23 Meeting resource management objectives with prescribed fire

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Introduction

The events of the 2000 fire season caught the interest of the media, the public, and many politicians. The destruction of homes in the wildland–urban interface was an obvious negative result of some of these fires. In addition, some fires burned with uncharacteristically high intensity, causing resource damage that may take a long time to recover. While the media tended to focus on these negative, destructive effects of fire, many of the fires of 2000 were beneficial, restoring a natural process often long absent in fire-maintained ecosystems. While attention was brought to the National Park Service (NPS) and prescribed fire, NPS prescribed-fire program accomplishments were omitted from ensuing discussions. We present examples from three parks where prescribed fire is successfully used to meet fire and resource management objectives: Sequoia and Kings Canyon National Parks, Grand Canyon National Park, and Bandelier National Monument.

Results from these park examples were obtained using established protocols from the NPS fire monitoring program (National Park Service 2001). The program's objectives are to: (1) record basic information for all fires; (2) document fire behavior; (3) determine whether prescribed-fire management objectives are achieved; (4) document and analyze short-term and long-term fire effects on vegetation; (5) establish recommended standards for data collection, analysis, and sharing; (6) follow trends in plant communities where fire effects literature exists; and (7) identify where additional fire effects research is needed. The NPS fire monitoring program utilizes permanent plots to measure a variety of vegetation and fuels attributes pre-burn and post-burn. This program began in some western parks in the 1980s and has expanded over the last decade to include all NPS units that use prescribed fire. This monitoring scheme is now implemented in over 50 parks nationwide and has also been adopted by other federal and private agencies.

First things first: setting fire and resource objectives

When implementing such a monitoring program, having benchmarks to serve as reference points for program success is critical. The best available information is used to formulate realistic objectives for resource conditions in order to make progress towards achieving goals. This information may include research data, field sample data, written historical accounts, and historic photographs. In some cases, interpreting what little information is available is very challenging; however, resource managers must make decisions even in the face of uncertainty. Once a target condition is agreed upon, specific objectives are written, a desired degree of certainty in the results is determined, and protocols are established to collect the appropriate

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data. Involving the park staff at many levels, as well as local scientists from universities or cooperating–neighboring agencies, is vitally important to this process. It is also essential for all staff to remember that setting objectives is a work in progress and when new information is available, or unexpected trends are identified, objectives may need to be revised or the program re-evaluated. When new information is used to re-evaluate program goals or objectives, the adaptive management process comes full circle.

Prescribed fire success stories

Example 1—Sequoia and Kings Canyon national parks: Giant sequoia–mixed conifer forest type. Sequoia and Kings Canyon national parks are located in central California in the southern Sierra Nevada range. The parks' prescribed fire program began in 1969 after nearly a decade of fire research in giant sequoia groves, and the parks' fire effects monitoring program began in 1982. The giant sequoia–mixed conifer forest, where prescribed fire efforts were first focused, is located at elevations ranging from 5,500-7,200 ft on all aspects with coarse and acidic soils. The overstory consists of mature white fir *(Abies concolor),* sugar pine *(Pinus lambertiana),* giant sequoia *(Sequoiadendron giganteum),* incense cedar *(Calocedrus decurrens),* and ponderosa pine *(Pinus ponderosa).*

The goal in this forest type is to reduce fire hazard and restore and maintain the natural fire regime, first restoring forest structure within a range of conditions present in the 1,000 years prior to settlement. Fuel reduction and stand density target conditions were defined using a combination of research data and expert opinion in a collaborative effort involving park staff and local U.S. Geological Survey Biological Resources Division scientists. Two specific objectives are measured to ensure that restoration target conditions are reached: (1) reduce total fuel load by 60-80% immediately after the initial prescribed fire; and (2) reduce stand density to 50-250 trees/ha (for trees <80 cm in diameter at breast height) and 10-75 trees/ha (for trees >80 cm in diameter at breast height) by five years after the initial prescribed fire.

Monitoring results indicate that in 28 plots that were distributed within 17 different fires that burned over a period of 14 years, mean total fuel load was reduced by 77% immediately post-burn (Keifer et al. 2000). The fuel reduction objective is successfully met with the initial prescribed fire treatment in the giant sequoia–mixed conifer forest type.

