RESTORING OAK ECOSYSTEMS ON NATIONAL FOREST SYSTEM LANDS IN THE EASTERN REGION: AN ADAPTIVE MANAGEMENT APPROACH

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Abstract.—The U.S. Forest Service has recently completed an ecosystem restoration framework and enacted accompanying policy to help guide its nationwide efforts. The Eastern Region is in the midst of translating the general guidance set forth in these documents to actual on-the-ground restoration. We envision a set of coordinated field demonstrations that will initially focus on oak-dominated ecosystems—ecosystems that are greatly imperiled by compositional changes to shade-tolerant trees such as maple (*Acer*) and beech (*Fagus*) due to long-term fire suppression. In collaboration with National Forests and the Northern Research Station, an adaptive management approach (learning by doing) is being promoted whereby an experimental design and a set of potential silvicultural treatments will be applied to a network of sites regionwide. Land managers, researchers, and the general public will all benefit from this "networked" field demonstration, which employs a uniform science-based method for project design, treatment selection and installation, and monitoring efforts.

INTRODUCTION

Land management continues to become increasingly complex with time as our ecological knowledge, environmental awareness, and demand for resources grow. Ecosystem restoration is one of a long list of new items that land managers now have to consider. Ecosystem restoration has a disproportional influence on land management as it embodies and simultaneously benefits many other resource endeavors, including improved biodiversity, forest health, and wildlife habitat conditions; increased representation of natural communities (including old growth) and threatened and endangered species; and the reduction of nonnative invasive species. The challenge of integrating a new mandate into land management warrants a well thought-out approach. The objectives of this paper are to do just that by 1) providing a brief history of ecosystem restoration as it pertains specifically to the U.S. Forest Service (USFS); and 2) proffering the use of adaptive management principles to design a network of integrated field experiments for learning and demonstration across National Forests of the Eastern Region.

NATIONAL ECOSYSTEM RESTORATION FRAMEWORK

Public interest in ecosystem restoration has burgeoned across America, bolstered in part by catastrophic wildfires of the western United States. Growing public concern helped galvanize and propel support for political action. Legislation followed in the form of the President's Healthy Forests Initiative (2002) and the Healthy Forests Restoration Act (2003). Attempting to implement this legislation underscored the need for a more holistic, overarching approach involving ecosystem restoration. This realization, in turn, spurred the need for clear language on the subject; specifically, what is ecosystem restoration and how can it be attained?

Although the USFS has had a long history of rehabilitating degraded lands (in particular the "lands that nobody wanted" in the eastern United States [Shands and Healy 1977]), actual policy and direction on ecosystem restoration were lacking. In response, the USFS established a team to help formulate the necessary steps to guide ecosystem restoration efforts on National Forests and Grasslands (Day et al. 2006). The resulting framework adopted a pre-existing definition for ecosystem restoration (the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed [SER 2004]) and provided the following guiding principles:

1) Seek and set goals for restoration only as societal choices; public involvement is key.
2) Make operational decisions at the lowest possible levels in an organization.
3) Consider the effects of restoration at local and landscape levels.
4) Give priority to restoring ecosystem processes, such as hydrologic pulses for rivers and streams or prescribed burning for fire-dependent ecosystems.
5) Establish objectives for the long term.
6) Recognize that ecosystems are dynamic and that change is inevitable; avoid "static endpoint" thinking.
7) Use multiple sources of relevant information, such as historical records, scientific studies, practical experience, and indigenous knowledge to set targets/benchmarks for evaluating progress based on monitoring.
8) Deal with uncertainty by using adaptive approaches to restoration.
9) Design and implement monitoring as part of restoration.
10) Learn as you go—use the feedback loop not only to modify treatments but also to modify objectives to incorporate new information or changing social or ecological needs.

The framework is purposefully general for application across a wide variety of ecosystems managed by the USFS. As such, it is meant to serve as a foundation to which information and strategies of increasing resolution can be added to help National Forests and Grasslands implement ecosystem restoration on the ground. The USFS's dedication to this effort has been further demonstrated by its recent adoption of official restoration policy (USDA FS 2008).

