Level	Total Miles
1-Basic Custodial Care	1,122
2-High Clearance Vehicles	3,136
3-Passenger Car Suitable	519
4-Moderate Degree of Comfort	428
5-High Degree of Comfort	32
Total	5,238

Source: USDA Forest Service no date (a)

In addition to the NFS roads, there are at least 2,705 miles of two-track roads on the Forest. These wheel-track roads are not constructed but have been formed by Forest users driving cross-country. In addition there are about 300 miles of trail on the Forest. Most trails are dedicated to nonmoterized uses.

3-8.1.2. Resource Conservation Measures

Standards, guidelines, goals, and objectives Forest-wide and for specific MAs have been developed and are used to manage recreation and travel opportunities. These were discussed in the Final EIS for the 1997 Revised LRMP (USDA Forest Service 1996a) or in the LRMP Phase I Amendment (USDA Forest Service 1997a). The Phase II Amendment alternatives propose several changes to recreation and travel opportunity direction that is as follows:

MA 5.4 Objective 207 and MA 5.43 Objective 205 set direction for winter and spring road density in Alternatives 3 and 6. Alternatives 1, 2, and 4 do not have similar direction.

> Alternative 3 - Manage for an open-road density of 1 mile of road per square mile or less from December 15 through May 15.
>
> Alternative 6 - Manage for an open-road density of 1 mile of road per square mile or less for general public travel from December 15 through May 15.

MA 3.1 Standards 9101, 9102 and 9103 and MA 5.4 Standards 9101 and 9102 restrict off-road and over-snow motorized travel in botanical areas.

> MA 3.1, Alternatives 1 and 2 restrict motorized travel to designated routes, prohibit off-road travel and restrict over snow travel to designated routes and areas. These are guidelines in Alternative 1 and standards in Alternative 2. Alternatives 3, 4, and 6 are standards as well and allow for exceptions for emergencies and administrative use.
>
> MA 5.4, Alternatives 1 and 2, may restrict off-road travel to designates routes, and do restrict over snow travel to designated routes and areas. These are guidelines in Alternative 1 and standards in Alternative 2, 3, 4, and 6. Standard 9101 for Alternatives 3, 4, and 6 restricts off-road motorized travel between December 15 and May 15.

3-8.1.3. Direct And Indirect Effects

In general, there would be few impacts on recreation or travel opportunities on the Forest from any alternative. The most direct effects would occur with restrictions on mechanized and motorized travel in research natural areas, botanical areas, and big game winter range, and the possible restriction of public access to research natural areas.

3-8.1.3.1. Effects Of Species-viability Management On Recreation And Travel Opportunities

Forest-wide, there would be decreased access for authorized motorized recreation activities in botanical areas and big game winter range for species-viability management. Unauthorized use in closure areas will continue to be curtailed through law enforcement activities. No developed recreation centers would be added or removed. Some trail routings might be moved away from locations of R2 sensitive species, but this would have minimal impacts on recreational or travel opportunities. Trail construction would be the same for all alternatives. Alternatives 3, 4, and 6 will have the most impact on motorized access followed by Alternative 2 and Alternative 1, which has the least affect.

Various silvicultural treatments for the promotion of species viability would be carried out that might require road construction or reconstruction if they are associated with commercial timber sales, but these impacts are within the scope of timber-related road construction analysis found in the 1996 Forest Plan EIS (see Chapter 2 Roads and Trails and Table II-18). To the extent that roads are constructed, there might be parts of the Forest that become accessible by four-wheel drive vehicles that are now inaccessible. Road construction and reconstruction associated with timber sales would be expected to change as timber sale levels change by alternative. Alternatives 1, 3, and 6 would have the most road construction and Alternative 2 the least. See Final EIS Chapter 3 Forested Ecosystems

3-8.1.3.2. Effects Of Research Natural Area Management On Recreation And Travel Opportunities

Alternatives 1 and 2 do not include any new RNAs; no effects on recreation and travel opportunities are anticipated.

