Determination of Fire-Initiated Landscape Patterns: Restoring Fire Mosaics on the Landscape

Michael Hartwell
Paul Alaback

One of the key limitations in implementing ecosystem management is a lack of accurate information on how forest landscapes have developed over time, reflecting both pre-Euroamerican landscapes and those resulting from more recent disturbance regimes. Landscape patterns are of great importance to the maintenance of biodiversity in general, and particularly in relation to wildlife habitat (Noss and Cooperrider 1994). The study of historical landscape patterns and forest structures can give land managers insight into understanding large-scale temporal and spatial stand dynamics. Historical stand structures can serve as models of naturally functioning, sustainable landscapes. Additionally, comparison of the historical structures with the present can give us insights into the relations of disturbance and environment to stand development. Such understanding is essential to long-term resource planning. There are many approaches available for assessing landscape pattern and stand structure, each with its own insight and limitations. This synopsis discusses an approach of interpreting landscape patterns and their relation to disturbance history in a specific case study.

There are three fundamental approaches to determining historical landscape patterns: (1) the study of historical records or accounts, (2) remote sensing, and (3) ground-based surveys. Before attempting to describe historical landscapes, a knowledge of past anthropogenic activities and other disturbance events is essential, as disturbance is the primary factor in determining forest stand structures. A study into the anthropogenic activity might yield dates or information on forest burning by Native Americans, dates of Euroamerican settlement, and related uses of forests. Historical accounts and vegetation descriptions might be available, but such information is usually quite fragmented and subjective. For example, early surveys might only describe areas that contain large merchantable timber or areas near roads or trails. If one were to rely on this information by itself he might conclude that these forest types covered the entire landscape!

A comparison of patterns through remote sensing can characterize some aspects of broad-scale landscape changes. Aerial photos are indispensable for interpreting general patterns. However, they are limited by an inability to accurately portray specific disturbance agents and their historical role. Selective logging activities have taken place in the Interior West since the mid-nineteenth century, thus the chance of finding photos that predate Euroamerican activities is rare. Additionally, the introduction of exotic pathogens has affected conifer species composition in the Northern Rocky Mountains (Keane and Arno 1993; O'Laughlin and others 1993). Forest structure and understory patterns from photos and satellite imagery are also difficult to discern. Through remote sensing we run the risk of falsely attributing the cumulative effects of light, low mortality disturbance events to the wrong agents, or of missing fundamental changes in forest structure and function.

The only way to accurately describe historical and current species compositions, forest structures, and disturbance events is through a ground-based study. Using age class analysis of live and dead trees and fire scars, we can describe both historic and contemporary stand structure of overstory trees and identify the major disturbance agents contributing to modern stand structures.

Determination of Landscape Patterns on the Bitterroot Front, Montana

We are currently examining historic and present landscape patterns on the Bitterroot National Forest south of Missoula, Montana. Stands in this forest have experienced both selective and clearcut logging, frequent fires, and insect or pathogen epidemics. Forest records that describe timber sales are not well documented prior to 1950. If available, such records could provide dates of logging entries and could aid in reconstructing age class structures. We are determining approximate logging dates through the interpretation of radial growth release on surviving trees, ages of post-logging stands, and evidence of harvesting technology (for example, stumps created by axe, cross-cut, or chain saw).

We are using a systematic grid of plots over the landscape to describe circa 1900 and present tree species compositions and age-class structures (Arno and others 1993). We used this approach to cover extensive areas in a broad range of forest types between 4,500 and 7,500 feet (mean sea level) on the primary Bitterroot Front, an east-facing escarpment (fig. 1). This elevation range encompasses dry ponderosa pine (*Pinus ponderosa*) in the lower elevations to subalpine fir/whitebark pine (*Abies lasiocarpa*/*Pinus albicaulis*) forests. We located our study areas within the forested zones of three mountain faces (fig. 2).

In: Hardy, Colin C.; Arno, Stephen F., eds. 1996. The use of fire in forest restoration. Gen. Tech. Rep. INT-GTR-341. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Michael Hartwell is a Graduate Research Assistant, School of Forestry, University of Montana, Missoula. Paul Alaback is a professor at the School of Forestry, University of Montana, Missoula.

