USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Region / Black Hills National Forest June 2022

Black Hills National Forest

Draft Forest Assessments:

Fire and Fuels

Prescribed burn on the Long Draw Project in the Mystic Ranger District, 2018.

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Fire and Fuels Conditions Trends

The Black Hills National Forest is like other national forests in the West where "fire seasons" have turned into "fire years." The traditional season is longer than before. The shoulder seasons, spring and fall, (and to some extent winter) have both demonstrated that large fire growth is not limited to summer weather conditions. Two recent, large fires in the immediate vicinity of the Black Hills National Forest are good examples. The Legion Lake fire burned more than 54,000 acres during early December 2017 primarily within Custer State Park, and the Schroeder Fire burned more than 2,200 acres in late March of 2021 on private lands. Small fires have been known to occur in every month of the year. As climate and the resulting weather conditions change, uncertainty will become the norm.

Reference Conditions

Disturbances are a major factor in structural diversity and composition of the Black Hills National Forest (Shepperd and Battaglia 2002). Human activities, weather (wind, hail, snow), wildfires, insects, and other factors act individually or in concert affecting forest conditions, and these interactions have had significant influence altering the current fire regime. Fire is a particularly important disturbance for the Black Hills National Forest. Frequent, low severity surface fires maintained open forest stands by killing most of the seedling recruitment and saplings before they were able to reach the canopy (Brown and Cook 2006). Fire exclusion has led to uncharacteristically heavier surface fuel loads and denser understories of young ponderosa pine, which can lead to more severe fire potentially damaging soils and killing overstories.

Fire regimes describe a generalization of historical fire occurrence by the typical frequency and severity (table 1). Condition Class is a depiction of the degree of departure from historical fire regimes (table 2). These classes categorize and describe vegetation composition and structure conditions that currently exist inside the Fire Regime Groups. Based on coarse-scale national data, they serve as generalized wildfire rankings. Fire severity generally indicates the degree to which a site has been altered or disrupted by fire. There are three severity rankings:

- Low severity fire does not substantially change the above-ground vegetation structure.
- Mixed severity fire will have a wide range of fire effects ranging from little vegetation change to stand-replacement fire. A patchwork of conditions occurs post-fire.
- Replacement fire top-kills more than 75 percent of the upper canopy.

Table 1. Frequency and severity of fire, by fire regime group

Fire Regime Group	Frequency	Severity
I	0 -35 years	Low to mixed
II	0 -35 years	Replacement
III	35 – 200 years	Low to mixed
IV	35 – 200 years	Replacement
V	200+ years	Replacement/ Any severity

Table 2. Condition class rating and description

Condition Class Rating	Landscape condition relative to historic conditions
1	Vegetation patterns and disturbance regimes characteristic of the natural regime
2	Landscapes are moderately departed from the natural regime
3	Landscapes reflect vegetation and disturbances that are uncharacteristic of the natural regime

The risk of loss of key ecosystem components from wildfires increases from Condition Class 1 (lowest risk) to Condition Class 3 (highest risk). Condition Class 1 has key ecosystem components intact, such as large old trees and soil characteristics that would naturally be found on that site. Condition Class 2 indicates the land is very different from its natural regime in terms of its vegetation or disturbances, or both. Condition Class 3 has lost key ecosystem components; an example could be the loss of characteristic large trees due to wildfires burning outside of the historic range of variability in areas with uncharacteristically high fuels loading of both surface and/or standing fuels.

Prior to European settlement of the region, fire was the primary driver of this disturbance-based ponderosa pine ecosystem (Shepperd and Battaglia, 2002). Historically, fire return intervals in the Black Hills were relatively frequent (0-35 years), and fire intensities were low (surface fires most common) to mixed severity (partial overstory mortality) (Brown et al. 2000, Brown et al. 2008). Mixed severity fire regimes are complex and difficult to characterize. Fuels, weather, and topography all take on important roles affecting fire behavior. Variable fuel conditions (arrangement, continuity, and quantity) exist across the landscape. These differing conditions can and do result in highly variable fire effects. Low, moderate, and high severity fire can occur on any sized fire. Past fires and resulting fuel conditions have a definite impact on future fires. The Black Hills are a prime example of a mixed severity fire regime with wildfires commonly burning at all levels of fire severity, resulting in a myriad of fire effects to forest ecosystems. Twelve fire history studies have been conducted in the greater Black Hills area that indicate mean fire-return interval ranged from 5 to 33 years with more variability in fire severity with increased elevation and moisture availability (Murphy 2017).

