Meeting Reviews

Fire for Restoration of Communities and Ecosystems

A symposium held at the ESA Annual Meeting, Albuquerque, New Mexico, 11 August 1997. Organized by Jeanette L. Rollinger, USDA Forest Service Forestry Science Laboratory, Grand Rapids, Minnesota and John Zasada, USDA Forest Service Forestry Science Laboratory, Rhinelander, Wisconsin.

The exclusion of fire from ecosystems to which it was a frequent visitor has produced profound alterations in historic ecological conditions; therefore, fire must be an integral component of ecosystem management. That was the overwhelming message conveyed by speakers at the symposium, Fire for Restoration of Communities and Ecosystems. Speakers from land management agencies and academia addressed both the conceptual and practical bases for using prescribed fire to restore degraded or highly altered forest-dominated ecosystems. The ecological as well as the social and political complexity of using fire to achieve ecosystem objectives permeated the discussions by all speakers. Overall, their tone was optimistic regarding the future use of this tool of conservation biology.

The symposium is summarized in the context of four questions: (1) Is prescribed fire a necessary and viable option for forest land managers doing ecosystem restoration? (2) Can the operational use of fire in restoration be accomplished in a complex and sometimes hostile socio-political environment? (3) Can the natural fire regime for a particular ecosystem be defined? (4) Can natural fire regimes be duplicated or mimicked by management plans that include prescribed fire prescriptions? Each of the seven speakers provided answers to these questions as well as real-world experiences from forest-dominated ecosystems ranging from north to south and east to west in the United States.

Is prescribed fire a necessary and viable option for forest land managers doing ecosystem restoration?

Alterations in historic forest conditions caused by the deliberate exclusion of fire still are not fully understood, often because reference sites or archival data are not available. Nonetheless, changes in spatial heterogeneity, stand structure, species composition and dominance, fuel loading, and soil properties were documented by symposium speakers. They argued that fire can be used and should be used to restore fire-adapted ecosystems to conditions more reminiscent of pre-European settlement. Although the speaker's examples were limited to four geographic areas of the United States, other equally convincing arguments in support of the use of fire in restoration could be given from forested and nonforested regions throughout the whole of North America.

Several speakers from the Bitterroot Ecosystem Management Research Project located at the U.S. Forest Service Fire Sciences Laboratory in Missoula, Montana summarized their restoration work in three northern Rocky Mountain ecosystems. Robert Keane and Diana Tomback's paper described restoration efforts in western Montana whitebark pine (*Pinus albicaulis*) ecosystems. This high-elevation species has a unique seed dispersion ecology that is entirely dependent upon the Clark's Nutcracker (*Nucifraga columbiana*), a jay-like bird that gathers and caches whitebark pine seed. Northern stands of this pine have declined during the last 60 years because of epidemics of mountain pine beetle (*Dendroctonus ponderosae*) and the white pine blister rust (*Cronartium ribicola*). Declining stands are being by replaced by shade-tolerant conifers, such as subalpine fir (*Abies lasiocarpa*), which substantially alter the character and diversity of these high-elevation ecosystems. This scenario has been exacerbated by the exclusion of fire, which historically was an infrequent though important disturbance factor in establishing whitebark pine. Recent studies have shown that prescribed fire, in conjunction with silvicultural thinning, can diminish the dominance of shade-tolerant conifers while enhancing whitebark pine regeneration and growth. However, at high elevations the burning window is narrow and short, limiting the application of fire.

Stephen Arno's presentation on his and co-authors Michael Harrington and Carl Fielder's restoration work documented the profound changes that have occurred in many ponderosa pine (*P. ponderosa*) ecosystems throughout Montana and much of the western United States. In this case the culprits are fire exclusion and selective harvest of large trees. The open, uneven-aged structure of historic pine stands maintained by frequent low-intensity surface fires has given way to complex, multi-storied stands characterized by thickets of Douglas-fir (*Pseudotsuga menziesii*) and true firs (*Abies* spp.). These late-successional stands not only are unrepresentative of historical ponderosa pine structure and species composition but also are extremely susceptible to intense, stand-replacing wildfires. Restoration in these systems, however, is complicated by dense stand structures, poor tree vigor, and heavy fuel accumulations. Therefore, spot burning of fuel concentrations before complete snow melt, reducing litter accumulations around the base of large trees, and silvicultural cutting often are necessary before area-wide prescribed fire can be applied. Once a prescribed fire regime is established, these authors believe that both second-growth and residual old-growth stands of ponderosa pine can be maintained in the more open conditions that occurred before 1900.

