USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Region / Black Hills National Forest

October 2023

Black Hills National Forest

Revised Forest Assessment:

Fire and Fuels

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

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov (link sends e-mail).

USDA is an equal opportunity provider, employer, and lender.

Contents

List of Tables

List of Figures

Wildland 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. Both fires occurred when fine herbaceous fuels were fully cured and available to burn. 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), wildland fires, insects, and other factors act individually or in concert affecting forest conditions, and these interactions have had significant influence altering the current fire environment. 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.

Prior to European settlement of the region, fire was the primary driver of this disturbance-based ponderosa pine ecosystem (Shepperd and Battaglia 2002). 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). The Black Hills are best described as a mixed fire severity regime; these 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. Historically, fire return intervals in the Black Hills were relatively frequent and fire intensities were low (surface fires most common) to mixed severity (partial overstory mortality) (Brown et al. 2000, Brown et al. 2008). Past fires and resulting fuel conditions have a definite impact on future fires.

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. 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. Black Hills LANDFIRE 2020 data shows the vast majority of Vegetation Departure (the amount the current vegetation has departed from simulated historical vegetation reference conditions) as being Low to Moderate, however, it does not consider missed fire return intervals. 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. 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. Large fires in the Black Hills are predicated on severe weather events and the persistence of those conditions, primarily wind. During the period of 1970-2020, 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. Approximately 26 percent of the statistical and recorded fire starts have been attributed to human causes. 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).

