National Park Service Fire Effects Monitoring Program

Rx Effects

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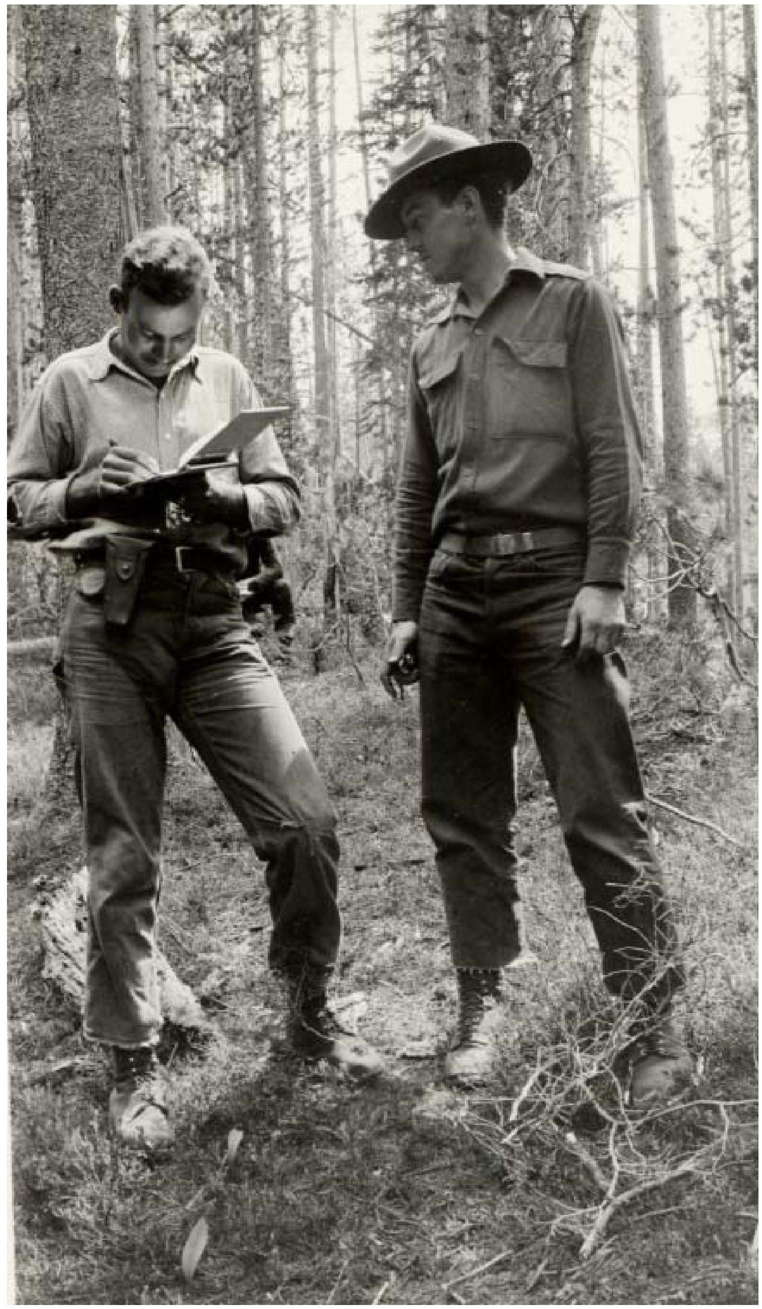
From the Editors

Becky Seifert and Eric Miller (YELL)

Is anyone noticing that fire effects is not just about monitoring prescribed fire anymore? This year we can add assessing fuels projects for fire regime and condition class to the list of work the NPS fire effects monitoring program is responsible for. As wildland fire gets more and more complex with public and congressional recognition of fuel load hazards, increasing urban interface problems, and increasing need for assessing fuels, vegetation, and fire regimes, the employment outlook looks good for the fire effects monitor that can keep up with it all.

Results! Several southwestern parks have ganged up with their FMH data to produce information on effects of prescribed fire in ponderosa pine. See our feature article. Also featured-- fire effects poetry!



Rangers gathering cover data in 1935.

Inside this issue:

Crown Fire, Crown Spacing, Crown Bulk Density: What's What?
Eric Miller, Yellowstone NP

Over the past year I've talked with many fire effects folks about monitoring canopy fuel reduction projects. The objective is to reduce canopy fuels to a point where crown fire cannot be sustained. This introduces two questions: How do you measure canopy fuels? And what is the threshold point beyond which crown fire cannot be sustained? I've spent a considerable amount of time this winter researching these questions.

