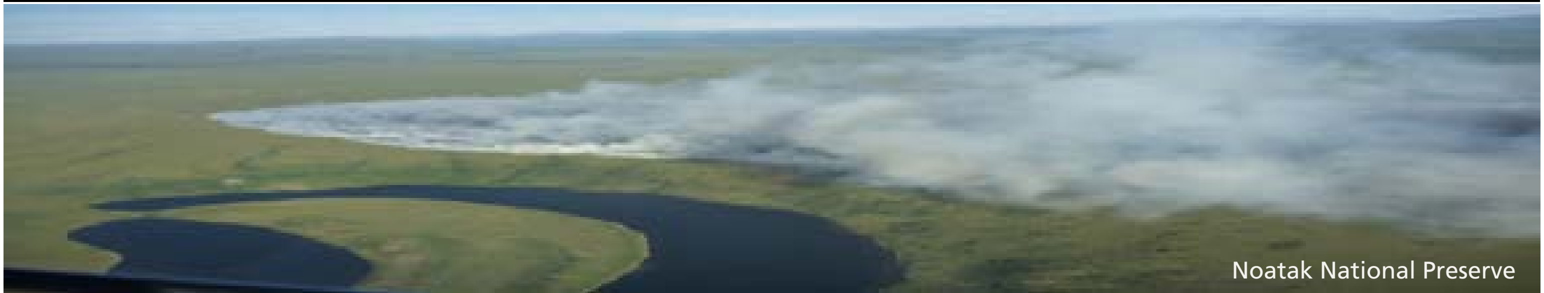
# RxEffects

National Park Service
U.S. Department of the Interior

Fire Ecology Program

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## Inside this issue:



## Reducing Crown Fire Potential at Mount Rushmore National Memorial using Mechanical Treatments

Dan Swanson, Northern Great Plains Fire Ecologist,
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Prompted by an ongoing mountain pine beetle outbreak in the central Black Hills, staff at Mount Rushmore requested assistance from the Midwest Regional Office in February 2010 to help prepare a plan to mitigate the impacts of a potential mountain pine beetle infestation. A plan was completed by a small group of specialists with input from memorial staff, the Black Hills National Forest, and other local stakeholders. Mount Rushmore N.M. preserves one of the largest remaining stands of old-growth ponderosa pine in the Black Hills. Forty-three percent (544 acres) of the memorial was either thinned and piled or thinned and chipped in late summer and fall of 2010.

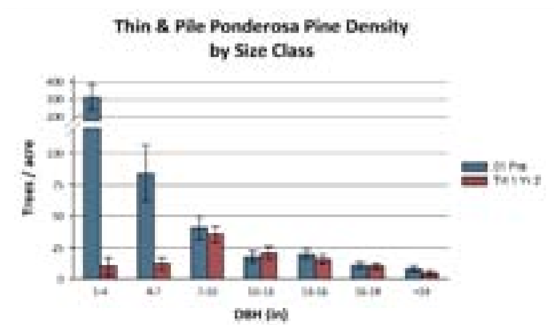


Figure 1. Changes in forest structure by size class in 13 monitoring plots within the thin & pile treatment area at Mount Rushmore N.M. following the hazardous fuel reduction project. Values represent means + standard errors.

Project parameters included cutting trees with 6 inch DBH or less within the thin/pile area and 10 inch DBH or less within the thin/chip area. Removing most of the smaller diameter trees greatly reduces the potential for stand-replacing crown fire within the memorial. The NGP fire effects and I&M crews installed and read 60 forest structure and fuels plots within the park in 2010 prior to this project's implementation. The crews returned in the summer of 2012 to perform a reread of the plots to assess the success of the project. Ponderosa pine density in the 1" to 4" and 4" to 7" DBH classes decreased by an average of 97% and 86% respectively in the thin and pile treatment unit (Figure 1).

Ponderosa pine density in the 1" to 4" and 4" to 7" DBH classes decreased by an average of 99% and 96% respectively in the thin and chip treatment unit (Figure 2). There was also a 52% decrease in ponderosa density in the 7" to 10" DBH class as the

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# Smoldering Combustion in Organic Soils

Adam Watts, Postdoctoral Research Ecologist, University of Florida

When planning a prescribed burn, there are many potential undesirable outcomes to avoid: injury, escape, excessive tree mortality, and endangered species "takes," among many others. For managers with deep layers of duff or organic soils on their lands, another consideration is the possibility of the occurrence of ground fires. The persistent production of smoke can make these fires among the most hazardous to the public, and their impacts and effects can be far-reaching. Yet the behavior and effects of the smoldering combustion that drives ground fires are poorly understood compared to flaming combustion.

As opposed to flaming combustion, which usually occurs in the space above fuels and consumes atomized or volatized compounds, smoldering is a flameless form of combustion that occurs directly on the surface of fuels. Recent research by Rory Hadden and Guillermo Rein of Imperial College in London into the physics of smoldering has shown that there are two stages of smoldering: pyrolysis and oxidation. Pyrolysis is an initial process that drives off water and other volatile compounds from the fuel, essentially similar to the processes that create charcoal or "bio-char." Following this initial "smoldering front," the pre-heated, carbon-rich matrix that is left behind undergoes oxidation. To the observer, pyrolysis is familiar as the smoke-producing process that leads to charred fuels (many of us have used the term "incomplete combustion" to describe it). Oxidation, meanwhile, occurs as blackened fuels become glowing embers, leaving behind white or gray ash.

Compared to flaming combustion, smoldering tends to be slow, and occurs at lower temperatures. These properties make it possible for smoldering fires, once established at the surface, to spread downward into the profiles of deep organic soils. This spreading can be directly transmitted through the fuel matrix, or speeded by embedded coarse fuels that Morgan Varner from Mississippi State University describes as "ignition vectors." Once smoldering begins below the original soil surface, the insulating properties of the soils themselves retain heat and allow ground fires to persist for long periods relatively independent of weather or other events (such as suppression efforts) at the surface.

Figure 1. Smoldering combustion can "scour" deep holes or basins into thick organic soils. It is common for smoldering to be more severe around the bases of trees, where roots can facilitate the formation of air channels that promote greater combustion of soils. The Microtopographic changes that result can have implications for local hydrology and wildlife habitat, in addition to obvious direct consequences for plant communities. When normal hydrology returns to this drought-affected wet prairie, the area around the base of this now-dead tree will likely become a shallow marsh.