Alternative 3 includes approximately 2,500 acres of candidate RNAs. Alternative 4 includes approximately 7,800 acres of candidate RNAs. Alternative 6 includes approximately 2,300 acres of candidate RNAs. The recreation opportunity spectrum class is “semi-primitive, nonmoterized.” Motorized or mechanized recreation and travel opportunities would not be allowed in RNAs. Restrictions on nonmotorized public access in RNAs are unlikely but are possible (see Section 3-6.2 Research Natural Areas and USDA Forest Service 2005g for more information on RNA road closures). There are no foreseeable issues associated with the nine candidate RNAs that would lead to restricting nonmotorized public access. The candidate RNAs are located in areas of the Forest that have not been significantly altered by human activity. Thus, recreation in these areas in general is limited. Many of the candidate RNAs have two-track roads and Forest Service System roads and trails. The motorized roads would be closed and the system trails would either be rerouted or the nonmotorized use allowed (see Final EIS Section 3-6.2. Research Natural Areas). The total area that would be included in RNAs (if all candidates were designated) equals less than 1 percent of the total Forest area.

3-8.1.3.3. Effects Of Fire-hazard And Insect-risk Management On Recreation And Travel Opportunities

Various treatments for fire-hazard and insect-risk management would be carried out that might require road construction or reconstruction if these treatments are associated with commercial timber sales. To the extent that roads are constructed, there might be parts of the Forest that become accessible by four-wheel drive vehicles that are not now accessible. Road construction is generally associated with timber sale levels, which vary by alternative (see Final EIS Chapter 3 Forested Ecosystems and the 1996 Final EIS Chapter 2 Roads & Trails & Table II-18).

3-8.1.4. Cumulative Impacts

Cumulative effects for recreation and travel opportunities result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The current recreation and travel opportunity situation describes past actions. The foreseeable cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Recreational activity in the Black Hills is gradually increasing, partially in response to Black Hills area population growth and development on private land, attractions such as the Sturgis Rally and similar events, Mt. Rushmore National Memorial, Custer State Park, Wind Cave National Park and other local destinations. These attractions draw people to the Forest who may then use the Forest for recreational activities that include the following: hiking, camping, scenery viewing, fishing, and hunting.

The Forest is undertaking a travel management plan as a separate action from the Phase II Amendment that will determine the extent of future travel opportunities on the Forest. While Phase II addressed only those travel management issues related to its purpose and need, the Forest-wide travel management plan will include a much broader set of issues and make site-specific decisions related to them. The Forest-wide travel management plan will abide by the Phase II Amendment direction in the Forest Plan or it will amend the plan with appropriate analysis and public participation.

Alternatives 3, 4, and 6 would include the strongest (more guidelines changed to standards with the language strengthened) direction in restricting travel generally for species viability. Alternative 2 has stronger direction restricting travel than Alternative 1. Alternative 4 would recommend the most candidate RNAs including the RNAs with the most travel conflicts followed by Alternatives 3 and 4. Fire and insect management would not impose additional restrictions on travel but may increase access, but only to the extent described in the 1997 Forest Plan. When considered in total Alternative 4 would place the most restrictions on travel in the Forest followed by Alternatives 3, 6, 2, and 1.

3-8.2. Scenic Resources

3-8.2.1. Affected Environment

The Final EIS of the 1997 Revised LRMP (USDA Forest Service1996a) presented information on the affected environment for scenic resources (refer to pages III-429 through III-440, and Appendix B-45 through B-60). The EIS sections generally described the scenic integrity of the Forest, summarized the scenic classification system, the valued landscape character unit (LCU), and scenic integrity objectives (SIO).

The visual appearance, density, and diversity of the vegetation on the landscape today is quite different than that documented during the Custer Expedition of 1874. Historically, fire was a major proactive force in shaping the composition and structure of the plant communities, and it played an important role in ecological processes within the Black Hills. In the Forest of today, vegetation composition and structure are more the product of human management activities (USDA Forest Service 1996a, p. III-203). Hardwoods such as aspen, birch, and bur oak probably have declined in extent due to increased conifer dominance. Understory herbaceous and shrub vegetation diversity has declined due to higher pine and spruce densities (USDA Forest Service 1996a, p. III-130).

Through the range of the ponderosa pine across the Black Hills landscape, the current conditions may be at increased hazard of uncharacteristically severe fire. As a result of the effective exclusion of fire in the late 19th through the 20th century, over a landscape that historically had a prevalence of surface fire or mixed severity fire (see Section 3-7.1.1.1 Historic Fire Regimes).