So, how do you measure canopy fuels? Traditionally crown spacing, or the distance between leaf tips or the distance between crown drip-lines, has served well. However crown fire is best modeled from canopy bulk density, or the amount of mass in the canopy per unit of volume (units lb/ft^3 or kg/m^3). Like crown spacing, canopy bulk density is not easily measured either. Currently the opinion of the experts is that the best way to model canopy bulk density is indirectly through measures of tree characteristics using software such as the Crown Mass© module of Fuels Management Analyst© (Acacia Services 2001). The fire effects monitor records tree species, DBH, height, crown ratio, and crown class. These data are entered into Crown Mass© which provides a profile of canopy bulk density from the ground to the tree tops in 30 cm intervals. These estimates are based on a limited amount of data in the literature relating canopy bulk density to easily measured tree characteristics. This lack of information is improving, however (see Scott and Reinhart 2002).

Ok, how do I know if my forest will sustain crown fire? If there is not enough mass of burnable fuel in the canopy heat transfer cannot occur. The minimum canopy bulk density needed to sustain crown fire is also not well understood but I've found several figures in the literature. Sando and Wick (1972) report that a minimum crown bulk density of 0.0023 lb/ft^3 or 0.037 kg/m^3 is necessary to provide vertical propagation of fire. Agee (1996) suggests 0.0062 lb/ ft^3 or 0.1 kg/m^3 which was corroborated in four case studies by Omi and Martinson (2002). As more fuels projects are opportunistically exposed to crown fire this threshold will become better defined.

Acacia Services and Fire Program Solutions, LLC. 2001. <http://www.fireps.com>.

Agee, J.K. 1996. The influence of forest structure on fire behavior. Pages 52-68 in Sherlock, J. (Chair). Proceedings of the 17th annual Forest and Vegetation Management Conference. The Conference, Redding,

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Fuel Factors and Reburn Potential in Lodgepole Pine Forests
Eric Miller, Yellowstone NP

Early post-fire forests historically have been used as tactical firebreaks in the landscape, particularly in ecosystems like Yellowstone's lodgepole pine forests with long fire cycles. Ignitions in post-fire lodgepole pine forests (our LP0 cover type) resulting from the extensive fires of 1988 were, for the most part, self-extinguishing. That is, until the 2000 fire season when lightning ignited the Boundary Fire in 12 year old lodgepole pine which grew to 150 ha (375 acres) over the next couple of weeks. In 2001 and 2002 the Falcon and Phlox Fires burned up to 800 ha (2,000 acres) of LP0. Other fires burning in mature forests went out when they encountered LP0. There had to be a threshold fuel factor that limited spread at one site while allowing it at another.

We began a fuel modeling project to identify this fuel factor. We looked at data from FMH plots at the Boundary, Stone, and Falcon Fires but decided we needed an approach that focused intensively on fuels. Beginning in 2001 we intensively sampled fuel loadings in typical LP0 stands using a photoseries approach modeled after Ottmar et al (2000). This approach gives us all the fuel loading information necessary for fire modeling and at the same time provides a photoseries usable to quickly characterize LP0 sites.

In 2002 and 2003 we hosted students from Brigham Young University and the University of Iowa as part of their Field Methods course. We provided the background, theory, and methodology supporting our project and the students provided the grunt labor and enthusiasm in the field. The students provided approximately 1,200 hours of work and we were able to sample 14 sites.

Some analysis to date suggests that the LP0 cover type fits both the timber-litter and grass fuel models. To date only sites with grass (or graminoids such as elk sedge) have carried fire for any significant distance. Fire spread is limited to late summer, after mid-August, when the sedge has cured and reached <80% moisture. We have observed that fire spreads through the graminoids during favorable periods and resides in rotten logs outside the burn period. We created a preliminary, HTML based photoseries on CD-ROM for use in the upcoming season and expect a final version next year.

Ottmar, R.D., R.E. Vihnanek, and C.S. Wright. 2000. Stereo photoseries for quantifying natural fuels. Volume III: Lodgepole pine, quaking aspen, and gambel oak types in the Rocky Mountains. NWCG. PMS 832. NFES 2629. 85 pp.

Why such a fright?
Andy Thorstenson, Wind Cave National Park

why such fright?

of the emblazoned spirit wildfire
is this not as wildly natural
as wildflowers or wildlife

born of lightning
germinated in a thunderstorm passing
its blossom is the most curious flower growing in the forest
a ponderosa will cast her scented needles
hoping to attract a suitor such as this
who might place a delicate kiss on her thigh

watch this intricate tango
wind leads fire follows
fire leads wind follows
cautiously developing its tastes
sampling the finer fuels, a deadfall tree
then speaking like god through a burning bush

growing syntripically with the intensity of a sun
becoming voracious in youth
climbing the vegetative ladder to its crowning achievement
whereupon it reaches maturity
changing all life around it
as a genius composer
whose singular penstroke
creates irreversible advance

Monitoring the Effects of Prescribed Fire Treatments on Ponderosa Pine Ecosystems in the Southwest National Park Intermountain Region

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Abstract

Preliminary management information for southwestern parks is being developed through analysis of long-term monitoring data collected according to the National Park Service Fire Effects Monitoring protocols. Data collected at Bryce, Grand Canyon, Saguaro, and Zion National Parks, and Bandelier and Walnut Canyon National Monuments from 1980 to present indicate that prescribed fire has been successfully used to reduce fuel loading while protecting resource values at risk from stand replacement type fire behavior.