A number of researchers have investigated the factors that influence combustion in a variety of organic soil types, in biomes from the Arctic to tropical peatlands. In general, the mineral content of organic soil exerts a significant influence on attributes such as the rate of spread, amount of soil consumed, and residence time. As one would expect, the most important factor influencing the potential for smoldering in organic soils is the water content. However, organic soils can experience sustained smoldering when they contain a surprising amount of water. Many types of organic soils will smolder when they contain well over 100 percent gravimetric water content—that is, as much or more water than the mass (weight) of the dry soil itself. A recent study on smoldering in the fibric peat soils underlying pond cypress swamps in southern Florida observed smoldering in a number of samples which contained more than 200% gravimetric moisture content. This property helps to

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# Burning Mixed Conifer Forests on the North Rim of Grand Canyon National Park: Lessons Learned and Initial Rapid Assessment Plot Results

Windy Bunn, Fire Ecologist, Grand Canyon NP
David Robinson, North Zone AFMO—Fuels, Grand Canyon NP North Rim and Kaibab NF North Kaibab Ranger District

## BACKGROUND

Grand Canyon National Park's (GRCA) Range Prescribed Fire Project is 2,278 acres with 59% of the project classified as mixed conifer forest and the remainder a mix of spruce-fir, ponderosa pine, and early successional aspen. Because the mixed conifer forests of the North Rim are considered Mexican spotted owl (MSO) recovery habitat, this project was designed to minimize high severity effects by taking a phased implementation approach to meet forest restoration objectives. The project was the first attempt by the park to conduct prescribed fire in the mixed conifer forest type.

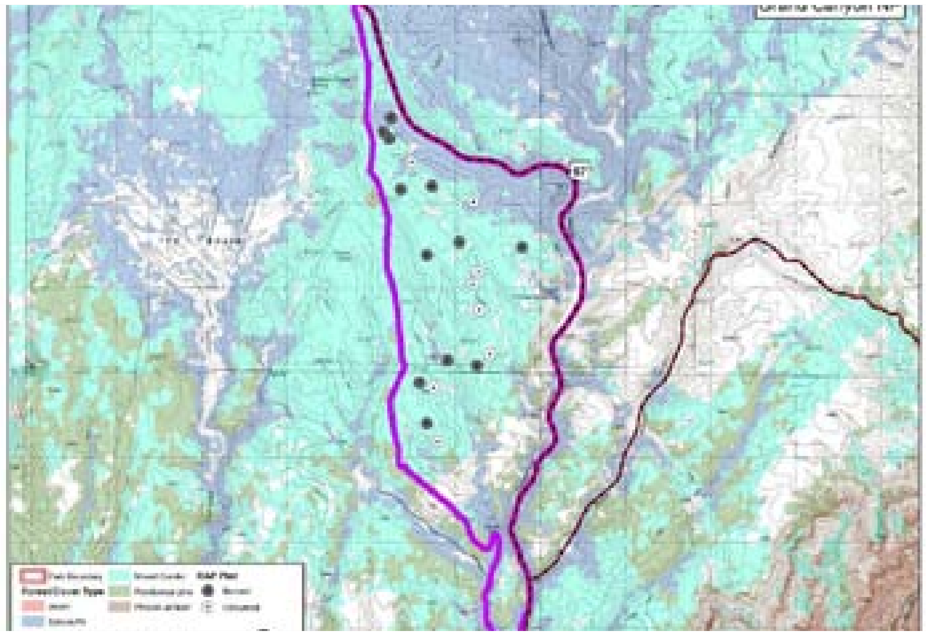

Figure 1. Range Prescribed Fire (purple outline) with burned (gray) and unburned (white)

Twenty rapid assessment protocol (RAP) plots were randomly located in the project in 2008 and were re-measured in 2012 prior to implementation to ensure that results were as accurate as possible. Pre-fire data indicated that total fuel loading averaged 50 tons/acre (range of 23 to 95 tons/acre) and pole-sized tree density averaged 335 trees/acre (range of 26 to 1250 trees/acre) before project implementation.

## PROJECT IMPLEMENTATION

Research efforts in the park have provided evidence of more frequent historic fire, and thus more departure from past conditions, on ridge tops and south aspects in the mixed conifer forests. The research results, along with burn unit reconnaissance, led to an implementation plan that was designed to create primarily backing and flanking fire spread along the ridge tops and upper slopes within the project area.

| Element | Prescription | Observation(s) |
|---|---|---|
| Temperature (°F) | 40 - 70 | Max daily: 56 - 62 |
| Relative Humidity (%) | n/a | Min daily: 16 - 20 |
| Midflame Wind Speed (mph) | 0 - 6 | Max daily: 3 - 6 |
| 1-hr TLFM moisture (%) | 5 – 15 | Min daily: 5 |
| Backing Rate of Spread (ch/hr) | 0.2 - 1.0 | Max daily: 0.75 - 1 |
| Backing Flame Length (ft) | 0.6 - 2.7 | Max daily: 0.3 - 0.8 |

Table 1. Range Project prescription elements and burn day observations for the five ignition days.

Ignition operations for the project occurred from October 27 to 31, 2012 via both hand and aerial ignition. Objectives for the project focused on the reduction of large woody debris (1000-hr TLFM fuel loading), with additional objectives of minimizing high severity fire effects and reducing the number of small trees (<6" DBH) within the project area. Prescription elements and burn-day observations are summarized in Table 1.