Considering the spread of ponderosa pine and the resulting loss of meadows since fire suppression and insect control was initiated, understanding what is “natural” is quite complex. The dense pine forest before us today is “natural” appearing to many; however, a review of the information available from before settlement and human influence thereafter indicates that is not the case. A scenic condition with more non-forested land and a diverse mixture of tree species, growing in an open-growing condition, is closer to conditions occurring before settlement (USDA Forest Service 1996a p. III-439).

Where there is a lack of noticeable human-caused disturbances that could detract from the dominant valued landscape character attributes (forested hillsides, towering rock formations, meadows, quiet streams), the Black Hills landscape has a high level of scenic integrity. However, the indirect effects of fire suppression have lead to gradual changes in ecological conditions (densely growing ponderosa pine, hardwoods being excluded, ponderosa pine encroaching into meadows) that can affect the scenic sustainability of those same valued landscape character attributes. Areas of high fire hazard or high mountain pine beetle risk in the Black Hills landscape are examples where the scenic sustainability of the valued landscape character attributes may be at risk.

Examples where the scenic sustainability was altered include:

> Landscape surrounding Deadwood, South Dakota (2002 – Grizzly Gulch Fire – 11,600 acres), near Jewell Cave National Monument along U.S. Highway 16 (2000 – Jasper Fire – 83,508 acres and 2001 Elk Mountain II Fire – 13,195 acres), and along U.S. Highway 16 west of Rockerville, South Dakota (2002 – Battle Creek Fire – 12,500 acres).
>
> Large concentrations of ponderosa pine killed by mountain pine beetles in Beaver Park, Kirk Hill, south and west of Bear Mountain, around Ditch Creek, west of Deerfield, and in the Boles Canyon areas.

3-8.2.2. Resource Conservation Measures

Standards, guidelines, goals, and objectives for the Forest as a whole, and for specific MAs, have been developed and are used to manage scenic resources. [These were discussed in the Final EIS for the 1997 Revised LRMP (USDA Forest Service 1996a p.III-429 thru III-436) and the 1997 Revised LRMP (USDA Forest Service 1997a, throughout Chapter 2].

Under Objective 10-02, under Alternatives 3, 4, and 6, the SIOs within the WUI would be moderate or low, although a higher level of scenic integrity may be achieved. (SIOs of very high, or high, within the WUI would be reduced to moderate—"a scenic integrity level that refers to landscapes where the valued landscape character 'appears slightly altered', and noticeable deviations must remain visually subordinate to the landscape character being viewed.") Where the SIO is moderate, the criterion would be met within two full growing seasons after completion of a project. Where the SIO is low, the criterion would be met within four full growing seasons after completion of a project. This change supplements Guideline 5606 (USDA Forest Service 1997a p. 2-72). Care in design will determine how well the activities appear to blend into the surrounding landscape.

Guideline 2414 (USDA Forest Service 1997a p. 2-32), under Alternatives 1 and 2, recommends management for tree stands to enhance the scenic quality and recreational opportunities, including areas of large, yellow-barked ponderosa pine, areas of hiding cover for wildlife, and areas with open, park-like conditions. Under Alternative 3, Guideline 2414 would apply except where it conflicts with emphasis species needs. Under Alternative 4, Guideline 2414 would apply except in Reserve areas. Under Alternative 6, Guideline 2414 would emphasize large ponderosa pine in open stands.

Under Alternatives 1 and 2, Guideline 8402 (USDA Forest Service 1997a p. 2-91), allows the use of non-native vegetation to improve scenic beauty and diversity. Under Alternatives 3, 4, and 6, revegetation with native vegetation is preferred.

3-8.2.3. Direct And Indirect Effects

Scenic integrity and scenic resource management would be unaffected by Alternatives 1 and 2. Alternatives 3, 4, and 6 present varying approaches to provide for specie viability and reduce fire hazard and the risk of insect activity; in addition there would be indirect effects due to other management actions on the Forest associated with implementing each alternative. The effects of each approach are summarized in the following sections.

3-8.2.3.1. Effects Of Species-viability Management On Scenic Resources

All action alternatives would produce overall long-term beneficial impacts, improving the scenic integrity of the landscape. These alternatives emphasize a visually appealing landscape by providing a diversity of vegetative species and size classes, vista openings featuring rock outcroppings, and park-like stands of large ponderosa pine where they can be viewed by the public (Guideline 2414, USDA Forest Service 1997a p.2-32). These scenic objectives may be modified with new Objective 10-02, which allows temporary changes in scenic objectives to accomplish management objectives including management for species viability resulting in management activities that may be more visible in the landscape.