Prior to burning, the mean density of smaller-diameter trees is over twice the maximum target density (Figure 23.1). By one year post-burn, mean density of this size class is dramatically reduced, although the mean does not fall within the target range. Five years following prescribed fire, density is further reduced and the mean (and nearly the entire 80% confidence interval) falls within the target range. Larger-diameter tree density is only slightly reduced over the five-year time period and none of the post-burn large tree mortality are giant sequoias (Figure 23.1). The forest structure restoration objective is largely met after a single treatment with prescribed fire in this forest type.

Once restoration target conditions are met, the objective shifts to using targets for maintaining the fire regime (e.g., ranges of historic fire return interval, season and severity of fire; Keifer and Manley, in press). Rather than attempting to maintain a fixed forest structure, the fire regime will then influence and shape ecosystem structure and function.

Example 2—Grand Canyon National Park: South Rim ponderosa pine type. Grand Canyon National Park is located in northern Arizona on the Colorado Plateau. The prescribed fire program started in the early 1970s and continues to concentrate on the forested plateaus on the north and south side of the Grand Canyon. The South Rim ponderosa pine forests are dominated by ponderosa pine *(Pinus ponderosa),* but piñon pine *(Pinus edulis),* Utah juniper *(Juniperus osteosperma),* and Gambel oak *(Quercus gambelli)* may also be present. These stands are located at

6,000-7,500 ft in elevation on all aspects with shallow, silty loam soils, and barren rock outcrops.

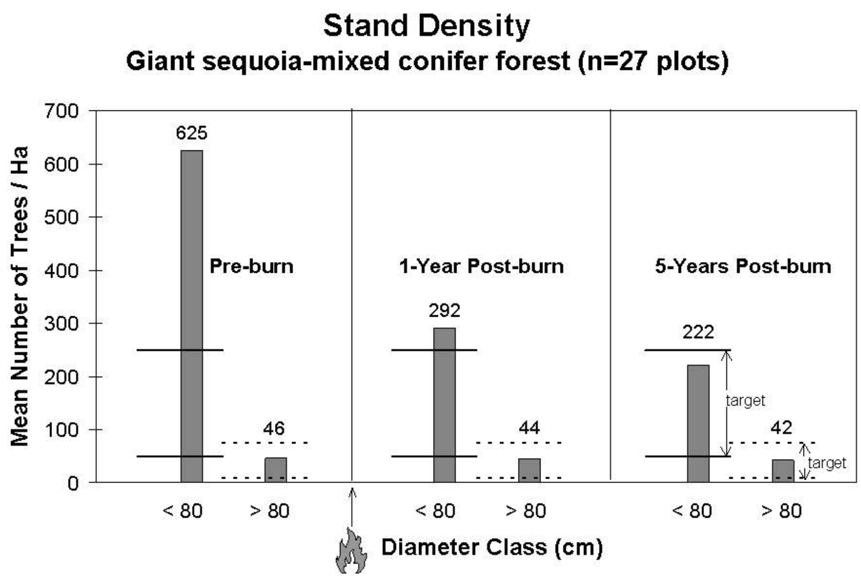

Figure 23.1. Giant sequoia–mixed conifer forest stand density reduction at Sequoia and Kings Canyon national parks. Error bars indicate 80% confidence intervals.

The goal in these old-growth ponderosa pine stands is to use prescribed fire to restore the forest structure present before fire suppression activities. First, fuels must be reduced before a lightning- or human-caused fire burns through them in an uncharacteristically intense manner. Additionally, it is important to minimize overstory ponderosa pine mortality, as there is not an overabundance of trees in the large size classes. Before burning, mean fuel loads are at least twice as high as the maximum historic levels, and caution is needed to keep fires cool enough to limit overstory mortality.

In the South Rim ponderosa pine monitoring type, overstory, and fuel load targets were defined using local research results and written historical accounts. Two objectives are used to measure success in achieving this goal: (1) reduce total fuel load to 0.2-9.3 tons/ac within three prescribed fire cycles, and (2) maintain overstory ponderosa pine densities of 47-62 trees/ha, measured five years after the initial prescribed fire.

