FIRE EFFECTS AND VEGETATION RECOVERY FOLLOWING EIGHT LARGE WESTERN WILDFIRES

Proceedings of the 3rd International Fire Ecology and Management Congress

L. B. Lentile, P. Morgan, M. J. Bobbitt, Department of Forest Resources, University of Idaho, Moscow, ID

A. T. Hudak, S. A. Lewis, P. R. Robichaud, Moscow Forestry Sciences Laboratory, USDA Forest Service Rocky Mountain Research Station, Moscow, ID

INTRODUCTION

Ecologists have long recognized the enormous variability in fire effects and vegetation response that results from even the most severe fires. Causal factors, fire effects and ecosystem response to fire vary over time and space within dynamic systems and defy simple classification. Burn severity classifications are used to describe a suite of fire effects on soil and vegetation, potential successional trajectories, and rates of ecosystem recovery. Because large-scale fires are heterogeneous in their effects across the landscape, such events provide ideal opportunities for characterizing initial fire effects and vegetation recovery across the range of burn severities.

Vegetation diversity and landscape pattern were examined relative to burn severity following eight large wildfires that burned in 2003 and 2004 in California chaparral (CA), in mixed-conifer forests in Montana (MT-W and MT-NW), and in boreal forests in interior Alaska (AK). Project goals were 1) to quantify immediate post-fire effects on soil, forest floor, and plant communities, 2) to characterize post-fire vegetation recovery, and 3) to use remotely sensed measures of burn severity to describe landscape-level fire effects.

METHODS

Field data collection

Fifty sites were established immediately post-fire across the full range of burn severities. Sites consisted of nine plots systematically arranged to span a 130 m x 130 m area, with plots composed of fifteen 1 m x 1 m subplots sampling a 9 m x 9 m area. Surface cover fractions of soil, ash, litter, etc., and their degree of charring, were estimated ocularly at all subplots; duff/litter depths and overstory canopy cover were measured at every plot; proportions of green/scorched/charred vegetation and seedling/sapling/shrub/tree mortality were estimated in one plot per site. One year post-fire, measurements were repeated in the most centrally located plot on each site. Understory species composition and cover were inventoried in four subplots per site.

Satellite data collection

Landsat data were used to calculate the delta Normalized Burn Ratio (dNBR) (Key and Benson 2002) on images taken one year before fire and immediately post-fire. Data were not included for the two fires in Alaska. Values were classified according to severity thresholds (Key and Benson 2002). Values were imported into ArcView GIS® and Patch Analyst© was used to examine spatial patterns of burn severity. Size distributions for patches of different burn severity were compared with a nonparametric multi-response permutation test (Mielke and Berry 2001). Multiple comparisons for the multi-response permutation tests were based on Peritz closure (Petrondas and Gabriel 1983) and tested for significance at the 95% confidence level.

RESULTS AND DISCUSSION

For all eight fires, species richness and understory plant canopy cover were low and non-native species were more abundant where fires burned severely. Species diversity was highest on less severely burned sites. A greater number of forbs were found when compared to other plant life forms, independent of burn severity. Post-fire plant cover was dominated by grasses in chaparral systems, forbs in mixed-conifer forests, and shrubs in boreal forests.

For individual fires, there was considerable variation in post-fire response. One year post-fire, species richness was similar in the CA and AK fires, with ~54 individual species observed. Species richness was similar in the MT-W and MT-N fires, and higher overall with ~72 species observed. Species composition was dominated by forbs independent of severity on sites in CA and MT, while shrub species were more common on burned sites in AK. Lichen and moss species were also important on AK sites, and, to a lesser degree, on the MT-NW sites. In general, mean plant cover was more similar on low and moderately burned sites in all fires, with highest cover found in CA, followed by the four fires in MT, and lowest in AK. Several species were common in terms of presence and cover contribution across the range of burn severities and across sites within a geographic region. These species may be well-adapted to the fire regime associated with the particular vegetation type, and exhibit multiple life strategies such as seed-banking and sprouting to ensure successful post-fire regeneration.

Site conditions, prefire vegetation, as well as post-fire revegetation strategies most likely explain the high variation observed in post-fire response across sites and burn severities. Preliminary results suggest that initial fire effects such as soil charring, litter and duff reduction, and tree mortality are correlated with reduced one-year post-fire understory plant cover and richness, and thus could be used as indicators of burn severity influencing vegetation recovery rates.

The proportion and pattern of patches burned in different burn severities were dissimilar across sites. Patch size was significantly different in low, moderate, and high severity in individual fires and across all fires ($P < 0.05$). In general, more of the landscape was classified as moderately burned, and moderately burned patches were largest in size. For all fires, ~ 6% of the landscape was classified as high severity with relatively small patches. Thus burn severity at both plot and landscape scales will influence successional trajectories following fires. Quantified indicators of burn severity will facilitate consistent characterization of post-fire effects and prediction of likely post-fire responses across a broad range of sites and conditions.

Table 1. Summary statistics for eight wildfires including the mean, standard error (SE) and range of patch sizes, and the mean proportion of the landscape classified as unburned or as low, moderate, or severely burned.

	Mean Patch Size (ha)(SE)	Range (ha)	Proportion of Landscape %
Unburned	6.3 (2.6)	< 1-24	25.1
Low Severity	3.7 (1.5)	1-5	27.0
Moderate Severity	14.4 (5.9)	7-24	42.1
High Severity	7.4 (3.0)	1-22	5.8

SUMMARY AND CONCLUSIONS

Vegetation recovery was lowest on severely burned sites. Unburned vegetation, as well as many small patches of low, moderate, and high burn severity having high proportions of surviving vegetation, show accelerated rates of recovery. These results suggest that variation in post-fire vegetation response is high within individual fires and across multiple fires. More work is needed to better quantify burn severity, identify post-fire effects that are indicative of longer term ecological change, and to elucidate patterns of fire effects and recovery at broad scales. Understanding patterns of vegetation that influence and that are influenced by burn severity will improve the effectiveness of strategic fuels management and post-fire rehabilitation efforts.

LITERATURE CITED

Key, C.H., and Benson, N.C. 2002. The normalized difference burn ratio (NDBR): A Landsat TM radiometric measure of burn severity. http://www.nrmsc.usgs.gov/research/ndbr.htm. US Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

Mielke, P.W. Jr., and Berry, K.J. 2001. Permutation methods: A Distance Function Approach. Springer-Verlag, New York. 352 p.

Petrondas, D.A., and Gabriel, K.R. 1983. Multiple Comparisons by Rerandomization Test. Journals of American Statistical Association 78 (384): 949-957.