## INITIAL RESULTS

Due to the intentionally heterogeneous burn pattern generated during this prescribed fire, eight of the twenty RAP plots remained unburned after the completion of the project (Figure 1). In general, the prescribed fire had the largest immediate post-fire effects on rotten logs, litter and duff fuel loading, and

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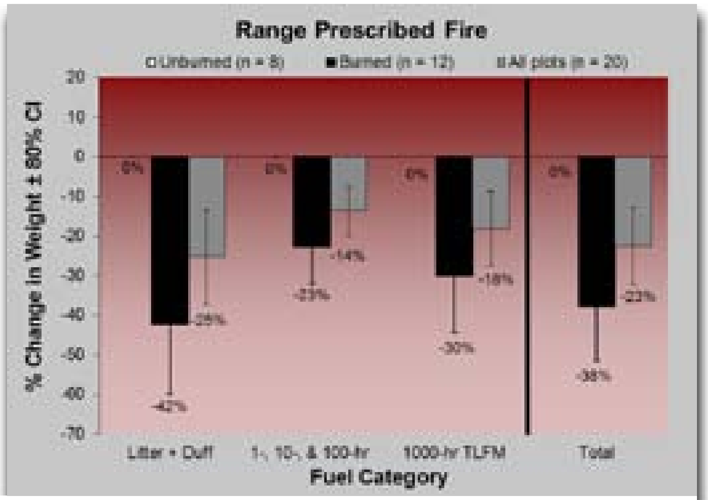


Figure 2. Fuel reduction results by fuel category for the Range Prescribed Fire.

conifer seedlings. Longer-term effects will be measured in the coming years.

Average reduction in total fuel loading across the entire burn unit (all twenty plots) was 23% one month after the fire (Figure 2). Unburned plots showed no change in fuel loading because the pre-burn measurements were conducted one month prior to the burn. Total fuel loading decreased by an average of 38% in burned plots, with litter, duff, and rotten logs showing the largest reductions. The twelve plots that burned met the minimum acceptable 1000-hr fuel reduction of 30%, on average, despite the fact that sound 1000-hr fuel increased in the burned plots one month after the fire due to standing dead trees burning and falling down. Because of the number of unburned plots, 1000-hr fuel reduction in the unit as a whole was below the acceptable range (average reduction of 18% for the twenty plots).

Live conifer seedlings (<1" DBH), saplings (1 – 6" DBH), and overstory trees (>6" DBH) were also measured during the one-month post read in order to make an initial assessment of mortality. One month after the fire, conifer seedling density was reduced by an average of 29% and conifer sapling density was reduced by an average of 16% across the entire burn unit (all twenty plots; Figure 3). No overstory conifer tree mortality was recorded in any of the plots. Unburned plots showed no change in conifer density because the pre-burn measurements were conducted one month prior to the burn. In burned plots, conifer seedling density was reduced by an average of 48% and conifer sapling density was reduced by an average of 27% one month after the burn. Tree density will be measured again two years after the fire to track potential delayed mortality in all tree size classes.

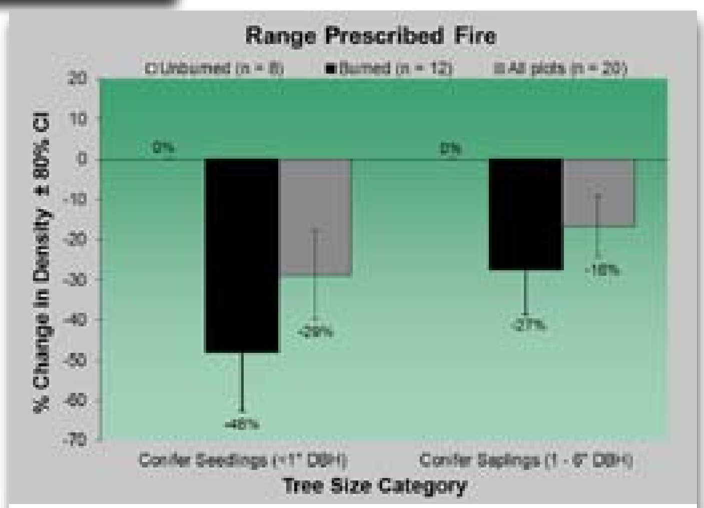


Figure 3. Live conifer seedling and sapling reduction results for the Range Prescribed Fire.

FUTURE APPLICATION

The Range Prescribed Fire Project provided GRCA managers with an opportunity to evaluate a phased approach to mixed conifer forest burning that was designed to achieve both forest restoration objectives and the protection of MSO recovery habitat. The project was implemented in late October when the daily burn period was short and

Figure 4. Photos of a burned plot in the Range project before (left) and one month after (right) the prescribed fire.

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explain why smoldering fires are so difficult to extinguish. Indeed, they are notoriously long-lived, and historically have been the largest and longest-lasting fires on Earth. Burning Mountain in New South Wales, Australia, has experienced a smoldering fire in a coal seam that is estimated to have lasted more than 2000 years. Closer to home, the Honey Prairie Fire in the Okefenokee swamp of Georgia and Florida lasted nearly an entire year, despite massive suppression efforts and winter rains.

Because ground fires in organic soils continue to burn during the night at about the same rate as during the day, the smoke they produce can linger during nighttime hours where it becomes an irritant for people sensitive to smoke, as well as a significant safety hazard to motorists. The occurrence of deep organic soils in low-lying areas—themselves prone to accumulate smoke as well as fog—magnify the hazard. In January 2012, a worst-case scenario occurred in northern Florida, when a "superfog" event occurred adjacent to I-75 and claimed 11 lives.

In addition to local safety and air-quality concerns, the impacts of smoldering combustion extend to the global scale. Although organic soils comprise only a very small portion of Earth's surface, they are estimated to contain up to a third of terrestrial carbon. Severe droughts or human alterations to hydrology (through drainage, water withdrawals, and even results of changes to fire regimes) can cause peatlands, swamps, and other areas with substantial accumulations of organic soil to become available (i.e., sufficiently dry) for combustion. In contrast to fires that occur among aerial fuels—which can consume aboveground biomass that represents decades, and in extreme cases perhaps a century's worth of accumulated carbon—ground fires can consume the equivalent of centuries, and in some cases a millennium or more, of accumulated carbon in a single fire. This difference can be significant in terms of global carbon cycles: while many prescribed fires and even wildfires may be "carbon-neutral" over ecologically short periods of time (the lifespan of a tree, for instance), the release of carbon from smoldering in organic soils may be more similar to the release of carbon from fossil fuels, which is considered to be a net addition of carbon to the atmosphere. In terms of global climate change, the potential impact of carbon released from smoldering combustion is further magnified by the composition of smoldering emissions, which contain far higher proportions of carbon monoxide and other greenhouse gases.