Background

The consequences of fire suppression and extensive livestock overgrazing in southwestern ecosystems over the last century are well documented. Research has shown that these anthropogenic effects have resulted in dramatic changes in the southwestern ponderosa pine fire regime and have produced significant ecological effects on the fire-prone landscapes. High accumulations of litter, duff, and dead and down woody fuels, increased tree densities, low herbaceous cover, decreased availability of soil nutrients, increased disease and mortality in trees, loss of habitat, and increases in large stand replacing fires are a few of the consequences of more than 100 years of fire suppression (Allen, 1989; Cooper 1960; Covington, et. al., 1992; Swetnam, et. al., 1996). Conflagrations like the 1996 Dome Fire, the 2000 Cerro Grande Fire, and the 2002 Rodeo-Chedisky Fire are becoming more frequent in ponderosa pine forests, where large scale stand-replacing fire events were once anomalous.

Introduction

The cumulative and synergistic effects of extensive overgrazing and effective fire suppression in the southwest have created an ecologically complicated and potentially hazardous situation for current land managers as well as the public. Fire and resource managers at Bandelier National Monument, Bryce Canyon National Park, Grand Canyon National Park, Saguaro National Park, Walnut Canyon National Monument, and Zion National Park are attempting to mitigate some of the consequences of past land uses and fire suppression in the ponderosa pine ecosystem by implementing prescribed fire treatments that attempt to emulate historic fire disturbances. An essential part of this restoration process is to monitor the effects of fire treatments on vegetation and fuels. Permanent Fire Effects Monitoring vegetation and fuel plots, read before and after prescribed fire, were installed in the ponderosa pine vegetation type in each park unit (USDI NPS, 2001). These 50 x 20 meter plots were installed to record structural changes in the vegetation and fuels and to determine if prescribed fire program objectives are being met or if adjustments to burn prescriptions are necessary.

Data collected on the vegetation and fuel plots at each park unit were compiled and analyzed using the National Park Service Fire Effects Monitoring software (USDI NPS, 2000). Analyses were conducted with an 80% confidence and 25% precision level for the following monitoring variables: fuel loading, overstory trees (dbh > 6 in.), and pole-sized trees (dbh = 1-6 in.). For each variable, the data were analyzed according to burn season (SPRING = March-June, SUMMER = July-September, and FALL = October-December), as well as combined across all seasons to show the overall trend for

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each variable. The fuel data were analyzed (by burn season and combined) to show the mean fuel loading in tons per acre over time as well as the percent change in fuel load from pre-burn levels. Similarly, the overstory and pole-sized tree data were analyzed (by burn season and combined) to show changes in the mean number of trees per acre over time and the percent change in tree densities from pre-burn levels.

Fuels

Fuel load (tons/acre) and percent change from pre-burn levels were calculated for litter, duff, 1-, 10-, 100-, 1000- hour fuels, and total fuel load for each burn season as well as combined across all burn seasons. In general, all park units have objectives that specify at least a 40% reduction in total fuel load.

Litter and duff showed the largest reduction in summer burning, from 21 tons/acre in pre-burn to 8 tons/acre immediate post-burn (62% reduction) (n=44). One and ten-hour fuels were reduced the most from pre-burn (.9 tons/acre) to immediate post-burn (.5 tons/acre) in spring burning (49% reduction) (n=10). Thousand-hour fuels were also reduced the greatest from pre-burn (4.3 tons/acre) to immediate post-burn (.8 tons/acre) during spring burning (55% reduction) (n=10). One hundred-hour fuels showed the greatest reduction (29%) in fall burning, from pre-burn levels of 1.4 tons/acre to .8 tons/acre at immediate post-burn (n=50). Overall, summer burning had the largest effect on total fuel load, (60% reduction), due to the large reduction in litter, duff, and 1000 hour fuels (n=44). However, both spring and fall burns showed adequate reduction (42% for both) of total fuel load from pre-burn to immediate post-burn.

When combining the data across all seasons, a trend of all woody fuels returning to pre-burn levels by five years post-burn was observed, with the litter and duff layer not quite reaching pre-burn levels at five years post-burn.

Overstory

The mean number of trees per acre for pre-burn, 2, and 5 years post-burn and the percent change in tree densities from pre-burn levels were calculated for overstory trees in the following dbh size classes: 6-11.9 in., 12-17.9 in., 18-23.9 in., and 24 in. and larger. This analysis was conducted for each burn season, as well as combined across all seasons. In general, the overstory tree objectives in all park units relate to reducing the density of the smallest trees while retaining the larger diameter trees.