Frequent fire intervals tend to maintain the current seral state. Generally, in the past, the Black Hills would have experienced periodic, low-intensity fires that would have reduced accumulated surface fuels and regenerated pine seedlings, thereby preventing high-intensity fires (Fire Regime I). Previous fires would have modified the effects of future fires, resulting in a mosaic of conditions ranging from openings, to groups of seedlings, to clumps of older aged trees, including large “yellow barks” or large ponderosa pines that would have dominated the landscape. Inevitably, larger and higher intensity fires would have occurred due to local conditions; however, they most likely did not consume all the trees on the landscape, leaving seed tree sources behind (Shepperd and Battaglia 2002).

Departure and Trend

Fire exclusion is the primary management decision that has led to the current fire and fuels condition on the Black Hills National Forest and has dramatically altered the historic fire regime. Other activities such as intensive timber management, grazing, and development of the wildland urban interface have also contributed to changes in fuel structures and composition that are uncharacteristic of the natural fire environment. Additionally, the Black Hills National Forest recently endured a nearly 20-year-long mountain pine beetle epidemic that caused extensive mortality, created heavy surface fuel loadings, increased grass production, and created the opportunity for prolific regeneration of ponderosa pine. The Black Hills National Forest has missed approximately five fire return intervals (>100 years of fire exclusion), which has led to uncharacteristic accumulation of live and dead fuels across the national

forest, classifying most of the area with either a Condition Class rating of 2 or 3. Most fires occurring in the Black Hills National Forest are suppressed within the first 24 hours when conditions allow; when more critical fire weather conditions are present, large fire growth is more probable. During the period of 1980-2020, 5,672 fires were recorded within the administrative national forest boundary for a total of 243,375 acres; 11 fires burned 200,714 acres or 80 percent of the total recorded acres. Most of the acres burned occurred during very few fire events (figure 1). The Black Hills have averaged 113 fires a year for the past 50 years. Of recorded fires since 1970 in the Black Hills, 97 percent burned less than one acre (figure 2).