Alternatives 3 and 6 protect sensitive plants, and plant species of local concern, as needed to conserve botanical features. This may result in increased scenic value in specific settings, but may not result in appreciably greater scenic value across the Forest. In areas where dense stands may remain (or be encouraged), visual penetration into the forest may be limited, also limiting views of large trees and/or rock outcropping that may be present.

3-8.2.3.2. Effects Of Research Natural Area Management On Scenic Resources

Alternatives 1 and 2 do not include any proposed RNAs.

Under Alternatives 3, 4, and 6, RNA designation reduces the potential for management activities. Ponderosa pine community types within the RNAs would be allowed to go through natural succession. RNA management should not adversely affect scenic integrity; however, due to existing ecological conditions, natural disturbance processes may take place that can dynamically change the appearance of the vegetation on the landscape, and thus the scenic values. Eventually, with natural disturbances, the vegetation communities within the RNAs may return to conditions similar to those that existed before the Forest was managed. With the exception of Cranberry Springs, all proposed RNAs are located within 1 mile of private land. When dynamic changes occur, short-term disruption to the landscape can be anticipated. In the long term, RNA management may result in increased scenic value in specific settings.

3-8.2.3.3. Effects Of Fire-hazard And Insect-risk Management On Scenic Resources

In general, Forest management activities that reduce fire hazard and insect risk can provide structural stage and vegetative diversity in the Forest. Both of these actions would affect the scenic values across the Forest. Fire-hazard reduction activities in the WUI in Alternatives 3, 4, and 6 reduce SIOs (Objective 10-02).

Management activities to create a moderate-to-low fire or mountain pine beetle hazard will create a more open forest condition (change in texture and color), as understory and overstory trees are thinned. The change in the vegetation density will be particularly evident on steep slopes. The shape of the units (form) will have a bearing on the natural appearance of these management activities (thus geometric patterns should be avoided). These form, texture and color differences could be most evident along the boundary between treated lands and un-treated (private or the Forest) lands. Access roads, to manage the forest, depending upon location, may be more visible in the landscape. Fire-hazard reduction activities in and near the WUIs in Alternatives 3, 4, and 6 allow reduced SIO objectives (Objective 10-02) for 2 to 4 years.

These changes will likely be evident from private lands and communities that have views of this treated landscape. Rock formations, hardwoods, and meadows should become more evident. In time, fall color from the hardwoods should also be more evident in the landscape. There is long-term potential for more large trees in these treated landscapes.

3-8.2.4. Cumulative Effects

Cumulative effects for scenic resources result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The current scenic resource situation describes past actions. The foreseeable cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

In the long term, the increase in species diversity (hardwoods, shrubs, grasses, meadow communities, etc.) should add to the valued attributes in the landscape, improve the scenic sustainability of the vegetation in the landscape, and thus improve the scenic integrity.

Continued community development (e.g., expansion of community boundaries, road systems, and other developments) near the WUI provides potential for cumulative impact on scenic resources as more homes and roads are built. At the same time, it is expected that new home owners will focus on reducing fire and insect hazard and maintaining or improving scenic quality on their private lands.

On the NFS lands, implementation of Alternatives 1 and 2 does not change the scenic integrity. Alternatives 3, 4, and 6 would result in an immediate shortterm reduction in existing scenic integrity (as human-caused disturbances will be more evident). This will be offset by the increase in hardwoods leading to visual diversity and enhanced visual quality and the scenic recovery of fire-hazard treatment areas 2 to 4 years after treatment. Reducing fire hazard will reduce the severity and extent of future wildfires that will lead to smaller areas visually impacted by wildfire and a faster recovery of areas that do burn, but at a lower fire severity.

Continued community development (e.g., expansion of community boundaries, road systems, and other developments) near the WUI could place a higher value on the scenic resources and reduced fire and insect hazard in those areas.

Alternative 6 would have the greatest positive impact on scenic resources because of the combined effect of reduced fire hazard and increased hardwood restoration acres, followed Alternatives 3, 1, 4, and 2.