Prior to the first-entry prescribed fire, total fuel loads averaged 15 tons/ac. After one prescribed fire treatment, fuel loads are reduced to a level just within the target range of desired conditions (Figure 23.2). Nine plots are needed to assess the fuel load with the desired 80% confidence; however, data have been collected only on seven plots. Although there is not statistical confidence in this trend across all South Rim ponderosa pine stands, it is occurring on seven plots.

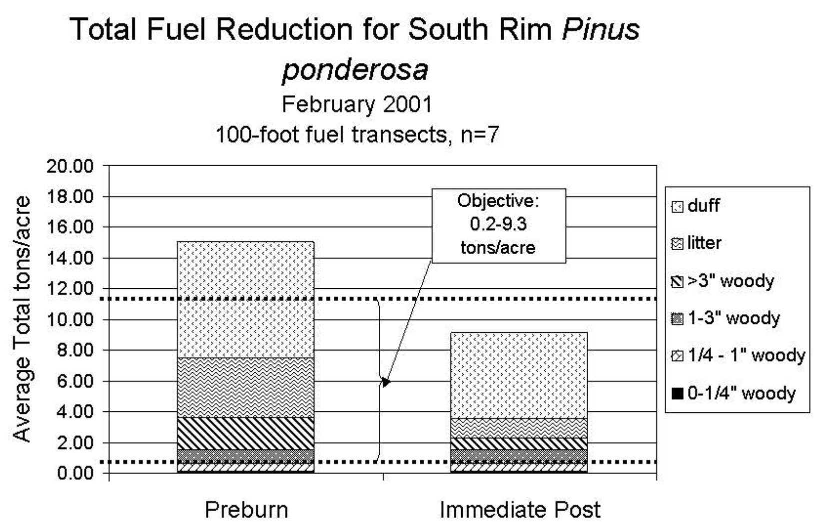

Figure 23.2. South Rim ponderosa pine total fuel reduction at Grand Canyon National Park. Dashed lines represent target condition.

For ponderosa pine trees over 41 cm in diameter, the objective is to achieve and maintain 47-62 trees/ha five years after the burn. Since delayed mortality can still be seen in up to the fifth year post-burn (Harrington 1993), that is when success in meeting this objective will be measured. Because only 11 plots have reached the five-year post-burn visit, two-year post-burn data were analyzed to identify trends. Pre-burn and post-burn overstory densities on 20 plots that have reached the two-year post-burn time period show little change (Figure 23.3).

At Grand Canyon, a good portion of the fuel reduction has been achieved after one prescribed burn, while at the same time there is not significant ponderosa pine overstory mortality. These data illustrate the trend toward simultaneously reducing fuels and limiting overstory ponderosa pine mortality. It is expected, through a series of burns, that fuel loads will continue to be decreased while overstory ponderosa pine structure is retained in these forests, and monitoring will continue to ensure that this is indeed true.

Example 3—Bandelier National Monument: Lower-elevation ponderosa pine type. Bandelier National Monument is located on the southern end of the Pajarito Plateau in the Jemez Mountains of northern New Mexico. This area is composed of volcanic ash and lava flows that have been eroded into deep canyons. Nearly all of the monument's vegetative communities have been significantly affected by historical land-use practices, such as grazing and fire suppression. The consequences of these anthropogenic effects have resulted in dramatic changes in the fire regimes at Bandelier and have produced significant ecological effects on the fire-prone landscapes (Allen 1989).

Research shows that the synergistic effects of extensive overgrazing, effective fire suppression after the 1900s, and climate patterns (including a severe drought that occurred in the Southwest in the 1950s) have produced rapid ecosystem changes in the lower-elevation (5,500-7,000 ft) ponderosa pine vegetation type (Allen 1998). Decreased herbaceous plant cover and productivity, ponderosa pine overstory tree mortality, and increased densities and up-slope recruitment of piñon and juniper trees are a few of the observable effects.

