Science Feature

Management of ponderosa pine forest at Mount Rushmore National Memorial using thinning and prescribed fire

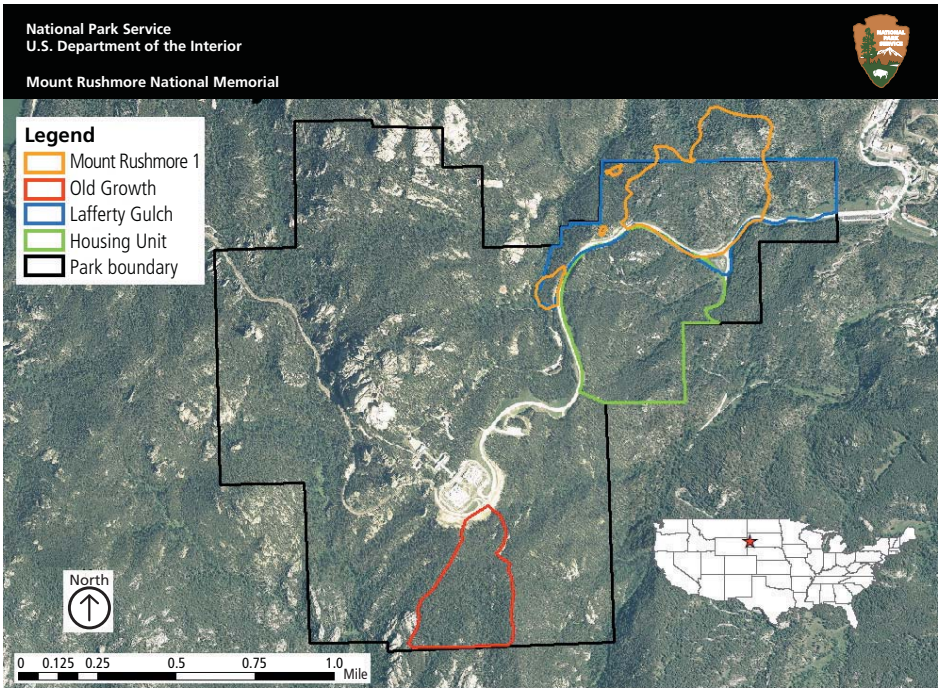
By Cody Wienk

MOUNT RUSHMORE UNderstandably has become synonymous with South Dakota. References to the massive granite sculpture of Presidents Washington, Jefferson, Roosevelt, and Lincoln are in the state nickname, on the license plate, and on the state-themed quarter. The memorial is known around the world and millions of people visit every year. Yet, I imagine few visitors appreciate the significance of the natural resources that surround the famous sculpture. For example, a research project completed in 2005 highlighted the value of the ponderosa pine (*Pinus ponderosa*) forest at Mount Rushmore. Symstad and Bynum (2007) reported that 66% of the memorial (850 acres [344 ha]) is covered by old-growth ponderosa pine forest and that it comprises "the second largest contiguous area of old growth within the Black Hills."

Even though the ponderosa pine stands of the memorial maintain many old-growth characteristics, their structure has changed significantly over the past century. Protection from timber harvest has maintained the large, old trees in the memorial, but fire suppression has allowed a dramatic increase in smaller-diameter pine trees (fig. 1a). These dense thickets of pine regeneration can act as ladder fuel and in the event of a fire, can carry fire into the overstory, resulting in a crown fire. These conditions make the forest susceptible to severe wildfires and insect outbreaks (Shepperd and Battaglia 2002; Brown and Cook 2006). The National Park Service (NPS) Northern Great Plains Fire Management Office has undertaken a combination of research and fire management projects in an attempt to restore the historical structure to these forest stands and make them less susceptible to stand-replacing disturbances (fig. 2). This article describes some of the significant forest management studies and actions designed to achieve this goal.

Figure 1a (above). Before thinning, the Old Growth project area is typical of forested areas in the Black Hills, characterized by dense growth of small-diameter trees with relatively few larger, older trees. **Figure 1b (facing page).** After thinning, the forest in the Old Growth project area is more open, fuel loads are reduced, and sunlight penetrates to the forest floor, stimulating vegetation growth.

NPS/NORTHERN GREAT PLAINS FIRE ECOLOGY PROGRAM (2)



NPS/MIDWEST REGION FIRE ECOLOGY PROGRAM, AUGUST 2009

Figure 2. Recent forest thinning and restoration projects at Mount Rushmore National Memorial.