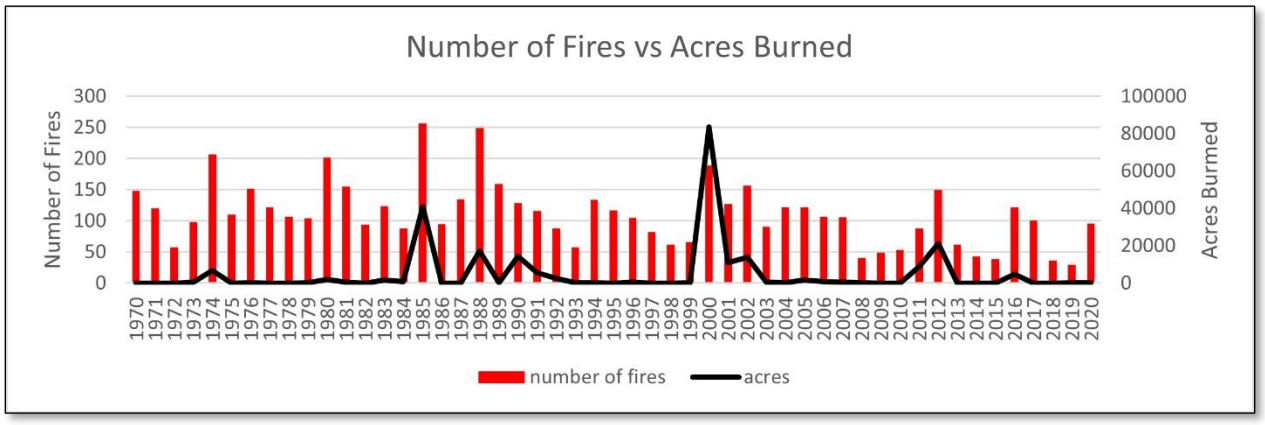

Figure 1. Number of fires vs acres burned, 1970-2020

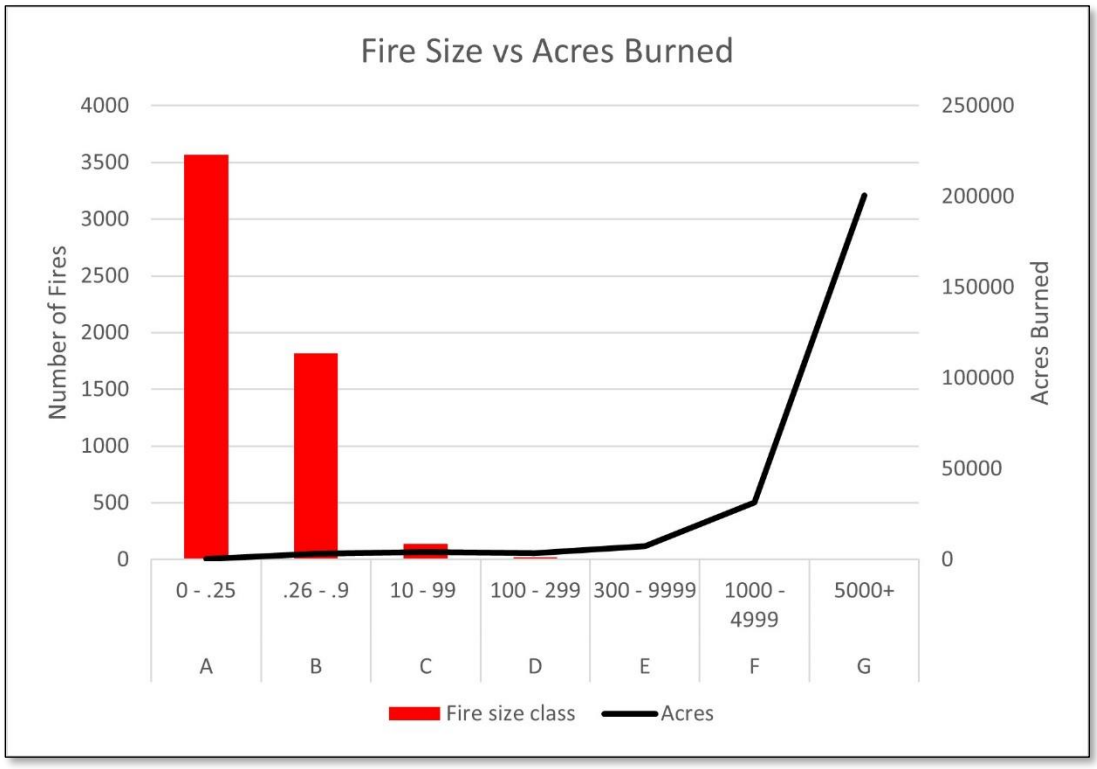

Figure 2. Fire size vs acres burned

About 70 percent of the Black Hills National Forest is part of the suitable timber base. Approximately 500,000 acres have been commercially treated and 250,000 acres have had non-commercial treatments since 1997. These activities have resulted in varied fuel beds and stand densities available to burn under wildfire conditions. Though open timber stands offer a reduction in the potential for stand-replacing crown fires, the open nature of these stands also allows for a faster moving fire due to increased grass and pine regeneration. Timber management has reduced overstory stand densities in many places across the Forest, reducing the likelihood of high-intensity crown fire. However, these activities have also removed the majority of very large trees (>16 inches), which are resilient to fire impacts due their thicker bark and higher canopy base heights. The majority of commercial sale units (for the past 15 to 20 years) utilized whole-tree skidding techniques. This yarding method allows for the majority of the biomass associated with harvested trees to be removed from the forest, thereby reducing the amount of activity fuels, which are the material left behind due to timber harvest or thinning. Recently, under the Black Hills Resilience Landscape Environmental Impact Decision, approximately 55,000 acres were treated utilizing overstory removal as the primary silvicultural treatment. These areas, if burned by wildfire, will show very little resilience; the residual seedlings and saplings will be vulnerable to fire for a few decades to come.