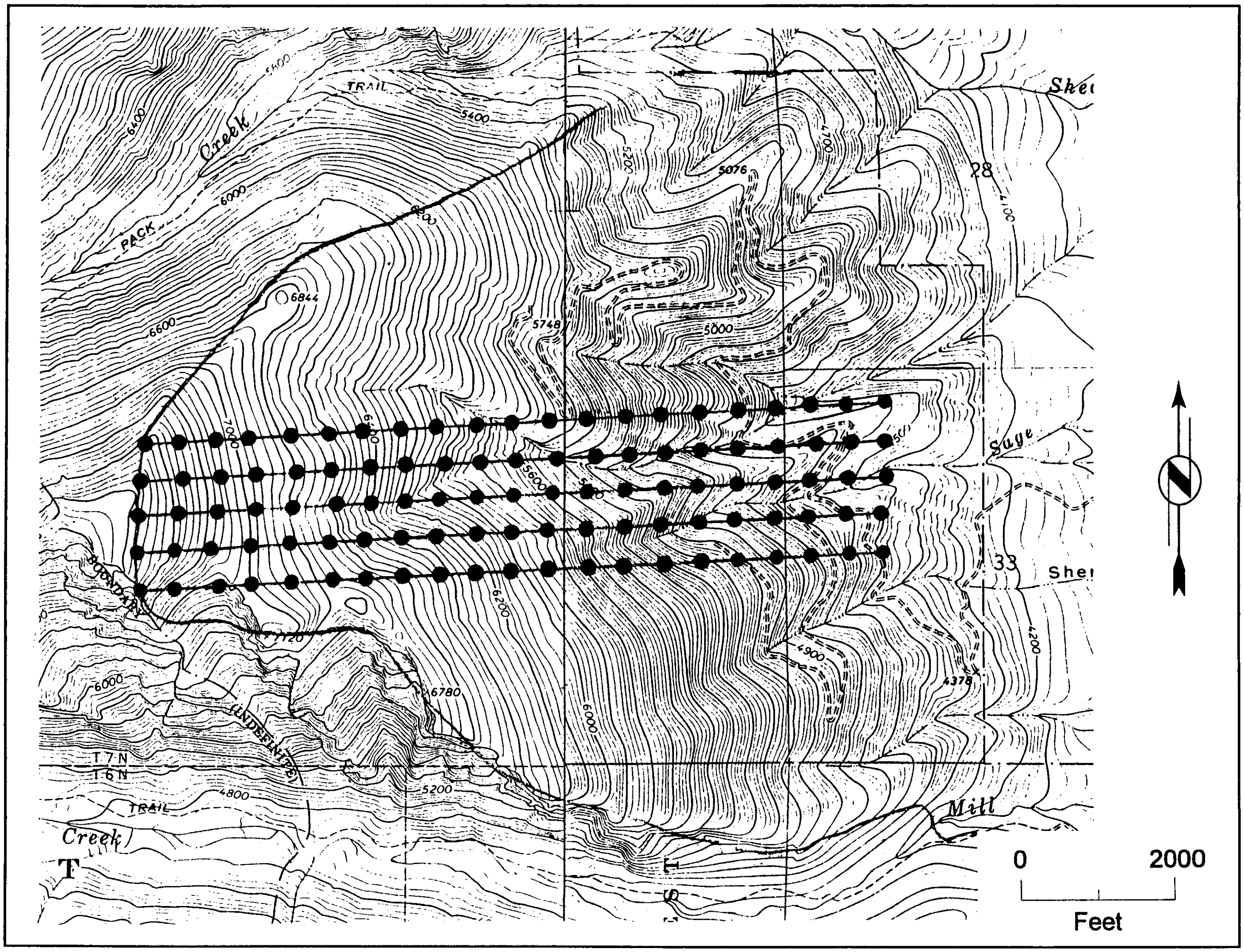

Figure 1—Plot locations in one of the three study sites on the Bitterroot Front.