Summer burning appeared to produce the largest reduction (7.1%) in overstory trees, from pre-burn levels of 134 trees/acre, to 124 trees/acre by 5 years post-burn (n=23). The majority of this reduction was in the 6-11.9 in. size class. The largest size class (24+ in.) experienced no reduction. Spring (n=6) and fall (n=25) burning produced similar reductions in overstory trees by 5 years post-burn, 4.6% and 4.5%, respectively. In both cases, all of the reduction was in the smaller size classes (6-11.9 in. and 12-17.9 in.). There was no reduction in the largest size class (24+ in.) with spring burning and a small increase (+1 tree/acre) after fall burning.

Combining the data across all seasons produced similar trends as when the data was examined by season. Overall, overstory trees were reduced from pre-burn levels of 112 trees/acre to 105 trees/acre (6% reduction) at 5 years post-burn (n=55). The largest reductions were found in the smaller size classes, while the larger diameter trees were maintained at pre-burn levels.

Poles

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The mean number of trees per acre for pre-burn, 1, 2, and 5 years-post-burn and the percent change in tree densities from pre-burn levels were calculated for pole-sized trees for each burn season, as well as combined across all seasons. In general, most park units desire at least a 30% reduction in pole sized tree density.

The largest reduction (39%) in pole sized trees was observed in fall burned plots, from 112 trees/acre in pre-burn to 60 trees/acre at 5 years post-burn (n=22). Summer burning resulted in a 38% reduction in pole sized trees, from 185 trees/acre in pre-burn to 128 trees/acre at 5 years post-burn (n=20). A 3% reduction in pole sized trees was observed from pre-burn (129 trees/acre) to 5 years post-burn (103 trees/acre) with spring burning. However, the sample size was only 5 plots.

When combining the data across all burn seasons, a 35.7% reduction in pole sized trees was observed from pre-burn levels of 145 trees/acre to 93 trees/acre at 5 years post-burn (n=47).

Conclusions

This analysis provides some preliminary information to fire and resource managers in the Southwest Intermountain Region to determine if current restoration strategies in the ponderosa pine ecosystem are appropriate in respect to fire and resource management goals. In general, it appears that the total fuel load is being reduced by adequate amounts (at least 40%) between the pre-burn and immediate post-burn time period with spring, summer, and fall burning. Pole sized trees show comparable decreases between summer and fall treatments, with roughly a 40% reduction in the mean number of pole sized trees/acre between the pre-burn and 5 year post-burn time period. From the pre-burn to the 5 year post-burn period, overstory trees in the smaller size classes (6-11.9 in. and 12-17.9 in.) show the largest reduction (7.1%) in summer burning, and a smaller reduction with both spring (4.5%) and fall (4.6%) burns. The larger diameter trees (24+ in.) were maintained at pre-burn levels with spring and summer burning, and increased slightly (+1 tree/acre) with fall burns. The above results appear to be within acceptable ranges according to fire and resource management objectives for each park unit.

Continuing to monitor the vegetation and fuel plots and tracking this data into the future will provide a means for determining long term changes in forest structure and will help managers to determine the appropriate return interval for prescribed fire in this restoration phase.

Future Analysis

The next step in this process is to analyze the data using a more rigorous statistical package, such as SAS (Statistical Analysis Software), to determine the significance of our results. This future analysis will be based on the concept of a repeated measures experimental design, which takes into account the fact that each experimental unit (plot) is measured more than once, and that multiple measurements on the same plots are not independent. The data will also be analyzed under the assumptions of compound symmetry because it is not expected that measurements made closer in time (i.e. pre-burn and post-burn vs. pre-burn and 2 year post burn) are more highly correlated.

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NIFC Photos

Crown Fire, Crown Spacing, Crown Bulk Density: What's What?

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RxFx Subscription and Submission Information

Rx Effects is the newsletter of the Fire Effects Monitoring Program in the National Park Service. It is an outlet for information on Fire Effects Monitoring, FMH, fire research, and other types of wildland fire monitoring. The newsletter is annually produced 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, event schedules, and abstracts of papers or posters resulting from your program. Submissions will be accepted in any format (e.g., hard copy through the mail or magnetic files through e-mail). The goal of the newsletter is to let the Fire Effects community know about you and your program.

Rx Effects is issued each year in the Spring. The next submission deadline is 26 March 2004. If you would like a subscription or more information please see our website **www.nps.gov/yell/technical/fire/rxfx.htm** or contact Eric Miller 307-344-2474. Fire Management Office, P.O. Box 168, Yellowstone National Park, WY 82190-0168.♦

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