Prescribed Fire

Prescribed fire (broadcast and pile burning) is another management action that occurs on the Black Hills National Forest. Approximately 1,000 to 3,000 acres of broadcast burning is accomplished annually, generally during the spring, fall, or winter seasons. Piled material burned includes hand-piles, large top-wood piles resulting from commercial harvest, and limited machine piling of mountain pine beetle fuels. Approximately 1,000 to 3,000 top-wood piles are burned across the Black Hills National Forest in support of commercial timber operations each year. As a management action, broadcast prescribed fire is not implemented at a pace nor scale to have a meaningful effect on the overall fuels condition present on the national forest. Broadcast and pile burning accomplishment by acre for 1997-2021 is shown in figure 3.

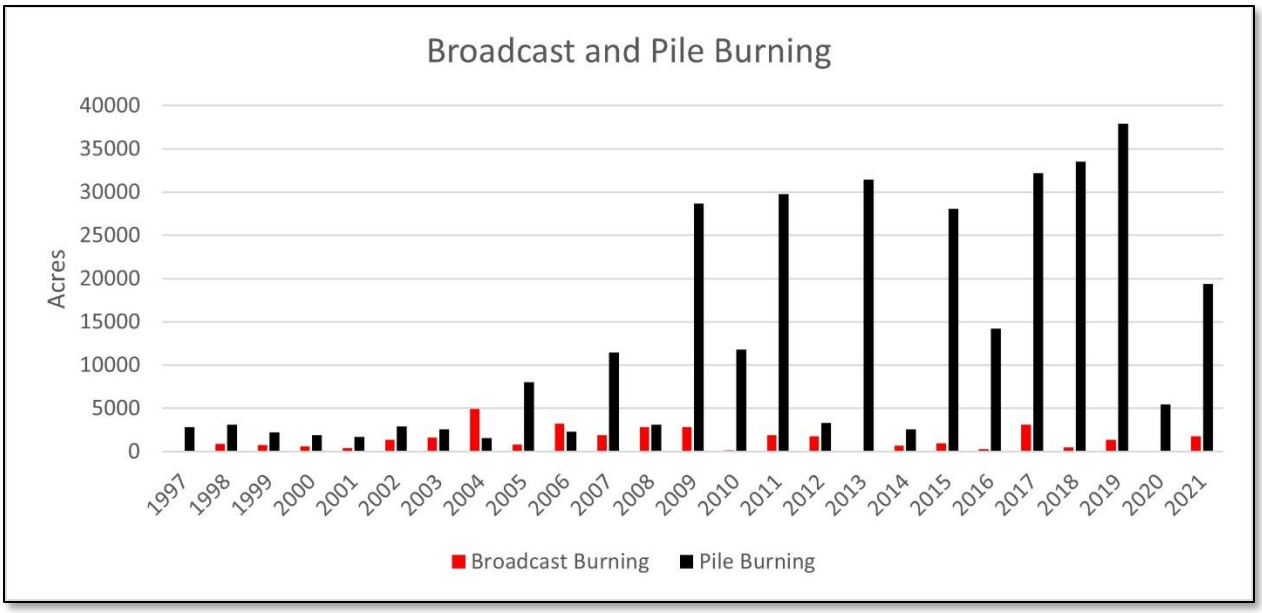

Figure 3. Broadcast and pile burning accomplishment by acre, 1997-2021

In 2019, the Forest Service (Rocky Mountain Regional Office fire staff) performed a strictly spatial analysis utilizing LANDFIRE data (LF 2014) to inform a baseline annual goal for prescribed fire across the region that assumes that broadcast burning is appropriate where Fire Regime Groups 1, 2, and 3 and Condition Class 2 and 3 intersect outside of designated wilderness. Ninety-four percent of the Black Hills National Forest is rated either a Condition Class 2 or 3 describing the need for treatment. For a theoretical prescribed fire program placing the *entire* Black Hills National Forest on a 40-year rotation, more than 29,000 acres a year of prescribed burning would need to be implemented. The 10-year average (2009-2018) for broadcast prescribed fire is 1,360 acres; this identifies an annual deficit of nearly 28,000 acres a year. Clearly, this is not a site-specific analysis, nor does it consider significant constraints to implementing prescribed fire on the Black Hills National Forest, but it does effectively describe the fire deficit on the national forest. The Forest Service is planning to re-analyze with the most recent LANDFIRE data (LF2016-LF2020), and the results will be incorporated into future analysis at the national forest level.