The attitude of many managers that smoldering should be avoided, prevented, or suppressed is well-founded, due to its well-established negative impacts on human health and safety, and potential impacts to local carbon stocks and global carbon cycles. However, ground fires, though historically infrequent, have been a part of the ecology of many ecosystems with organic soils. Their periodic occurrence may have a number of ecological effects that maintain structure, function, or habitat in ways analogous to the occurrence of regular fires in upland ecosystems. We know, for example, that fire is one of the factors that maintains the composition and structure of small pond cypress swamps in southern Florida. Also, changes to the elevation of the soil surface that occur from prolonged smoldering (Figure 1) may cause changes to local hydrology, lengthening hydroperiods where ground fires "scour" small basins in the landscape. In areas where groundwater levels fluctuate seasonally, these basins can hold water longer into droughts or dry seasons, serving as watering holes for terrestrial wildlife or refugia for aquatic animals.

Unfortunately, the relatively limited understanding we have of smoldering combustion exists primarily as knowledge concerning the physics, behavior, and environmental factors governing smoldering. We know far less about the ecological and hydrologic effects of ground fires. Therefore, just as suppression of forest fires produced negative consequences in upland ecosystems, it is possible that our actions to prevent and suppress ground fires may have unintended consequences. While it would be hard to argue that a smoldering fire should be allowed to degrade air quality and produce hazardous conditions on roadways just because of some potential benefits to wildlife habitat, we should work to improve our knowledge of the broader effects of smoldering fires so that we know what potential ecological tradeoffs might be occurring.

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contract allowed for thinning up to 10” DBH.

Figure 3a shows the high density of small diameter trees in the understory of a pretreatment plot in 2010. Following the thin & pile treatment, small diameter tree density was greatly reduced and crown base heights increased (Figure 3b).

FlamMap v.5 was used to model crown fire potential pre- and post-mechanical treatment at the memorial. LANDFIRE National 2001 was used as the base vegetation map for this analysis which has a 30-meter pixel resolution. Modeling inputs include canopy cover, stand height, crown base height, canopy bulk density, fuel model, fuel/foliar moisture, temperature, relative humidity, wind speed, elevation, slope, and aspect. Ninetieth percentile weather conditions for mid- to late-July were used in the model to capture the typical height of the fire season, which included temperatures of 90 degrees F, relative humidity of 10%, and 20-foot winds from the southwest at 20 mph.

Crown base heights averaged 3.9 meters in the plots that had no mechanical treatments, 5.7 meters and 6.4 meters respectively in the thin & pile and thin & chip treatment areas following the 2010 hazardous fuel reduction project, and 6.7 meters in plots that were mechanically treated between 2003 and 2009. Figure 4a shows that approximately 29% of the memorial would have had a surface fire in 2001 prior to the Lafferty Gulch (2003), Old Growth (2009), Colorado State University Research (2009), and 2010 hazardous fuel reduction projects. Passive and active crown fire accounted for 44% and 13% of the fire activity classification in the pretreatment state.

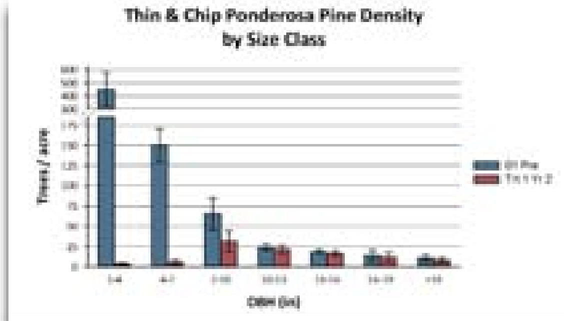



Figure 2. Changes in forest structure by size class in 13 monitoring plots within the thin & chip treatment area at Mount Rushmore N.M. following the hazardous fuel reduction project. Values represent means + standard errors.

Following the four mechanical treatment projects, combined passive and active crown fire potential decreased to 8% of the memorial (Figure 4). Removing most of the smaller trees greatly reduced the potential for a stand-replacing crown fire within the memorial, primarily due to the significant increase in crown base heights post-treatment.

Ultimately, it is hoped that these treatments will make the forest more resilient and resistant to infestation of mountain pine beetle, and allow prescribed burn treatments to behave primarily as surface fires, which was historically the dominant fire type at the memorial.

Figure 3. (a) Pre- and (b) post-treatment photos from the thin & pile treatment area at Mount Rushmore N.M.

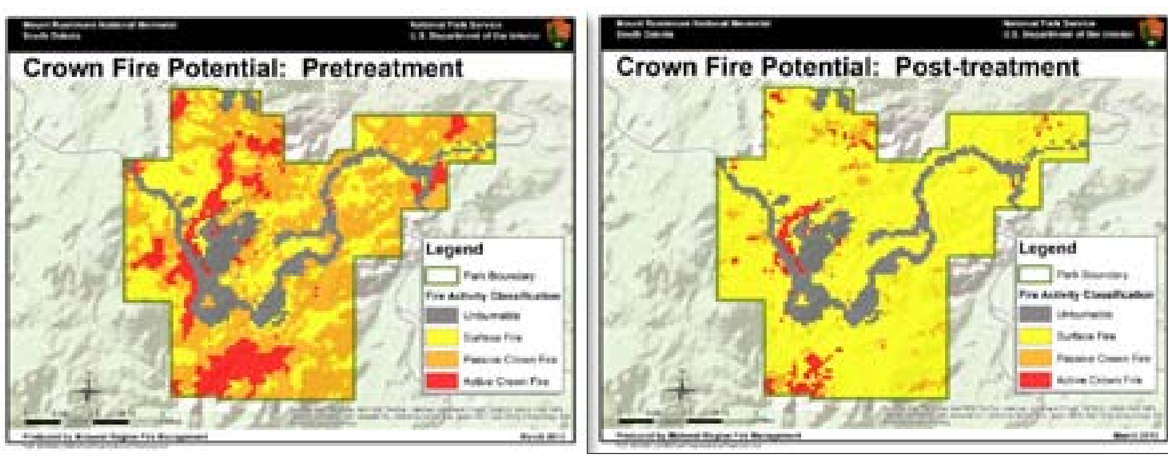
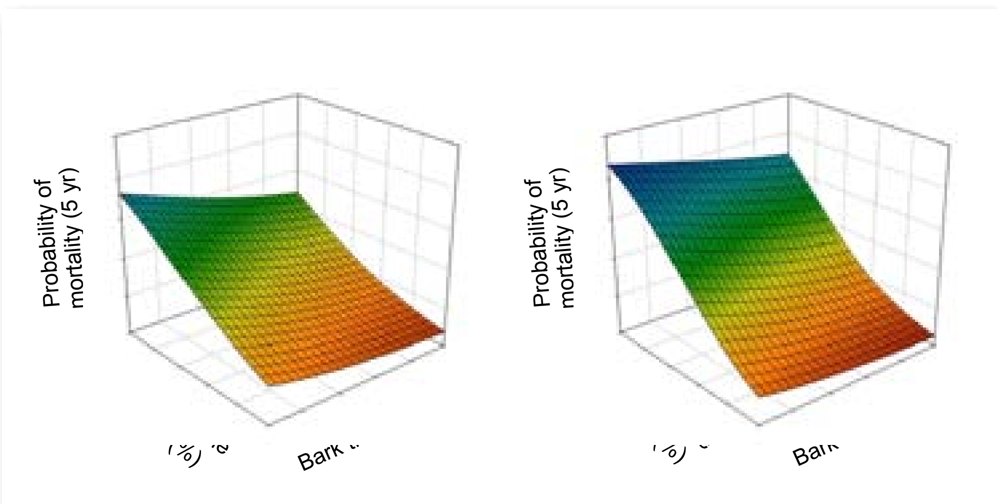