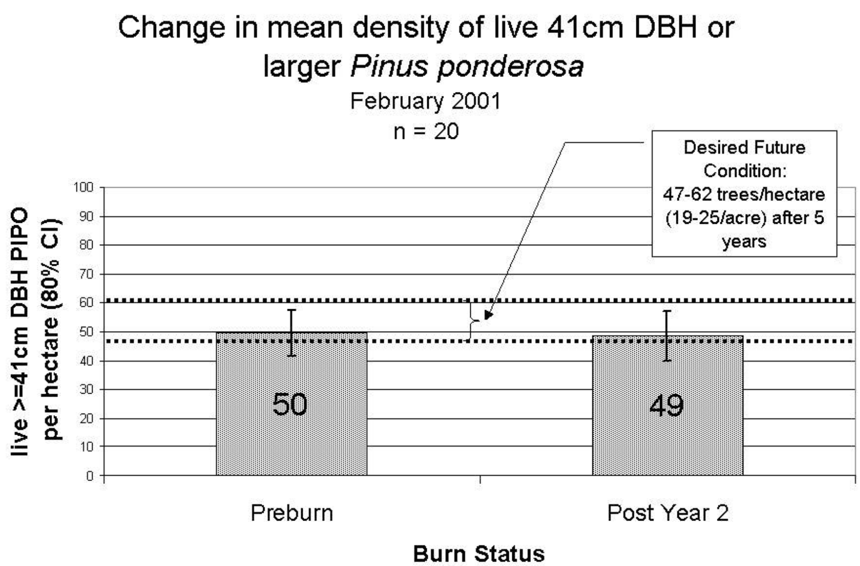

Figure 23.3. South Rim ponderosa pine overstory density changes at Grand Canyon National Park. Error bars indicate 80% confidence intervals.

Fire and resource managers at Bandelier established sustainable management objectives for the lower-elevation ponderosa pine type based upon the park's resource management plan and local ponderosa pine research. The overall goal is to use fire to restore the ponderosa pine forest structure to the natural range of variability present between 1600 and 1880. Specific objectives are: (1) reduce piñon and juniper pole tree density by at least 20% within five years post-burn, and (2) reduce ponderosa pine overstory (diameter at breast height >20 in) tree density by no more than 10% within five years post-burn.

Park managers burned the area in 1992 and again in 1997. Data analysis after two prescribed fire cycles shows a decrease in pole-sized piñon pine and juniper tree densities from pre-burn levels of 16 trees/ac to one tree/ac two years after the second burn (Figure 23.4). Piñon and juniper pole tree densities are now within the target condition (a maximum of 12 trees/ac) for this vegetation type, successfully meeting the primary objective.

The data also show a slight increase in overstory ponderosa pine density from six trees per acre prior to the burn, to approximately 8 trees per acre two years after the second burn (Figure 23.5). This demonstrates that the second objective is also accomplished.

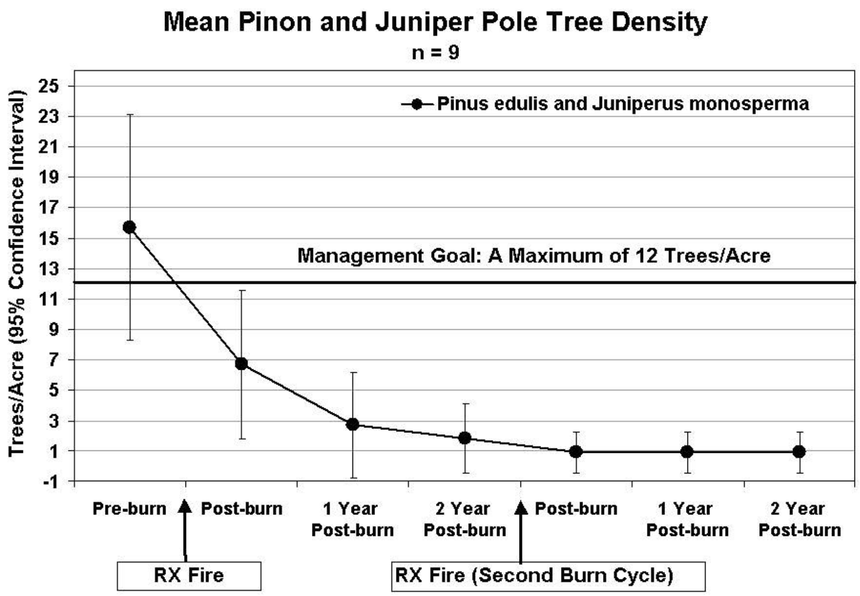

Figure 23.4. Lower-elevation ponderosa pine mean pole tree density at Bandelier National Monument. Error bars represent 95% confidence intervals.