Fuels Treatments

Fuels treatments and timber-stand improvement (TSI) projects are generally considered synonymous on the Black Hills by thinning seedling- and sapling-sized ponderosa pine in the understory. The difference is in how the resulting activity fuels are treated. Fuels-oriented treatments focus on modifying potential future fire behavior as opposed to just thinning a stand to improve stand health. Both surface fuels and stand density are considered. Fuels-oriented projects would thin, pile, and burn the piles in limited areas along private property boundaries or roads, thereby reducing the residual biomass left on-site. Historically, TSI projects would have treated the activity fuels by lopping and scattering the cut trees adding to surface fuel load; this fuel profile can produce enough energy release to scorch the residual trees sufficiently to cause mortality. The probability of crown fire may be reduced; however, this fuel profile will have greater opportunity to burn as it is a dead vs live fuel. More recently, both Fuels and TSI projects have started to more fully integrate, mixing treatments to ensure positive fuels outcomes. Larger areas are being treated with mastication, which, although not as effective as piling and burning, does rearrange the fuels in such a manner as to reduce potential fire behavior. Approximately 8,900 acres per year are treated through Fuels/TSI projects. Currently there is a significant need for thinning in the understory; approximately 260,000 acres need Fuels/TSI thinning across the national forest in the next decade.

Mountain Pine Beetle Impacts

The nearly 20-year-long mountain pine beetle epidemic has had an enduring impact on the Black Hills National Forest. The primary management tool utilized by the Black Hills National Forest was aggressive commercial thinning of dense stands of mature ponderosa pine on operable ground. The open nature of these stands now allows for prolific pine regeneration with several thousand stems to the acre being common (Shepperd and Battaglia 2002, Bolt 1973). Areas affected by the mountain pine beetle and not harvested are complex and are not represented by standard and widely accepted fuel models. These areas have uncharacteristically high surface fuels loads, a significant grass component, and abundant pine regeneration. This complex fuel arrangement is conducive to fast-moving, high-intensity fires with long residence time, which can damage soils and produce heavy smoke of long duration. To date, the Black Hills National Forest has not experienced an intense fire burning this type of fuel arrangement due to effective fire suppression and a lack of critical fire-weather and fuels conditions. However, some smaller fires have occurred in this fuel type where spread by spotting created a high resistance to control. This has been witnessed on larger fires on other national forests as well. Two prescribed fires have been implemented within areas of mountain pine beetle mortality, the Whaley and Long Draw prescribed fires. Fire burned more intensely on both projects within this fuel complex, producing enough crown scorch to

induce overstory mortality. More than 430,000 acres of the Black Hills National Forest were adversely affected by the mountain pine beetle; of those affected acres, less than 50 percent were unharvested/thinned (USDA Forest Service 2017).

Communities

The Black Hills National Forest encompasses two states, six counties, and 56 at-risk communities, as identified in Federal Register (Volume 66, No. 3, published on January 4, 2001). All six counties have Community Wildfire Protection Plans. Some of these plans have been recently updated, and others are nearly 15 years old. Private inholdings are spread throughout the national forest, and new construction of single-family homes and cabins is increasing. Utilizing a three-mile buffer around private property, nearly all of the Black Hills National Forest could be considered wildland urban interface. Infrastructure ranging from high-voltage transmission lines to Forest Service recreation areas represent values at risk. Tourism brings more than three million visitors per year. These factors all increase fire risk and values at risk.