Figure 4. Crown fire potential at Mount Rushmore N.M. (a) pretreatment (2001) and (b) following modern-day mechanical treatment projects (2012). FlamMap v. 5 was used to model fire behavior using LANDFIRE 2001 as a base map which has a 30-meter pixel resolution.

# Getting the most out of monitoring data: Using multiple FFI databases to examine regional-scale questions

MaryBeth Keifer, Fire Ecologist, Fire Management Program Center

Monitoring is an essential part of adaptive management, however, collecting monitoring data takes significant commitment and fiscal investment to ensure a high quality and effective program. For this reason, and especially during times of decreased agency funding, using existing monitoring data for multiple purposes is an important strategy for maximizing limited funds. In cases where monitoring data have been collected across a wide geographic area, these data may be appropriate for addressing some regional-scale questions, in addition to their intended, local application.




One such regional question of interest concerns potential unwanted effects of prescribed fire, specifically, high rates of mortality for large trees and fire-tolerant *Pinus* species. In a collaborative project led by Research Scientist Phil van Mantgem of the U.S. Geological Survey (USGS), this issue was addressed by examining post-fire mortality patterns for two common genera in the western U.S., *Pinus* and *Abies*, using observations from a national-scale prescribed fire effects monitoring program in the National Park Service (NPS) (van Mantgem et al., 2013).

FEAT/Firemon (FFI) data from seven NPS units were merged into a single database so that individual trees of the genera *Pinus* and *Abies* from across the southwestern U.S. could be used in an analysis of mortality following prescribed fire. Criteria for including data from a park unit were a presence of both *Pinus* and *Abies*, plots with 5-year post-fire survey data (to capture delayed post-fire tree mortality; van Mantgem et al., 2011), and trees ≥ 15 cm DBH (diameter at breast height, 1.37 m) that were alive prior to burning. Bandelier National Monument, Bryce Canyon National Monument, Grand Canyon National Park, Lassen Volcanic National Park, Sequoia and Kings Canyon National Park, Whiskeytown National Recreation Area, and Yosemite National Park all contributed fire effects monitoring data for this project.

Results from the synthesized data indicated that the annualized mortality rate of large trees (>50 cm DBH) over 5 years was 4.4 % per year, similar to that found in other studies, and mortality rates were similar for large *Pinus* and *Abies*. For small trees (≤50 cm DBH), the mortality rate was higher, 7.0% per year, and differed between *Pinus* (5.7%) and *Abies* (9.0%). The overall mortality rate of all trees combined was 6.5% per year, with lower rates for *Pinus* (5.5%) compared to *Abies* (8.3%). By five years post-fire 25% of *Pinus* and 35% of *Abies* had died, largely due to the difference between the genera in mortality rates of the small trees.

Models of post-fire mortality probabilities suggested statistically significant differences between the genera, after including differences in bark thickness (Figure 1). Accounting for these differences resulted in only small improvements in the model, suggesting they are not likely to be biologically important. Differences in tree mortality probability also appear to exist between the California and Colorado Plateau regions, perhaps due to differences in species composition, fuels, fire weather or ignition patterns.

Results from this study suggest that unusually high post-fire mortality does not occur for large trees or for *Pinus* relative to *Abies* following prescribed fires conducted within a broad area of the southwestern U.S. This work, supported by grants from the Joint Fire Science Program (JFSP) and the National Parks Service (NPS), demonstrates the usefulness of combining monitoring datasets to examine questions of regional significance. For more details about this study,

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## Does burn severity effect the age of soil carbon released during a tundra fire? A case study from Noatak National Preserve

Jennifer Barnes, Regional Fire Ecologist, Alaska Region National Park Service

Tundra fires are relatively common in the Noatak National Preserve. These fires can burn into the organic soils which can impact vegetation succession and have the potential to release ancient stored soil carbon. After a record number of fires burned in Noatak National Preserve during 2010, the fire ecology program was funded by the NPS Fire Program's Reserve Fund and the Arctic Network I&M program to assess: 1) the effects of burn severity on vegetation; and 2) the age of carbon burned in these fires.

Figure 1: Tussock cotton grass bloom vibrantly 1 year after the 2010 Lake Tutusirok Fire in Noatak National Preserve. Photo credit: 2011 NPS Alaska Fire Management

In 2011, thirty-four sites across five large fires from the 2010 fire season were assessed for burn severity, post-fire vegetation composition, and soil carbon age. Within the selected fires, remotely sensed burn severity maps indicated that 76% of the area was classified as unburned to low severity, 23% was moderate severity, and only 1 % of the area was classified as high severity by Monitoring Trends in Burn Severity. In most areas monitored, the burn severity was low to moderate. As a result the cotton-grass tussocks were resprouting vigorously (Figure 1) and low shrubs such as Labrador tea, low-bush cranberry and dwarf shrub birch were also resprouting.