Mechanical thinning and an unplanned wildfire

In 2003 the Northern Great Plains Fire Management Office initiated a mechanical thinning project in Lafferty Gulch (see fig. 2). The office's Fire Ecology Program established monitoring plots throughout the area to document changes in the ponderosa pine stands and to assess the success of the treatments. The project involved mechanical removal of most ponderosa pine trees smaller than 6 inches (15 cm) in diameter, which reduced pole-sized trees by more than 90% (see fig. 1b). The material was then stacked by hand into an estimated 3,500 piles on the 115-acre (46 ha) treatment area. Crews burned the piles starting in January 2004 when snow cover was adequate to keep the fires from spreading. However, after about two weeks of burning, on the night of 27 February 2006, a chinook wind moved across the area. The warm winds rapidly reduced the snow cover and allowed the smoldering piles to creep into surrounding litter and duff, starting a wildfire called the Mount Rushmore 1 fire. Firefighters contained the fire after it burned approximately 100 acres (41 ha) on the memorial and neighboring USDA Forest Service land. Although it was unintended, the wildfire resulted in some positive benefits. Total fuel load across the burned area decreased by more than 70% and tree density was further reduced because the fire was hot enough to kill some of the overstory or larger, more mature trees (fig. 3, next page).

Research and old-growth restoration potential

I collaborated with Peter Brown, director of Rocky Mountain Tree-ring Research, on a research project funded by the Joint

Fire Sciences Program. This program is an interagency research partnership between the U.S. Department of the Interior and the U.S. Department of Agriculture that funds wildland fire research. We initiated the project in fall 2005 at Mount Rushmore with the goal of using tree-ring data to document changes in the historical fire regime[1] and forest structure[2] over the past several centuries, and to estimate crown fire risk and the effects of potential mitigation measures. Brown's team collected data from 1,000 living trees, snags, stumps, and logs throughout the memorial. The research results indicated that between the years 1600 and 1900, fires burned across the memorial an average of every 17 years. However, the last wildfire to burn here was in 1893, before fire suppression began to be commonplace in the Black Hills (Shepperd and Battaglia 2002).

Historically, the Mount Rushmore forests would have been dominated by large, old ponderosa pines with few seedling- and pole-sized trees and a rich understory of shrubs and herbs. When fires started under these conditions, it most often would have been a surface fire and few large trees would have been killed. Primarily because of fire suppression, today's forest contains more small-diameter trees, fewer large trees, and higher fuel loads (Brown et al. 2008). These conditions leave the forest susceptible to stand-replacing crown fire. However, many stands at Mount Rushmore maintain many large, old trees as well as remnant understory vegetation that should flourish once the pole-sized trees are removed to allow much needed sunlight and moisture to reach the forest floor. This condition makes restoration to historical stand structure very feasible.

[1] **Fire regime:** A combination of frequency, seasonality, severity (impact as measured by organic matter loss), intensity (amount of energy released from a fire), and scale of wildland fire across a landscape.

[2] **Forest structure:** The horizontal and vertical distribution of layers in a forest, including height, diameter, density, and species present.

NPS/ CODY WIENK

Figure 3. The Mount Rushmore 1 wildfire started in late winter 2006 when fire from slow-burning slash piles from a mechanical forest-thinning project increased in intensity following warm weather. Seventeen months after the fire, this view reveals brown trees killed by the wildfire. The town of Keystone is visible at the center.

Thus, the Mount Rushmore area could be a valuable reference landscape for Black Hills old-growth forest.

The principal investigator presented his findings to park and fire management staffs at the memorial in May 2007. He recommended mechanically thinning smaller-diameter trees and then using prescribed fire to reduce litter and duff accumulations. He also suggested that NPS Northern Great Plains Fire Management staff (stationed nearby at Wind Cave National Park) initiate thinning treatments in the remnant old-growth stands of the memorial. As a direct result of this research and the recommendations, fire management staff began to restore old-growth forest in the southern part of the memorial in fall 2008 (see fig. 1). Using chain saws, crews removed most ponderosa pine trees 5 inches in diameter and smaller and stacked the resulting fuel in piles by hand. They thinned approximately 30 acres (12 ha) that fall and completed an additional 25 acres (10 ha) in summer 2009. At least 2,000 debris piles were created during this project and will be burned over the next couple of winters when weather conditions permit.

Chipping: Another tool in the management toolbox?

The traditional approach to thinning ponderosa pine stands includes mechanically removing smaller trees, consolidating the resulting material, and burning the slash piles while there is snow cover. Since winter snow is often unreliable in the central and southern Black Hills, managers were interested in exploring alternatives to this method. Chipping the thinned material and broadcasting the chips on-site is an alternative that has been used in western forests (Wolk and Rocca 2009; Miller

NPS/KATE CUENO

Figure 4. An alternative to burning slash piles, chipping reduces forest debris to small wood fragments spread on the forest floor. Research in the Housing project area is investigating the effects of chipping on soil chemistry, ground disturbance, and vegetation.