Climate Change

Climate predictions for the Black Hills National Forest should be considered mixed for its potential effect on fire and fuels. Temperatures are expected to increase, with a predicted tripling of days above 95 degrees Fahrenheit and a slight increase in annual moisture. Precipitation patterns may become more variable from year to year. This will lead to more non-typical fire seasons. During the wetter seasons, fewer fires will occur with fewer acres burned; however, more grass will grow, and increased pine regeneration will amplify future fuel loading. More fires will likely occur during dry seasons. Compound events (drought mixed with hot temperatures) are also more likely to occur; these events will provide conditions for an increase in fire size and occurrence. The number of fires, acres burned, and intensity of fire will all likely increase as the climate warms. Timberlake et al. (2021) states that 2012 is a year that land managers can look to as an example on how to plan for future fire seasons. The year 2012 was an active fire year for the Black Hills; 150 fires were recorded with 21,110 acres burned. Fire season activity for 2012 is shown in table 3. Many of these fires were small due to aggressive fire suppression.

Table 3. Fire season activity for 2012

Fire Size Class	Size (acres)	Number of Fires	Acres Burned
A	0 to 0.25	88	10
B	0.26 to 9	49	106
C	10 to 99	6	150
D	100 to 299	2	414
E	300 to 999	3	1,544
F	1,000 to 4,999	0	0
G	>5,000	2	18,886
Total		**150**	**21,110**

Future Planning

The Black Hills National Forest is currently in the development process of Potential Operational Delineations (PODS), a strategic planning tool developed using a combination of local expertise and advanced spatial analysis that identifies the safest and most effective control lines used to contain a

wildfire, and which can assist in integrating land management objectives and incident response. The two primary outputs are the Suppression Difficulty Index (SDI) and Potential Control Lines (PCL). SDI values balance potential fire behavior with responder accessibility and mobility. PCLs help identify and visualize where opportunities may exist to interrupt fire spread. Combining these two outputs can support vegetative treatments at the right place and time. This planning effort is part of a national effort to facilitate collaborative work with partners before fires start. PODs will become integral to future fuels treatment planning for the Black Hills National Forest.

The Need for Change

The current goals, objectives, and standards in the current forest plan are outdated and limit management of Fire and Fuels.

- There is a need for the forest plan to tier to the National Cohesive Wildland Fire Management Strategy. This national strategy was prepared jointly with Tribal Nations and State, local, and nongovernmental partners. It articulates the shared goals of (1) restoring fire-adapted ecosystems on a landscape scale, (2) building fire-adapted human communities, and (3) responding effectively to wildland fire.
- Reasonable guidance regarding natural fire needs to be considered. Standard 4103 states that prescribed fire should be utilized through "planned and natural ignitions" to achieve management objectives. Suppression objectives outlined within the Fire Management Direction Summary Table are so limiting that all natural ignitions are suppressed to the smallest possible footprint.
- There is a need for an analysis of current and potential surface fuels and the role they play regarding fire severity. The results of this analysis will have management implications that primarily affect commercial and non-commercial vegetation treatments. Guideline 4110 states that "activity and natural fuel treatments" should be tiered to the rarely used fire modeling output of BTU/sec/ft. Treatments that do not meet the fire modeling value are broken into what seems to be arbitrarily sized units by fuels breaks.
- Management direction that promotes desired outcomes over a rating system needs to be considered. Fire Hazard ratings on the Black Hills National Forest were defined in the 1996 Long Range Management Plan-FEIS:

  > "Changes in fire hazard over time were calculated in FVS by correlating fire hazard with stand structure. Different fire hazards were determined depending if the stand was on steep slopes or moderate slopes. Later in the analysis process, the output from FVS was prorated based on the percent of each strata in each slope class."

The Fire and Fuels Extension of the Forest Vegetation Simulator is very generalized, is limited to consistent inputs for fire behavior calculations, and does not take in surrounding conditions into considerations. This method only considers stand density, canopy closure, and slope; fire behavior fuel models were not acknowledged. Surface fuels (type, loading, and continuity) are a critical factor in determining fire behavior and severity. FVS can provide good information at the stand level but is not an appropriate model for landscape level analysis. By this rating system, a dense stand of large trees (High Hazard) is commercially thinned, the Fire Hazard is lowered to Moderate or Low depending on the number trees harvested in each stand. Neither surface fuels nor ladder fuels were considered in this rating system.

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