The midelevations in the Rocky Mountains are dominated by lodgepole pine (*P. contorta*), a seral forest

type that many people associate with fire. Nonetheless, the problem of fire exclusion plagues these ecosystems as well as those elevationally above and below. Colin Hardy described the initial work that he and Ward McCaughey have done on the Tenderfoot Creek Experimental Forest in central Montana. The fire ecology of lodgepole pine is complex: natural fire regimes included intense stand-replacing conflagrations, mixed severity fires, and low-intensity surface burns, often within the same fire perimeter. The resulting ecosystems were a spatially diverse mosaic of one- and multi-aged stands. A long-term study recently has been set up on two paired watersheds within the experimental forest to test various combinations of silvicultural treatments and prescribed mixed-severity and low-intensity fires. The challenge facing these researchers is to design operationally feasible treatments to restore and maintain spatial and biological diversity in lodgepole pine ecosystems.

Moving to the southern Coastal Plain, Ron Myers of The Nature Conservancy in Tallahassee, Florida and Joan Walker of Clemson University, whose co-author was Brian van Eerden of the University of Georgia, discussed the disruption of historic fire regimes that has occurred in longleaf pine (*P. palustris*) ecosystems. This problem is compounded by anthropogenic alterations in the original landscape, leaving conditions outside the range of historical variation. Nonetheless, the authors believe prescribed fire can restore remnant natural longleaf pine forests, as well as plantations, to something reminiscent of historic conditions. Walker presented results of research in xeric longleaf forests in the upper Atlantic Coastal Plain. The objective of this research is to restore in a more widespread way the forest conditions of remnant longleaf sites, which are characterized by open pine canopies, sparse oak (*Quercus* spp.) midstories, and ground layers dominated by wiregrass (*Aristida stricta*). Fire alone, however, cannot do this job on sites where fire has been long excluded or in dense plantations where wiregrass, the primary fuel necessary to carry prescribed surface fires, is sparse or absent. Thus, silvicultural thinning of overstory pine canopies and plant introductions may have to accompany the reintroduction of fire.

Fig. 1. Restoration of ecosystems to historic conditions often will require use of prescribed burning in combination with other silvicultural or phytocultural techniques, particularly when fire has been excluded for a long time. Here thinning of thickets of young trees combined with low-intensity surface fire have been used during restoration of an old-growth ponderosa pine ecosystem.

An attempt to reintroduce fire into a degraded pitch pine (*P. rigida*) ecosystem in the southern Appalachian Mountains was described by Ron Hendrick of the University of Georgia. His coauthors included Amy Major, also of the University of Georgia, and Katherine Elliot and James Vose of the U.S. Forest Service Coweeta Hydrologic Laboratory. Their major objectives were to reduce a dense understory dominated by mountain laurel (*Kalmia latifolia*), promote pine and oak regeneration, and encourage development of herbaceous species. A single spring burn achieved mixed results. Postburn laurel stem densities were substantially reduced, but root systems vigorously resprouted. Pine and oak seedlings were common after the fire but did not persist. Top-killed oak saplings, however, resprouted and grew vigorously. Herbaceous and low-woody species richness doubled after the fire. It appears that restoration objectives in this ecosystem may only be achieved by multiple prescribed fires, possibly combined with other vegetation treatments.

Can the operational use of fire in restoration be accomplished in a complex and sometimes hostile socio-political environment?

The ultimate frustration for an ecosystem manager would be to have a well-conceived restoration plan in place that involved prescribed fire and then be told by a superior or governing board, "No, you can't do that." Equally frustrating would be to run into a buzz saw of public controversy and opposition. Yet those are the realities of wildland management in the late 20th century. Nonetheless, two of the symposium papers revealed that there is cause for optimism.