Initial results from the carbon dating show that the 2010 fires primarily consumed organic soil material that was less than 60 years old. This implies that given enough time, the carbon released from tundra ecosystems during wildfires will mostly recover through vegetation succession. However, soil carbon ages are consistently older for soil monoliths from high-severity burns (where more of the organic material is consumed) and from areas that have burned more than once over the past 60 years. Preliminary data indicates that organic soils that are burned severely or multiple times may be as old as 900 years. This suggests that the "ancient" tundra soil carbon that has accumulated over the geological past is vulnerable to increases in fire frequency and severity in response to climatic warming.

Results from this study have helped determine how the severity of fires can influence the vegetation recovery and the age of carbon burned in tundra fires. Based on our mapping and monitoring, these recent fires appear to not be burning severely, which may help reduce the loss of ancient stored carbon. A final report is targeted for completion in 2013.

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view the full text of the article at http://dx.doi.org/10.1016/j.foreco.2012.09.029.

Further work using these combined data is ongoing. One study is in progress to examine whether recent warming trends in climate may lead to an increase in fire severity (post-fire tree mortality), independent of changes that may increase fire intensity (the amount of heat released during a fire). Also, while FFI data are used on a local scale to assess management objectives, the effectiveness of fuels treatments has not been assessed over large spatial and temporal scales. Recent JFSP funding will support using these combined data to assess whether prescribed fire can lead to long-term reductions in surface fuels and fire risks in coniferous forests of the western U.S. The FFI data will be used to examine the variability of fuels reduction treatments and long-term fuels accumulation patterns both within and among major forest types, and determine the effectiveness of prescribed fire in terms of modeled fire behavior, parameterized using observed patterns of fuels dynamics.

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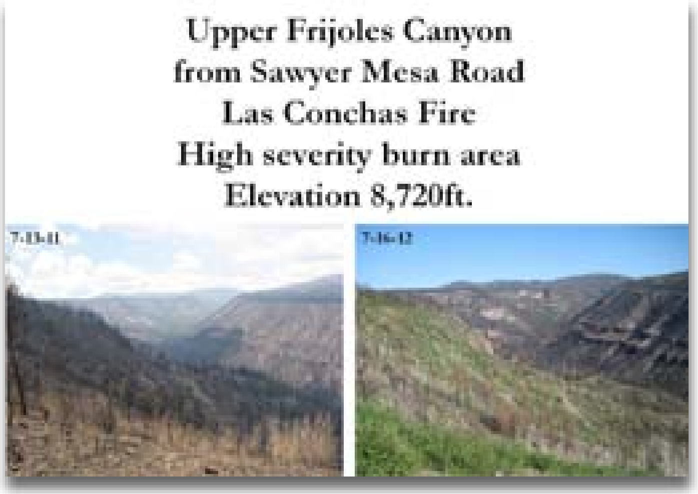
# Monitoring Vegetation Recovery After the Las Conchas Fire

Laura Trader, Fire Ecologist, Bandelier National Monument
Beth Gastineau, Lead Fire Effects Monitor, Bandelier National Monument

Bandelier National Monument's Fire Ecology Program is monitoring vegetation recovery after the Las Conchas Fire, New Mexico's second largest wildfire. The Las Conchas Fire ignited in the Jemez Mountains in north-central New Mexico at approximately 1:00 p.m. on June 26th, 2011, after an aspen tree fell on a power line. The fire ultimately burned 156,593 acres, with more than 14,000 acres consumed in the first 14 hours, at an unprecedented rate of fire spread and forest fuel consumption in this forest type and fire regime (predominantly frequent, low intensity, surface fires).

Two weeks after the fire, Bandelier's Fire Ecology Program set up photopoints in all of Bandelier's major drainages: Upper Frijoles Canyon, Alamo Canyon, and Capulin Canyon. The photopoints were installed in high burn severity areas and are retaken once a month. A series of vegetation plots in varying burn severities are also being monitored over time to record vegetation recovery, and to aid in determining if mechanical treatments implemented by Bandelier's Fire Management Program helped to reduce burn severity and pattern.

The photopoints show general vegetation recovery patterns and will be used over time to inform fire and resource managers and other park personnel.






Photos Courtesy of Bandelier Fire Ecology

All photopoints were installed in high burn severity areas.

Upper Frijoles Canyon Photopoint: This photo is taken from Sawyer Mesa Road, looking west into Upper Frijoles Canyon, at 8,720 ft. elevation. Common species seen in this area include *Quercus* species (oak) and *Robinia neomexicana* (New Mexico Locust).

Alamo Canyon Photopoint: This photo looks northeast into Upper Alamo Canyon, 8,600 ft. Common species include *Quercus* species (oak), *Robinia neomexicana* (New Mexico Locust), *Bromus inermis* (smooth brome), *Chenopodium* species (goosefoot), and *Verbascum thapsus* (common mullein).

Capulin Canyon Photopoint: This photo looks south into the headwaters of Capulin Canyon, 8,690 ft. Common species include *Quercus* species (oak), *Robinia neomexicana* (New Mexico Locust), *Bromus inermis* (smooth brome), and *Geranium* species.

No seedling trees were observed in any of the photopoint areas.

The lack of precipitation in 2011 and 2012 is having an effect on vegetation recovery. The annual average precipitation, as recorded by a weather station located near Bandelier's fire tower, was 8.3 inches in

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# Metadata, Mapping, and Merging – Exciting Momentum in the FFI World

Mary Beth Keifer, Fire Ecologist, Fire Management Program Center

## METADATA MADNESS

Thanks to work by all NPS fire ecology staff, great progress has been made in creating metadata and archiving backup files for all NPS FFI (FEAT/FIREMON Integrated) fire effects monitoring databases on the NPS IRMA (Integrated Resource Management Application) Data Store site. Through this effort, metadata are posted for over 90% of the agency's 100 fire effects monitoring data sets and about 85% of the FFI database backup files have been uploaded to the Data Store. These references and database archives provide a critical record of NPS fire effects monitoring efforts and are an important step in maintaining the integrity of these valuable long-term monitoring data resources.

