Devil's Tower National Monument

Belle Fourche Prescribed Fire Monitoring Report

Prepared by Andy Thorstenson
Northern Great Plains Fire Monitoring Team

Introduction

The Belle Fourche prescribed fire burn unit is located on the southeast face of the world famous igneous extrusion known as Devil's Tower. Ignition of the 286-acres of mixed Ponderosa Pine forest occurred between the hours of 11:30 a.m. and 4:30 p.m. on April 29, 1998. Stated objectives of the burn included a reduction in dead and downed material, an increase in native species, a 20 to 30% reduction in overstory trees, and a 75% reduction in pole-sized understory trees. These objectives will be measured through the study of two long-term fire monitoring plots and ten tree mortality transects that have been established on this burn unit.

Staff for the Belle Fourche burn included burn boss Gary Kiramidjian, burn boss trainee Gary Kemp, Ignition Specialist Jim Dahlberg, Holding Boss John McDill, and Fire Behavior Analyst Dick Bahr. Fire personnel from Devil's Tower National Monument, Badlands National Park, Wind Cave NP, Black Hills National Forest, Theodore Roosevelt NP, Mount Rushmore NM, Wyoming Division of Forestry, and Hulett Volunteer Fire Department operated engines and staffed control lines on this fire.

Summary of Events

Preparation for the burn began the preceding week with the establishment of fire control lines on the northeast and west flanks. Flammable materials were removed, and water storage tanks with hoses were placed to contain the fire. The south boundary of the unit was an established roadway while the north boundary was the talus slope of Devil's Tower.

Burn staff conducted a briefing for all personnel involved in the operations on the morning of the burn detailing assignments, safety, and tactics. A National Weather Service forecast and on-site weather observations were obtained to assess compliance with prescription parameters. These are summarized in Table 1.

Table 1 Weather Conditions

Condition	Prescription	Forecast	Observed
Temperature (F)	40-75	74	66-73
Relative Humidity	20-45%	26%	19-26%
Wind Speed (mph)	2-12	2-7	0-8
Wind Direction	Any	South	SW,S,SE
Fuel Moisture	4-12%	5%	3-6%

Fire Behavior Observations

During the Belle Fourche burn, fire activity was monitored in different fuel types, on all aspects, and on varying slopes. Fire intensity, rate of spread, and flame lengths were measured as the fire moved through the burn unit. Monitoring took place throughout the day in order to assess changes in fire behavior. Observations were made at the flaming front when possible and behavior estimated from a distance when fire intensity increased. Fire intensity generally increased as the day progressed, reaching its peak at approximately 4:00 p.m. At that time, torching, spotting, and active crowning dominated the fire. Aided by a wind shift, the fire made a

run from the west flank toward the road and into the center of the burn. Further ignition to secure containment lines added acres to the head fire. As a result, much of the unit was burned under these conditions. Table 2 illustrates observed fire behavior in Fuel Model 2, Ponderosa pine with a grass understory, which composed the majority of the unit.

Table 2 **Fire Behavior Observations (Fuel Model 2)**

Fire Type	Flame Length	Rate of Spread	Time	Slope
Head	1-1.5 ft	9 ch/hr	1415	25%
Flanking	1.5 ft	4.5-6 ch/hr	1530	32%
Backing	6 in	1.2-2.5 ch/hr	1230	25%

Fire Effects Observations

Two long-term fire monitoring plots are located within the Belle Fourche unit and will be analyzed at intervals of 1, 2, 5, and 10 years to determine the vegetative effects of this prescribed burn. The fuel consumption and burn severity are two variables that have been quantified by a post-burn assessment on May 26,1998. Also ten tree mortality transects have been located on the unit to assess survival rates of pole-size (2.5 to 15 centimeter dbh) and overstory trees (greater than 15 cm dbh). Tree mortality will be measured annually for the next three to four years at which time an accurate assessment of mortality can be made.

Fuel loading was measured at 80 points along 8 different transects and re-read at the same points post-burn. The pre-burn value was approximately 11.3 tons per acre while the immediate post-burn showed 3.7 tons per acre remained, indicating that 67% of available dead fuel was consumed. Dead and down woody fuels were measured a 2.5 tons per acres pre-burn and 1.9 tons per acre immediate post burn, showing a 24% reduction in fuel loading. Litter and duff measured 8.4 tons per acre pre burn and 1.8 tons per acre post burn, showing a 79% reduction. Note that additional fuels will build up rapidly as scorched needles and branches drop and as dead trees fall.

The Fire Monitoring Protocol has levels of fire severity that describe the intensity which material burned. Separate readings are taken for substrate (litter and duff) and for vegetation (green needles and grass) to determine severity. For the fire monitoring plots within this burn, severity for substrate fuels was determined to be light to moderate. This indicates that surface fuels were not completely consumed and soils were not excessively heated. Vegetation burn severity was determined to be lightly burned. This level indicates that the fire consumed most of the grass but that the basal growing stems were unburned. In Ponderosa, needles and small stems were partially consumed in live trees, while larger branches and trunks were scorched. This correlates well with the ocular estimates that were made on the day of the fire.

Ignition Pattern

Ignition began at approximately 11:00 a.m. in the northeast corner near the base of the tower. The primary fuel for this test fire was model 9 ponderosa pine litter. Firing proceeded along the east and west perimeters in an effort to reduce fuel and secure these areas. As upper areas cooled, firing continued downhill along the perimeter creating a secure blackline to contain the fire. The initial ignition plan called for strip ignition to begin at the upper elevations of the unit, near the tower, and continue down to the road, using flanking fire to move cross-slope. (See attached map) However higher temperatures, lower relative humidity, and cross-slope winds changed the ignition pattern. As ignition continued on the west flank near the powerline, torching and wind shifts created more active fire behavior. Short uphill runs and spotting near the entrance road led to a decision to backfire from the road to secure the perimeter. This last

ignition action of the day resulted in the central part of the unit being burned as an upslope head fire.

Smoke Monitoring

Daytime observations of smoke from the Belle Fourche burn indicated the column lifted vertically several thousand feet and was visible from several miles away. In the evening, nighttime subsidence kept the smoke near the ground and carried it downvalley toward the community of Hulett. On the morning of April 29, smoke was visible in the area of the burn and in the low-lying areas north and east of Devil's Tower. Residual burning continued for the next several days, but smoke production from this remained minimal and impacts were noticed only in the immediate vicinity of the burn.

Conclusion

The Belle Fourche prescribed fire ended 92 years of fire exclusion in a place where fire naturally occurred every 14-25 years. To reintroduce fire after a long absence is one of the greatest challenges and highest risks that a land management agency faces. Accumulations of fuel, changes in the forest structure, and changes in species composition can create extreme fire intensity that would never have been possible in a system where fire was a regular part of the ecosystem.

The immediate and obvious effect of this fire is the preponderance of brown needles and blackened trees on the highly visible slope of Devil's Tower. However, looking underneath the canopy, the positive results of the fire can be seen. Root-sprouting species such as chokecherry and aspen are already sending up new growth; grasses, forbs, and sedges are taking advantage of the increased sunlight and added nutrients in the post-fire world. Since it is the long-term health of the ecosystem that is the focus of the prescribed burning program, many criteria need to be assessed over the course of several years before a true assessment of this fire can be made. With a long-term fire monitoring program in place, a quantifiable assessment of burn objectives can be made.