NPS/KATE CUENO

Figure 5. This forest stand in the Housing project area has been thinned and chipped.

and Seastedt 2009). However, resource managers in western U.S. national parks are hesitant to use this method because of uncertainties about impacts of this type of treatment to herbaceous vegetation and soil.

The National Park Service funded and initiated research in 2008 to assess the impacts of thinning, chipping, and use of heavy machinery on herbaceous vegetation and soils of Black Hills ponderosa pine forests. Researchers established plots in the 125-acre (51 ha) Housing project area (see fig. 1) to determine pretreatment conditions of the study sites. During 2009, crews used chain saws to remove most trees smaller than 6 inches in diameter, and used a remotely controlled, tracked chipper to cut the material into fragments (figs. 4 and 5). The study is ongoing and focuses on depth of the wood chips, ground disturbance, and changes in herbaceous vegetation and soil chemistry. The research plots will be revisited over the next two years to evaluate changes to the site. Managers also hope to apply prescribed fire to the chipped areas to determine how the wood chips affect fire behavior in the forest.

Conclusions

The recent research and fire management projects have both resulted from and contributed to increased awareness of the significance of the natural resources at Mount Rushmore. This is just the first step, however, since only a small percentage of the memorial has been thinned. Moreover, park managers hope that prescribed fire can be applied over a large portion of the memorial once thinning is completed. The goal is to restore the old-growth forest structural characteristics, which should lead to an increase in abundance and diversity of understory vegetation such as roughleaf ricegrass (*Oryzopsis asperifolia*), upland sedges (*Carex* spp.), pasqueflower

[The goal of the research was to use] tree-ring data to document changes in the historical fire regime and forest structure [at the memorial] over the past several centuries, and to estimate crown fire risk and the effects of potential mitigation measures.

(*Pulsatilla patens*), raspberry (*Rubus* spp.), and current (*Ribes* spp.). This should also make the stands less susceptible to intense, stand-replacing fires and more resilient to mountain pine beetle outbreaks. These treatments may be put to the test because a mountain pine beetle outbreak is occurring on USDA Forest Service land adjacent to the memorial. Northern Great Plains Fire Management and Mount Rushmore staffs are currently collaborating on plans to apply restoration treatments to many of the remaining forest stands at the memorial.

Acknowledgments

Many people have been critical in the completion of the research and fire management projects at Mount Rushmore. Peter Brown (Rocky Mountain Tree-ring Research), Amy Symstad (U.S. Geological Survey), Mike Bynum (NPS Northern Great Plains Inventory and Monitoring Program), Kate Cueno (Colorado State University), and Monique Rocca (Colorado State University) have led the research efforts. The fire management and monitoring projects have been accomplished by the collaborative work of Dan Morford, Steve Ipswitch, Jim McMahill, Eric Allen, Andy Thorstenson, Dan Swanson, and Jon Freeman. Andy Thorstenson, Jon Freeman, Jim McMahill, Dan Swanson, Kate Cueno, Blaine Kortemeyer, and J. Michael Johnson provided helpful comments to develop this article.

Literature cited

Brown, P. M., and B. Cook. 2006. Early settlement forest structure in Black Hills ponderosa pine forests. Forest Ecology and Management 223:284–290.

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

Miller, E. M., and T. R. Seastedt. 2009. Impacts of woodchip amendments and soil nutrient availability on understory vegetation establishment following thinning of a ponderosa pine forest. Forest Ecology and Management 258:263–272.

Shepperd, W. D., and M. A. Battaglia. 2002. Ecology, silviculture, and management of Black Hills ponderosa pine. USDA Forest Service General Technical Report RMRS-GTR-97. Rocky Mountain Research Station, Fort Collins, Colorado, USA.

Symstad, A. J., and M. Bynum. 2007. Conservation value of Mount Rushmore National Memorial's Forest. Natural Areas Journal 27(4):293–301.

Wolk, B., and M. E. Rocca. 2009. Thinning and chipping small-diameter ponderosa pine changes understory plant communities on the Colorado Front Range. Forest Ecology and Management 257:85–95.

About the author

Cody Wienk *is the regional fire ecologist for the NPS Midwest Region in Omaha, Nebraska. Before this assignment he spent more than six years as fire ecologist for the NPS Northern Great Plains Fire Management Office at Wind Cave National Park. He can be reached at cody_wienk@nps.gov.*