Christopher Hawver described a unique attempt at restoration in The Nature Conservancy's Albany Pine Bush Preserve. This 930-ha preserve harbors a globally rare inland pitch pine barren, as well as the endangered Karner blue butterfly (*Lycaeides melissa samuelis*). The preserve lies within the city limits of Albany and is encompassed by housing developments, nursing homes, a methane-emitting landfill, a regional airport, two major highways, and secondary roads. In this intimidating environment, fire control and smoke emissions are major concerns. Yet the

New York State legislature, in the 1988 enabling act for the preserve, actually called for prescribed burning as the primary tool in preserve management, a precedent-breaking law in a state where fire had previously been prohibited in all forested areas. More than 190 ha have been successfully burned since 1991. Extensive public notification commences months before any burn is attempted, and on the day a burning window opens approximately 100 phone calls must first be made. Smoke spotters are stationed in sensitive areas on the preserve perimeter during each burn and can close it down if conditions deteriorate. Early results have indicated that, while fire will remain the primary restoration tool, supplemental management techniques, e.g., hand felling, tree girdling, and planting, may be needed to expedite restoration efforts and approach ecosystem goals.

The symposium paper by Jane Kapler Smith, Clinton Carlson, and Stephen McCool of the Bitterroot Ecosystem Management Research Project (presented by Steve Arno) discussed the social context for restoring fire-adapted ecosystems in the western U.S. Their thesis was that fire cannot be restored to ecosystems unless we can relate the need to do so to the public. Most fire managers realize that there is no innate acceptance of fire by the rank and file; unless they can be informed or, better still, involved in the planning stage of ecosystem restoration, it is likely that many will be wary if not downright opposed to setting a woods on fire. Nonetheless, the results of a survey conducted by the authors were somewhat optimistic. In response to the question "Should prescribed fire be used to increase ecosystem diversity," 75% replied, "Yes," or had no opinion. However, they were wary of expert opinion; 50% thought scientists were biased in favor of prescribed fire. When people in leadership roles were polled, most recognized the benefits of fire, but they also were worried about the health hazards of smoke, the aesthetic aftermath of fire, and safety issues—legitimate concerns. They suggested that alternative treatments also be considered. Interestingly, although

Fig. 2. In isolated tracts of wilderness in western North America, high-intensity, stand-replacing fires may be prescribed to duplicate historic events. This lodgepole pine ecosystem is recovering nicely from such an event in a manner typical of seral, pyrophyllic species.

50% of these leaders thought education was important, 25% felt it was hopeless. The authors concluded that the following paradigm should be adopted by managers using fire in ecosystem restoration when dealing with the public: inform—listen—accommodate needs—mutually learn. They considered mutual learning to be just as important as research.

Can the natural fire regime for a particular ecosystem be defined?

Joan Walker prefaced her longleaf pine findings by emphasizing the "messy" nature of restoration ecology—objectives often are arbitrary, information is fragmentary or anecdotal, social and political constraints can be daunting, and fire itself is an intractable treatment. The ultimate "mess" is the ecosystem itself, which can be highly variable, often altered in major ways by human interventions, and either deceptively simple or depressingly complex.

A major hurdle in sorting out this mess is determining the natural or historic fire regime for a particular ecosystem, because this is the principal basis for determining the prescribed fire regime to be used in restoration. Ron Myers defined natural fire regime as a set of recurring conditions that characterize fire-maintained ecosystems; in short, a fire history. These conditions include ignition sources, climate, topography, spatial relationships, and fuel properties, as well as properties of the fires themselves: intensity, behavior, frequency, seasonality, extent, and spatial pattern. Short of a time capsule (not available the last time we checked), amassing reliable data to reconstruct these elements of a historic fire regime usually is problematic. So we piece together the information and data that we have and make inferences to fill in the blanks.

To complicate the issue further, not only did conditions, and resultant fire regimes, vary considerably in time and space over historic forest landscapes, but they have been highly altered by humans, both native Americans and the white settlers who dispossessed them. Ecological changes abound: successional and structural stages once minor on the landscape now predominate; pollution has altered ecosystem chemistry and biological relationships in many places; plant and animal species have been extirpated or severely reduced in numbers; endangered species are given a political prominence that may

far outweigh their ecological significance; and introduced aliens confound the ecology of many communities. In addition, wild land has been fragmented or has given way to agriculture, urbanization, and the infrastructure of civilization. In this context, natural fire regime becomes a will-o'-the-wisp, a benchmark that is difficult to precisely define, subject to varying interpretation by scientists and managers, problematic to convert into a workable and justifiable prescribed fire regime.

Can natural fire regimes be duplicated or mimicked by management plans that include prescribed fire prescriptions?