In the future, the Fire Ecology Annual Reports will also be posted to the Data Store, providing a central location for archiving program reports along with the updated databases. In addition to serving an archiving purpose, the Data Store is also a way to communicate the fire ecology program's results and data to others, including research scientists who may have an interest in using the monitoring data for a variety of research issues useful for the science and land management communities. Please visit https://irma.nps.gov/App/Reference/Welcome to search and view the references for any of the parks' fire effects monitoring data sets. Thank you to all who have contributed to this work!

## WHERE IN THE WORLD?

Just where ARE all those NPS fire effects monitoring plots located? One immediate benefit of storing our FFI databases in the NPS Data Store can be seen in a recent effort to compile all fire effects monitoring plot geo-referenced coordinates where they can be accessed and viewed using NPMap, the web-based spatial tool for viewing and editing NPS fire program data. Along with staff from the NPS Inventory and Monitoring (I&M) Program and the NPS Geospatial Fire Analyst, we are currently building a geospatial dataset directly from the FFI databases stored in IRMA. This dataset will contain most data fields from the FFI macroplot form and will also be linked to a local park contact and the Data Store reference. As with all data, we are performing quality checking and will contact NPS fire ecology staff to assist in providing missing data and correcting errors. Once established, this dataset will be updated annually to reflect any changes or additions directly from IRMA. Please contact MaryBeth Keifer (marybeth_keifer@nps.gov) or Skip Edel (skip_edel@nps.gov) if you have any questions about this project.


In addition to the coordinates and other macroplot data, we are also working with the I&M Program staff to merge data for the standard protocols in FFI. Building regional and/or national databases is a major benefit of the SQL Server database and FFI standard protocols and will provide greater opportunity for exploring the wealth of NPS fire effects monitoring data across larger spatial scales to address regional questions. These combined databases will be useful for analyses by park and network fire and resource management staffs, as well as agency and university research scientists. Stay tuned for more information about this project as the work progresses.

## NEW TRAINING OPPORTUNITY FROM THE COMFORT OF YOUR DESKTOP

Self-paced study materials for FFI are now posted on the FFI website (http://www.frames.gov/partner-sites/ffi/training/). These materials are based on the presentations and exercises used in the FFI classroom training, but are a bit more detailed and descriptive. The Power Point presentations and exercises are designed to give new users enough information to begin using FFI in their monitoring program. The entire package of training materials can be downloaded at once, or individual modules can be selected for more specific focus on a particular aspect of FFI.

For general information about FFI, training announcements and materials, software, user guides and more are available on the FFI FRAMES website (http://www.frames.gov/ffi). Post any questions or suggestions regarding FFI on the FFI discussion group at http://groups.google.com/group/ffiemu or contact Duncan Lutes (dlutes@fs.fed.us) or MaryBeth Keifer (marybeth_keifer@nps.gov).

# Identifying patterns of high severity fire before fire exclusion in Lassen Volcanic National Park

Dr. Alan Taylor, Department of Geography, Penn State University

A major challenge for managers using prescribed fire or wildland fires to reintroduce fire effects into ecosystems where fire has been excluded is the lack of historic references to compare their fire effects to. For most places, we don't know what the spatial patterns of fire severity were before fire exclusion, so it is unclear if managed burn patterns are within the ballpark or not. Current patterns of fire severity in western forests are a contested issue, particularly in dry forest types that historically burned at relatively high frequency. In these types of forests, exclusion of fire has led to forest thickening that increases the probability of high severity fire. Assessments of severity patterns of recent wildfires in California conclude that fire severity is both within and outside the range of fire severity expected for fires that occurred before fire exclusion. Such contrasting scientific results make it difficult for managers to apply and evaluate severity information in the context of a fire program. For most places, we don't have information related to fire severity patterns prior to fire exclusion, so it is difficult to know if contemporary burn severity patterns are within the historical range of variability. Ideally, the determination of desired fire effects from wildland fires would be based in part on historical fire severity patterns. The goal of this work was to identify pre-fire exclusion forest fire severity characteristics in Lassen Volcanic National Park (LAVO) in California's southern Cascades. Most of LAVO is wilderness and was never logged. Fire exclusion began in LAVO around 1905.

Photo 204799 Description: Jeffrey pine-White fir and Red fir stands on Flatiron Ridge (foreground) and Saddle Mountain (background). In 1925, the forest is mostly patches of small trees amongst a matrix of brush (mostly Arctostaphylos patula, Ceanothus velutinus). This vegetation pattern is probably the result of a series of moderate and high severity fires that killed overstory trees and generated brushfields. The forests in 2010 are much more dense and the brushfields have been invaded by Jeffrey pine, White fir, Red fir, and Western white pine. Trees began to establish in a plot on Flatiron Ridge in the middle foreground about 95 years ago and some aged large diameter trees that survived the fires were >220 years old. The brushfield in the foreground has been completely overtopped by new regeneration.

To identify fire severity patterns before 1905 we used several types of field and geospatial data. This involved creating geo-referenced layers of early forest conditions using historical aerial photographs (1941), early photographs of forest landscapes and forest stands (1880-1925), and vegetation and tree ring sampling in patches identified in the aerial imagery and photographs. These data were then integrated to create maps of the extent and location of high severity burn patches generated by fires that burned before fire exclusion. The maps were then overlaid on a digital terrain model to identify relationships between topographic characteristics and high severity fire patches. Our data are most representative for severity patterns in the mixed conifer zone which historically experienced frequent low and moderate severity fire.

When ordered by size, the area of the median high severity fire patch was small (9.8 ha), but the largest was >1000 ha. Overall, high severity patches covered ca. 8% of the forested landscape, at least as interpreted using these methods. High severity burn patches also occurred more often than expected in certain places. Compared to random locations, high severity burn patches were found at lower elevation, on steeper slopes, and on slopes that had a more southerly aspect. Warmer and drier conditions on these relatively steep, lower elevation south-facing slopes were apparently more conducive to high severity fire than conditions on other topographic locations.