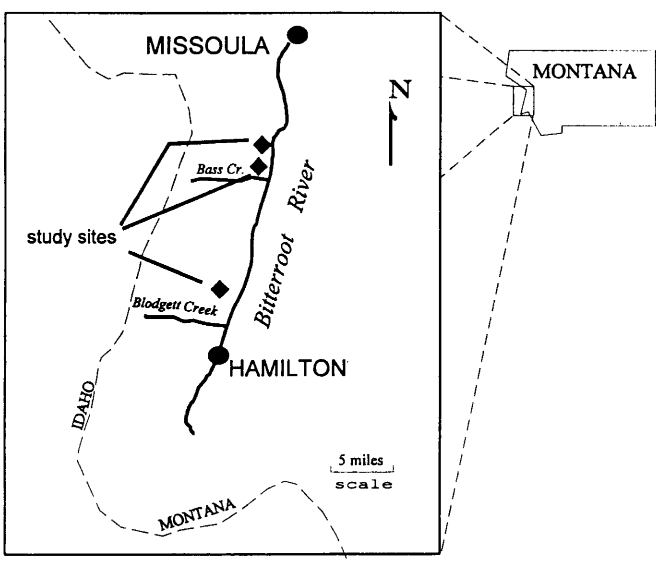

Figure 2—Map of southwestern Montana showing approximate locations of the three study sites.

Our key objectives are to describe: (1) circa 1900 and 1995 species compositions and age-class structures, (2) the relation of stand development to environment (microclimate, soils), and (3) the relation of stand development to disturbance. We recorded tree species by 2 inch diameter classes and identified cohorts of equivalent ages through increment boring near the ground line. Disturbance agents such as fire have been identified at each plot and their severity classified as nonlethal, mixed-mortality or stand replacement. Habitat types (Pfister and others 1977), aspect, slope, and elevation have been recorded at each point.

Application

Our inventory and assessment will provide a detailed picture of landscape processes reflected by shifts in species dominance and age-class structure as a result of disturbance (tables 1 and 2). This will be achieved through coordinated use of historical records, aerial photographs, and the field surveys. Such information will serve as indices to describe landscape changes in the last hundred years and provide baseline information for broadscale restoration efforts. Results from our studies will build a foundation for the implementation of ecosystem management by providing a quantitative assessment of landscape change.

Table 1—Stand composition of a lodgepole pine forest study area in 1900 and 1991, based on species basal area (Arno and others 1993).

Stand composition	1900	1991
	- - Percent composition - -	
Lodgepole pine	77	57
Subalpine fir	9	17
Whitebark pine	14	0
Mixed species	0	26

Table 2—Percentage of the areas with a given lodgepole pine class (Arno and others 1993).

Structural age class	1900	1991
	- - Percent composition - -	
Seedlings	43	14
Saplings	29	0
Poles	14	43
Mature	40	49
Overmature	14	40
Lodgepole pine absent	0	6

References

Arno, S. F.; Reinhardt, E. D.; Scott, J. H. 1993. Forest Structure and Landscape Patterns in the Subalpine Lodgepole Pine Type: A Procedure for Quantifying Past and Present Conditions. General Technical Report INT-294. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 17 pp.

Keane, R. E.; Arno, S. F. 1993. Rapid Decline of Whitebark Pine in Western Montana: Evidence From 20-year Remeasurements. Western Journal of Applied Forestry, April 1993, Volume 8 (2). pp 44-47.

Noss, R. F.; Cooperrider, A. Y. 1994. Managing Forests, chapter six in "Saving Natures Legacy: Protecting and Restoring Biodiversity." Island Press, Washington, DC.

O'Laughlin, J.; MacCracken, J. G.; Adams, D. L.; Bunting, S. C.; Blatner, K. A.; Keegan, C. E., III. 1993. Forest Health Conditions in Idaho, Executive Summary. University of Idaho, December 1993, Report No. 11.

Pfister, R. D.; Kovalchik, B.; Arno, S. F.; Presby, R. 1977. Forest Habitat Types of Montana. General Technical Report INT-34. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 174 pp.