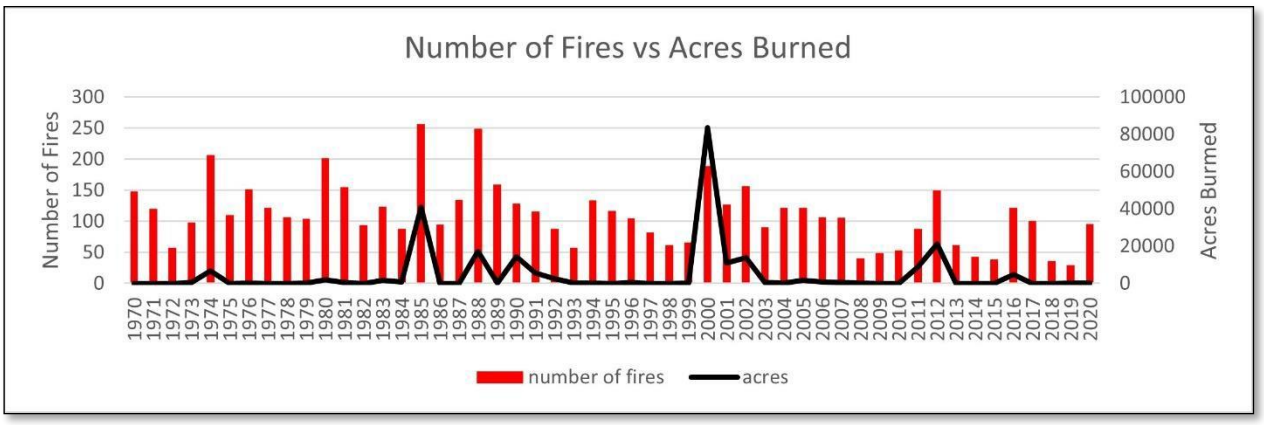

Figure 1. Number of fires vs. acres burned, 1970-2020

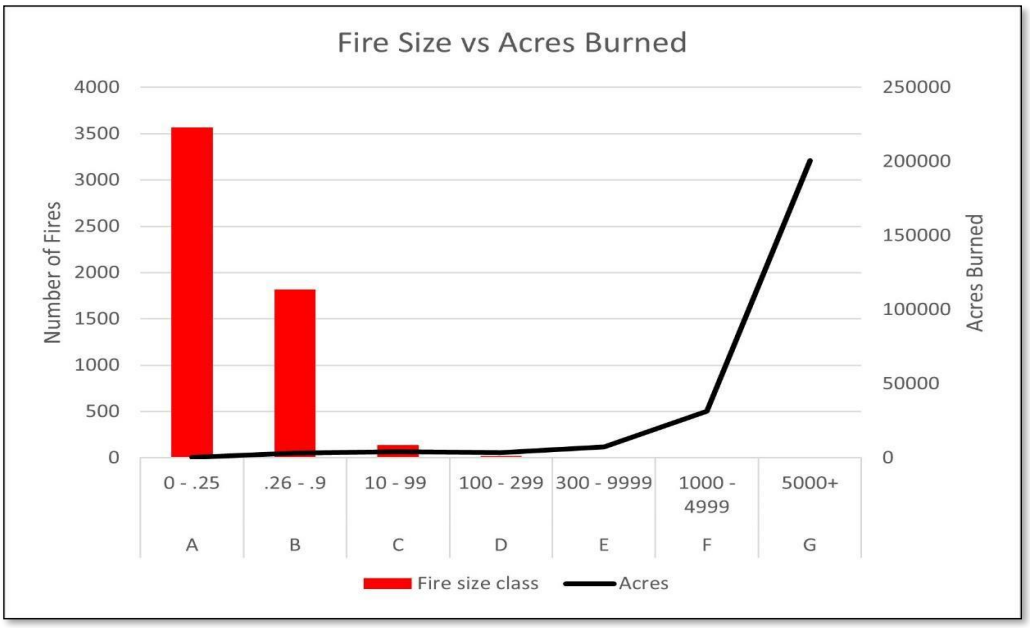

Figure 2. Fire size vs. acres burned

About 70 percent of the Black Hills National Forest is part of the suitable timber base. Approximately 500,000 acres have been harvested commercially and 250,000 acres have had non-commercial harvest treatments since 1997. These activities have resulted in varied fuel beds and stand densities available to burn under wildland fire conditions. Open timber stands generally offer a reduction in the potential for stand-replacing crown fires which are difficult to control. The open nature of these stands also allows for a faster moving, larger fire due to increased grass and pine regeneration; these fires can be easier to suppress and often result in protection of residual over-story and a reduction in high-severity fire effects. 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 the most resilient to fire impacts due to their thicker bark and higher canopy base heights. Most 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 surface fuels in the form of activity fuels (materials left behind in commercial or non-commercial activities). Commercial treatments reduce stand densities, and over time, increase both canopy base height and tree diameter. These effects reduce the potential for crown-fire and ultimately will make treated stands more resilient. 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 wildland fire, will show very little resilience; the residual seedlings and saplings will be vulnerable to fire for a few decades to come. The ponderosa pine ecosystem of the Black Hills is fully adapted to and dependent upon wildland fire; these systems are currently affected by a significant fire deficit. Active management can positively affect potential fire outcomes, however, fire within this ecosystem is unavoidable.

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. About 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 surface fuel condition present in the Black Hills National Forest. Broadcast and pile burning accomplishment by acre for 1997 through 2021 is shown in figure 3. These pile burning acres represent areas that have been actively managed either through commercial or non-commercial treatments with the resulting activity fuels piled for later burning. Generally, each pile created represents 10 acres of activity fuels. Though each pile covers a relatively small footprint, each pile represents a larger area of vegetation management.

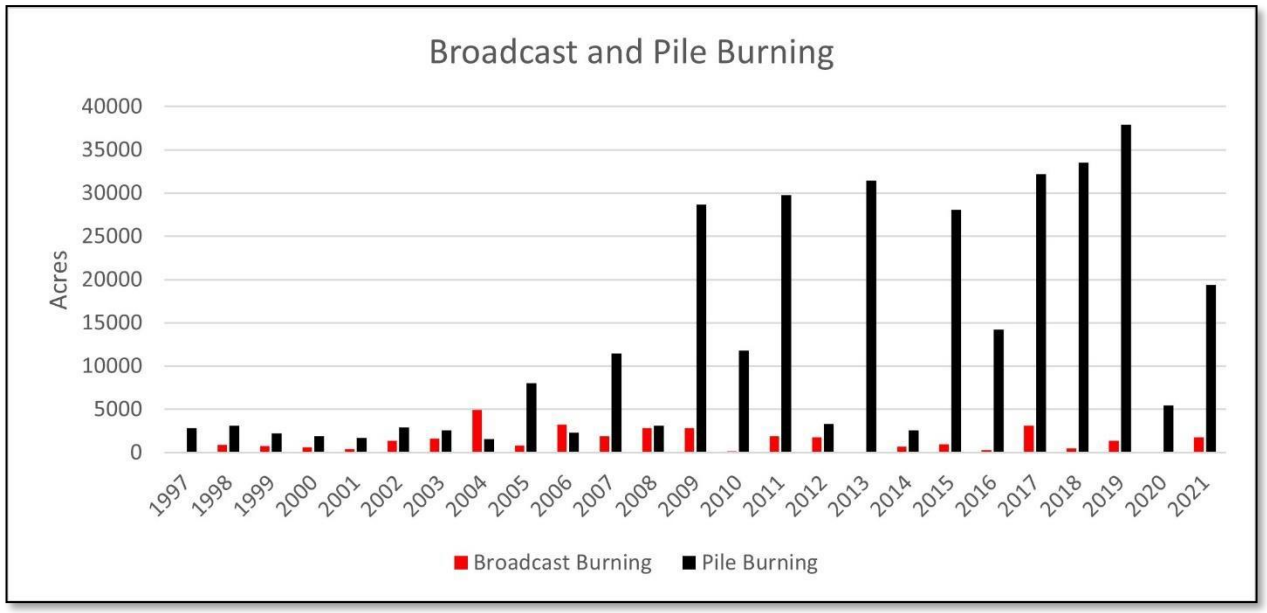

Figure 3. Broadcast and pile burning accomplishment by acre, 1997-2021

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 annually. 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. This does not consider constraints to implementing prescribed fire on the Black Hills National Forest, but it does effectively describe the fire deficit on the national forest.