The characteristics of high severity burn patches associated with prescribed and wildland fires in LAVO over the

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Photo 204805 Description: Brushfield and Jeffrey pine-White fir forest on the east side of Kelly Mountain. In the 1925 scene a large brushfield (Ceanothus velutinus, Arctostaphylos patula) covers the east slope of Kelly Mountain. This brushfield probably established after a high severity fire the killed the canopy of the Jeffrey pine-White fir forest over a wide area. The brush has disappeared by 2009 it has been replaced by a dense even-aged stand of White fir and Jeffrey pine. Height growth of trees in the immediate foreground has obstructed the view of the Kelly Mountain.

last 30 years are different from the characteristics of those that occurred prior to fire exclusion. About 2% of the landscape has burned at high severity, primarily from two wildfires, and the median high severity patch size is 15.7 ha. The largest patch covered 313 ha. The spatial positions of these burn patches on the landscape are different from those that occurred before fire exclusion. They were concentrated on more gentle terrain and on north- and east-facing slopes.

The different spatial location of recent high severity patches compared to those before fire exclusion is related to both prescribed burning and the restrictive nature of where wildfires started and were then permitted to burn. Prescribed burning for fuels reduction has been concentrated on gentle terrain along the park boundary. These burns are designed to create conditions that reduce the potential of future wildfire escape from the Wilderness core of the park into adjacent non-park lands. Likewise, recent wildland fires have been most severe on flats with lodgepole pine forests, and on fir- and pine- dominated forests on north- and east-facing slopes. It should be noted that these results do not yet include the Reading Fire, which burned 16,993 acres in the park last August (2012). Additional research is needed to determine whether severity patterns from the largest fire in the park's history were more similar to historical fires.

Managers recognize that nearly a century of fire exclusion has altered forest and fuel conditions in LAVO, and that reintroducing fire is essential for restoring it as a regulating process in these fire prone ecosystems. There are good reasons to focus initial prescribed burns along the park boundary and to use wildland fire as a means to reintroduce fire effects into these ecosystems. It is also important, however, for managers to know that the ecological effects and spatial characteristics of these burns may differ from the effects and characteristics of burns that occurred before fire exclusion. The data from this project provide a quantitative reference to evaluate the effects and effectiveness of prescribed fires and wildland fire in restoring severity patterns characteristic of functioning fire regimes. The data are also likely to be useful for fire and resource managers in parks that have similar ecosystems, such as Crater Lake, Yosemite, and Sequoia Kings Canyon.

This research was supported by the National Park Service Reserve Fund Research Request, through a Cooperative Agreement with LAVO and Penn State University.

Photo 204798 Description: Jeffrey pine-White fir and Red fir stands on Flatiron Ridge (foreground) and Saddle Mountain? (background). In 1925 patches of mature trees of variable size occur in a matrix of brush. This vegetation pattern is probably the result of a series of moderate and high severity fires that killed forest patches and generated brushfields. Brush cover is much lower in 2010 and the brushfields have been invaded by White fir, Jeffrey pine, Red fir, and Western white pine. Overall, the forest is now much more dense and the forest cover is much more homogenous than it was in 1925.

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Water Year (WY) 2011 and 8.83 inches in WY2012. These amounts are well below the historical annual average of 15.88 inches. Precipitation for the month of June (the month prior to when the photos were taken) in 2011 and 2012 was 0.1 inch, which is much lower than the historical average of 1.1 inches. Precipitation for the month of July (when the photos were taken) in 2011 was 1.35 inches, and 1.1 inches in 2012, as compared to the historical average of 2.35 inches.

The Las Conchas Fire, traveling north through Banelier, New Mexico on May 26, 2011. Photo Courtesy of Brian Kleisen.

Grand Canyon continued from page 4

potential delayed mortality in all tree size classes.

FUTURE APPLICATION

The Range Prescribed Fire Project provided GRCA managers with an opportunity to evaluate a phased approach to mixed conifer forest burning that was designed to achieve both forest restoration objectives and the protection of MSO recovery habitat. The project was implemented in late October when the daily burn period was short and maximum daily temperatures were low. Ignition operations were also confined to ridge tops and the upper portions of slopes. The cautious implementation approach achieved the minimum acceptable results in the areas that burned, but only 60% of the randomly located plots burned.

Daily fire weather and fire behavior observations along with RAP plot results from this project are already being used to develop plans for burning other mixed conifer units in the park and on the neighboring Kaibab National Forest. The results of the Range project suggest that mixed conifer units in the area could be successfully burned under warmer and drier weather conditions, and during days with longer burn periods than those that occurred in late October of 2012. This information gives managers more opportunities to find acceptable burn windows for the complex mixed conifer burn units planned for the future.

## Natchez Trace Receives Award

Congratulations to the Natchez Trace fire ecologist and fire effects crew for receiving the Achievement in Implementing Adaptive Management Award for 2012, from the National Park Service Fuels and Fire Ecology programs. Also, check out NATR fire ecologist Jesse Burton's interview in the April newsletter for the Oak Woodlands and Forest Fire Consortium. http://oakfirescience.squarespace.com/storage/April%202013%20NEWSLETTER.pdf


Clockwise from top left: Will Hilton, Jesse Burton, Dale Wilkerson (Acting Superindendant), Jennifer Falkey, and Carol Fields.

## RxFx Subscription and Submission Information

*Rx Effects* is the newsletter of the Fire Ecology Program in the National Park Service. It is an outlet for information on Fire Effects Monitoring, the Fire Monitoring Handbook , FEAT/FIREMON Integrated (FFI), fire research and other types of wildland fire monitoring. The newsletter is produced annually for the National Park Service but we encourage anyone with an interest in fire ecology to submit information about their program or research. Examples of submissions include: contact information for your program, summaries of your program's goals, objectives and achievements, monitoring successes and failures, modifications to plot protocols that work for your park, hints for streamlining collection of data, data entry and analysis, and event schedules. Submissions are accepted in any format (e.g., hard copy through the mail or electronic files through e-mail). Please see our website for author instructions. The goal of the newsletter is to let the fire ecology community know about you and your program.

Rx Effects is issued each year in the spring. The deadline for submissions is the last Friday in February. If you would like a subscription or more information please see our website www.nps.gov/fire/wildland-fire/what-we-do/science-ecology-and-research/rx-effects-newsletter.cfm or contact:

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