At this time, no alterations need to be made to the burn prescription or treatment frequency because managers at Bandelier are reasonably certain that pole-sized piñon and juniper tree densities have decreased, and overstory ponderosa pine densities have, at a minimum, been maintained. However, monitoring will continue in the lower-elevation ponderosa pine forest to track long-term changes in tree densities and corollary effects, such as increases in exotic species, which may negatively affect ecosystem function.

Conclusions

Examples from three different national parks demonstrate the success of NPS's prescribed fire program. Sequoia and Kings Canyon national parks simultaneously achieve fuel reduction and forest structure restoration objectives in the giant sequoia–mixed conifer forest. Grand Canyon National Park successfully reduces fuels while maintaining overstory ponderosa pine in the South Rim ponderosa pine forest type. In the lower- elevation ponderosa pine forest at Bandelier National Monument, piñon pine and juniper tree densities are reduced, while overstory ponderosa pine tree density is maintained. These three examples illustrate that prescribed fire can be used successfully and safely to achieve fire and resource management objectives.

These examples illustrate that prescribed fire, without mechanical thinning, achieves management goals, at least in some forest types. To achieve success within the social and political arena, we need to advertise fire successes to inform the public and Congress. As land management agencies explore fire hazard mitigation alternatives and evaluate prescribed fire use, we are responsible for understanding, weighing, and explaining all benefits and risks of both using fire as a resource management tool and excluding fire from fire-maintained ecosystems.

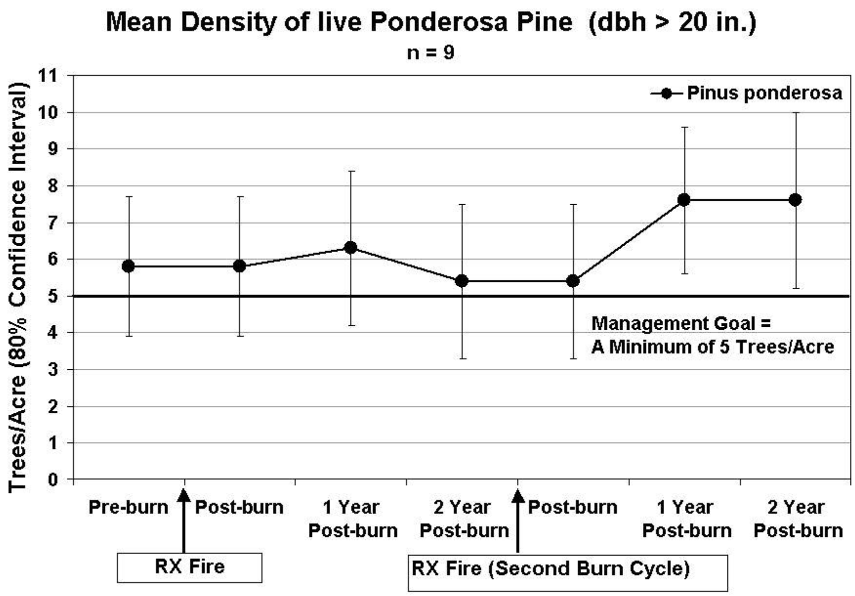

Figure 23.5. Lower-elevation ponderosa pine density at Bandelier National Monument. Error bars represent 80% confidence intervals.

Lastly, landscape-level success is dependent upon the degree of interdisciplinary collaboration between agencies. The fire events of 2000 demonstrate an urgent need for government agencies, private landowners, and the public to work together to reduce the risk of damaging fires and to achieve ecological goals with fire on public lands across vast landscapes.

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