Although historic fire regimes, if known, are useful guidelines for determining current management approaches, Myers emphasized that we should not necessarily be attempting to recreate historic landscapes or restore fire entirely to its historic role. In some cases these objectives may be impossible or even dangerous to accomplish. A case in point would be a natural regime that included stand-replacing crown fires; in densely populated areas such fires are too risky. Instead, we should focus on designing prescribed fire regimes to meet specific conservation goals, recognizing the constraints imposed by fuel buildups, landscape fragmentation, urbanization, political edicts, and public health and safety. A prescribed fire regime then becomes, according to Myers, a repeated pattern of burning that produces a desired or predictable future condition. This future condition may require, in most cases, alteration of the range of natural fire variability, concentrating on the end of the spectrum occupied by low-intensity surface fires or occasionally mixed-severity fires (Agee 1996). The development of complex, multistrata stand structures (fuel ladders) and high fuel accumulations in many ecosystems certainly will complicate this objective. On the other hand, in remote wilderness areas in the western U.S. and Canada, prescriptions for landscape-level, stand replacement fires may be acceptable, even desirable, provided boundaries of target burn units first are secured by using prescribed surface fires or other silvicultural treatments.

A recurring theme in the symposium was that fire is not the "silver bullet" of forest restoration. Whereas fire can accomplish many restoration objectives, its effectiveness often is limited. As Secretary of the Interior Bruce Babbitt emphasized in his speech to the assembled conferees at the 1997 ESA Annual Meeting, achieving that desired future condition often will require using fire in conjunction with other silvicultural or phytocultural methods: cuttings of various kinds, tree girdling, mechanical treatments, application of herbicides, planting, or seeding. In the worst case these additional treatments may strain already-tight budgets or evoke howls from environmental purists. In the best case, timber or other products may be carefully harvested and sold, offsetting total restoration costs. The prescribed fire regime, then, becomes just one component of the overall prescription for restoration of an ecosystem.

Conclusions

On 15 February 1996 the Federal Wildland Fire Management Policy and Program Review was jointly released by Secretary of the Interior Bruce Babbitt and Secretary of Agriculture Dan Glickman. Their joint policy is that "Wildland fire will be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role" (Babbitt 1996). The goal cannot be stated more plainly than that. As ecologists and resource managers we need to bring this policy to fruition, not only on federal land but in natural ecosystems on all ownerships. The 1997 ESA restoration symposium clearly established both the need for and successful results of restoration efforts using fire as a primary tool. Certainly there are problems to overcome, and the magnitude of restoration needs is staggering, but the momentum established by the federal secretaries, symposium speakers, and many others must be maintained and accelerated if the ecologically unfounded wildland management practices of the past are to be reversed.

Literature cited

Agee, J. K. 1996. Fire regimes and approaches for determining fire history. Pages 12–13 *in* C. C. Hardy and S. F. Arno, editors. The use of fire in forest restoration. U.S. Forest Service General Technical Report **INT-GTR-341**.

Arno, S. F., M. G. Harrington, and C. E. Fielder. 1997. Restoring fire in ponderosa pine/fir ecosystems. ESA Bulletin (Supplement) **78**(3):6.

Babbitt, B. 1996. Engaging stakeholders to reinvest in prescribed wildland fire. (Text of a speech delivered at The Tall Timbers Fire Ecology Conference, Boise, Idaho, 1 October 1997.) <www.doi.gov/alcove/fire.html>

Hawver, C. A. 1997. Ecological management in an urban landscape: reintroducing fire to the Albany pine bush. ESA Bulletin (Supplement) **78**(3):16.

Hendrick, R. L., K. J. Elliot, A. E. Major, and J. M. Vose. 1997. Using prescribed fire to restore degraded pitch pine communities in the southern Appalachians. ESA Bulletin (Supplement) **78**(3):16.

Keane, R. E., and D. Tomback. 1997. Restoration of whitebark pine ecosystems in western Montana. ESA Bulletin (Supplement) **78**(3):19.

Myers, R. L. 1997. Considerations in designing fire regimes for biodiversity conservation. ESA Bulletin (Supplement) **78**(3):25.

Smith, J. K., C. E. Carlson, and S. F. McCool. 1997. The social context for restoring fire-adapted ecosystems in the western United States. ESA Bulletin (Supplement) **78**(3): 34.

Walker, J. L., and B. Van Eerden. 1997. Legacies of land use: implications for restoring longleaf pine forests with fire. ESA Bulletin (Supplement) **78**(3):37.

Donald I. Dickmann
Department of Forestry
Michigan State University
East Lansing, MI 48824
dickman1@pilot.msu.edu

Jeanette L. Rollinger
Hazard Community College
Hazard, KY 41701