The Concept: Restoring Ecological Structure and Process in Ponderosa Pine Forests

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Elimination of the historic pattern of frequent low-intensity fires in ponderosa pine and pine-mixed conifer forests has resulted in major ecological disruptions. Prior to 1900, open stands of large, long-lived, fire-resistant ponderosa pine were typical. These were accompanied in some areas by other fire-dependent species such as western larch. Today, as a result of fire exclusion, most stands have dense thickets of small trees and are experiencing insect and disease epidemics and severe wildfires. These forests cover about 40 million acres in the Western United States and are the focus of concerns about declining forest health (American Forests 1995; Phillips 1995).

The Bitterroot Ecosystem Management Research Project has been testing the effectiveness of different silvicultural and prescribed fire treatments for restoring ponderosa pine forests. (The Bitterroot Ecosystem Management Research Project is an effort of the Intermountain Research Station and the University of Montana's School of Forestry in conjunction with the Bitterroot and Lolo National Forests.) The following four papers report some initial findings. But first I will summarize ecological changes that have occurred and the general concepts being used in restoration treatments.

Restoring more natural and sustainable conditions is complicated by profound changes in stand composition and structure, poor tree vigor, and fuel accumulation that place many stands outside the range of historic variability. A number of studies of historical conditions in ponderosa pine forests have determined that frequent low-intensity fires (average intervals were between 5 and 30 years in most areas) over the last few thousand years were very influential in maintaining open stands dominated by pine and accompanying seral tree and undergrowth species (Arno 1988). Many of these stands were self-perpetuating in uneven-age structures as a result of mortality of small groups of trees and subsequent openings being swept by frequent light fires that favored establishment of the most fire-resistant saplings, pine, and larch (White 1985; Arno and others 1995).

In the late 1800's and early 1900's, dramatic changes occurred in most of these forests. Logging selectively removed most of the large pines, grazing often removed most of the grassy fuels, and fire suppression interrupted the historic fire regime. An abundance of saplings became established and by the mid-1900's developed into dense stands and thickets of small trees (Weaver 1943, 1967). Numbers of trees and basal areas of tree stems per acre (a rough index of tree biomass) increased markedly. By the late 1900's, this had led to suppressed growth of even the larger trees that contributed to epidemics of insects and diseases covering millions of acres (Mutch and others 1993; American Forests 1992). These trends also occurred in unlogged old growth stands where fire was excluded (Arno and others 1995). In the moist half of this extensive forest type, shade tolerant trees (primarily firs) often became dominant with fire exclusion, producing stands differing greatly in composition as well as structure when compared with historic conditions. These forests occupy semiarid environments and are highly vulnerable to drought when overstocked with trees. They are heavily used by wildlife, for instance as big game winter range, but forage has become sparse as tree cover increased.

Ironically, exclusion of low-intensity fires virtually assures eventual occurrence of large high-intensity fires that kill most trees. Roughly half of the more than 3 million acres that burned in wildfires in 1994 in the Western United States was in these ponderosa pine forests. In an active wildfire year, the expense of attempting to exclude fire from these forests can reach one billion dollars. Paradoxically, these costly attempts at suppression are often unsuccessful. In comparison, costs of restoration treatments are modest. Sometimes the proceeds from harvesting dying trees and small trees will exceed total treatment costs.

Another issue is production of smoke from prescribed burning. Large wildfires produce more smoke than prescribed fires, but land managers are only held responsible for smoke from the latter.

The general concept of restoring natural processes on publicly owned wildland forests is widely accepted. In contrast, acceptable methods for human (manager) interaction with fire-dependent forests are highly debated. The scope of the need for reintroducing fire and fire substitutes on the landscape is staggering. To deal with this, priorities must be set to consider accessible areas where treatments can be done economically and where they can help protect broader areas having high values, such as the surburban/wildland interface.

As a result of ecological and economic evaluations, natural resource managers are highly interested in returning ponderosa pine forests to more historical and sustainable structures. Such strategies involve use of different silvicultural cutting methods along with various adaptations of prescribed burning and fuel removal as described in the following two papers.

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.

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References

American Forests. 1992. Health emergency imperils western forests. In: Gray, Gerald J., ed. Resource Hotline. 8(9): [pages unknown].

American Forests. 1995. Forest health and fire danger in inland Western forests: Proceedings of a conference; 1994 Sept. 8-9; Spokane, WA: Wash., DC: American Forests. 236 p. [Harman Press].

Arno, S.F. 1988. Fire ecology and its management implications in ponderosa pine forests. In: Baumgartner, D.M. and Lotan, J.E. eds. Ponderosa pine: the species and its management; symposium proc. 1987 Sept. 29-Oct 1; Spokane, WA. Pullman, WA: Wash. State Univ. Coop. Extension publ.:133-140.

Arno, S.F.; Scott, J.H.; Hartwell, M.G. 1995. Age-class structure of old-growth ponderosa pine/Douglas-fir stands and its relationship to fire history. Res. Pap. INT-RP-481. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 25 p.

Mutch, R.W.; Arno, S.F.; Brown, J.K.; Carlson, C.E.; Ottmar, R.D.; Peterson, J.L. 1993. Forest health in the Blue Mountains: a management strategy for fire-adapted ecosystems. Gen. Tech. Rep. PNW-GTR-310. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 14 p.

Phillips, J. 1995. The crisis in our forests. Sunset. July. pp. 87-92.

Weaver, H. 1943. Fire as an ecological and silvicultural factor in the ponderosa pine region of the Pacific slope. Journal of Forestry. 41:7-14.

Weaver, H. 1967. Fire and its relationship to ponderosa pine. Proc. Tall Timbers Fire Ecol. Conference 7:127-149. Tall Timbers Research Sta., Tallahassee, FL.

White, A.S. 1985. Presettlement regeneration patterns in a Southwestern ponderosa pine stand. Ecology 66(2):589-594.