Hazardous Fuels Treatments

Hazardous 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 thinning a stand to improve stand health. Both surface fuels and stand density are considered. Fuels-oriented projects would thin, pile (including surface coarse woody debris), 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 versus 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 were difficult 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 or 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). The Healthy Forest Restoration Act (HFRA) defines the Wildland Urban Interface (WUI) as:

(A) an area within or adjacent to an at-risk community that is identified in recommendations to the Secretary in a community wildfire protection plan; or

(B) in the case of any area for which a community wildfire protection plan is not in effect—

> (i) an area extending 1⁄2-mile from the boundary of an at-risk community;
>
> (ii) an area within 1 1⁄2 miles of the boundary of an at-risk community, including any land that—
>
> > (I) has a sustained steep slope that creates the potential for wildfire behavior endangering the at-risk community;
> >
> > (II) has a geographic feature that aids in creating an effective fire break, such as a road or ridge top; or
> >
> > (III) is in condition class 3, as documented by the Secretary in the project-specific environmental analysis; and

> (iii) an area that is adjacent to an evacuation route for an at-risk community that the Secretary determines, in cooperation with the at-risk community, requires hazardous fuel reduction to provide safer evacuation from the at-risk community.

Utilizing an expanded definition of WUI, ½ mile buffer applied to all non-Forest lands, approximately 52 percent is classified as WUI. Both South Dakota and Wyoming published updated Forest Action Plans in 2020, highlighting the states' forest resources, trends, threats, and opportunities. All six counties have Community Wildfire Protection Plans (CWPPs), which were collaboratively developed with the USFS, and are designed to help coordinate and communicate the priorities for the protection of life and property in the wildland-urban interface. Some of these CWPPs 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. 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 (Timberlake et al. 2021). 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 1. Many of these fires remained small due to aggressive fire suppression.

Table 1. 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

wildland fire, and which can assist in integrating land management objectives and incident response. The two primary inputs 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 inputs 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. Under the existing plan, 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 presented in a way that results in all natural ignitions 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. Under the existing plan, Guideline 4110 states that "activity and natural fuel treatments" should be analyzed using the fire modeling output of BTU/sec/ft. This fire modeling output (BTU/sec/ft) is not an informative or easily measurable metric and does not relate to a specific management question. 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 surrounding conditions into consideration. This method 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.

References

Agee, J.K., and Skinner, C.N. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management 211:83-96.

Bolt, C.E. 1973. Black Hills ponderosa pine. USDA Forest Service. Available in the project record in the Black Hills National Forest Supervisor's Office, Custer, South Dakota.

Brown, P., and Cook, B. 2006. Early settlement forest structure in Black Hills ponderosa pine forests. Available in the project record in the Black Hills National Forest Supervisor's Office, Custer, South Dakota.

Brown, P.M., Ryan, M.G., and Andrews, T.G. 2000. Historical surface fire frequency in ponderosa pine stands in research natural areas, central Rocky Mountains and Black Hills, USA. Natural Areas Journal 20(2):133-139.

Brown, P.M., Wienk, C.L., and Symstad, A.J. 2008. Fire and forest history at Mount Rushmore. Ecological Applications 18(8):1984-1999.

Environmental Threat Assessment Center. Unpublished report. Available in the project record at the Black Hills National Forest Supervisor's Office, Custer, South Dakota. Forest Ecology and Management 223(1-3): 284-290.

Murphy, S.K. 2017. Fire regimes of ponderosa pine communities in the Black Hills and surrounding areas. *In:* Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory.

Shepperd, W.D., and Battaglia, M.A. 2002. Ecology, silviculture, and management of Black Hills ponderosa pine. Rocky Mountain Research Station, Forest Service. U.S. Department of Agriculture.

Timberlake, T.J., Halofsky, J.E., Joyce, L.A., and Peterson, D.L. 2021. Climate change vulnerability in the Black Hills National Forest. U.S. Department of Agriculture, Forest Service, Western Wildland Environmental Threat Assessment Center.

USDA Forest Service. 2017. Black Hills resilient forest strategy. Available in the project record at the Black Hills National Forest Supervisor's Office, Custer, South Dakota.