EASTERN REGION PLANNING FOUNDATION

Land and resource management plans guide activities that take place on individual National Forests and Grasslands. It is through these management plans that opportunities for ecosystem restoration are identified and eventually implemented at the project level. The release of the ecosystem restoration framework and ensuing policy was fortuitous for the Eastern Region, where many National Forests/Grasslands had recently revised their individual land management plans (Fig. 1). As such, the Eastern Region was well positioned to begin restoration efforts with framework guidance, policy, and new management plans. A basic question ensued: "How can management and research at the Regional level best help eastern National Forests/Grasslands in their quest to restore ecosystems?"

IMPLEMENTATION OF RESTORATION THROUGH ADAPTIVE MANAGEMENT

A key role of USFS Regional Offices is to bring a broader perspective to issues, initiatives, or projects, especially those that span multiple National Forests and Grasslands or involve multiple partners or ownerships. Ecosystem restoration is a prime example – a multifaceted topic requiring broad integration for success. So, how best to embark on ecosystem restoration? One promising way is by taking an adaptive management approach (Walters and Holling 1990, Stankey et al. 2005). This approach is ideal in situations where high levels of uncertainty exist, which is indeed the case in restoring eastern U.S. ecosystems long affected by human manipulation (e.g., cutting, overgrazing, drainage, and introduction of nonnative pathogens and plants).

Adaptive management is founded on a formalized learning process that links directly to decision-making. Basically, it treats on-the-ground actions and policies as hypotheses from which we gain learning, which then provides the basis for modifying subsequent actions and policies (Stankey et al. 2005). A four-phase management cycle has been proffered that embraces learning, helping speed the acquisition and transfer of new knowledge

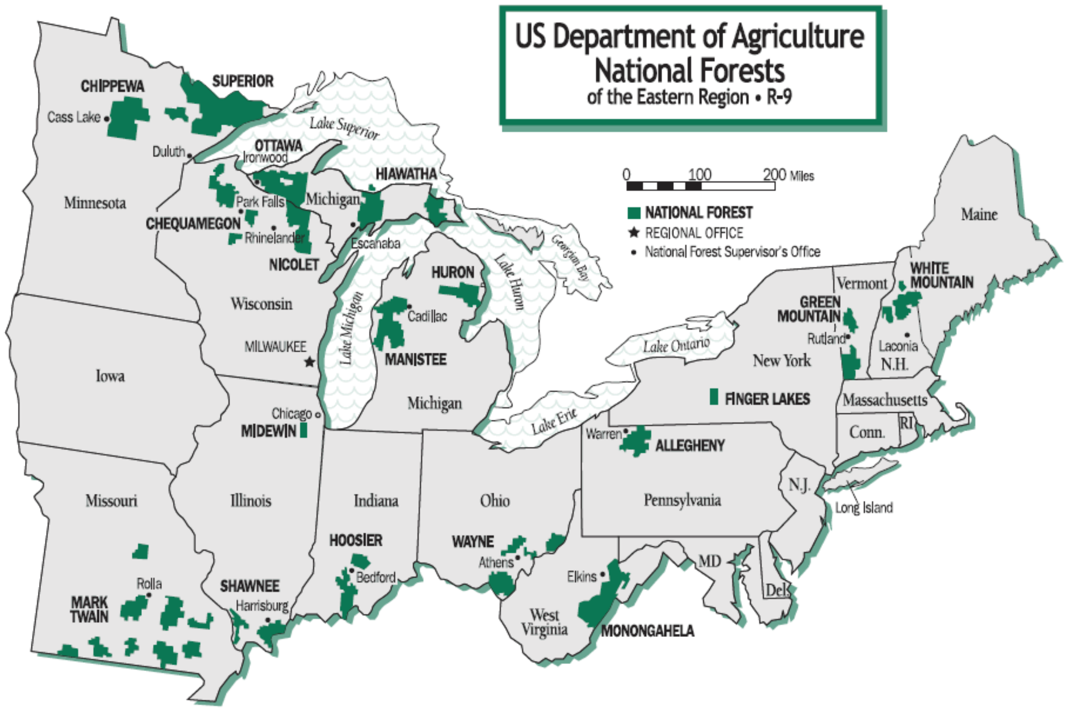

Figure 1.—The U.S. Forest Service Eastern Region and component National Forests and Grasslands.

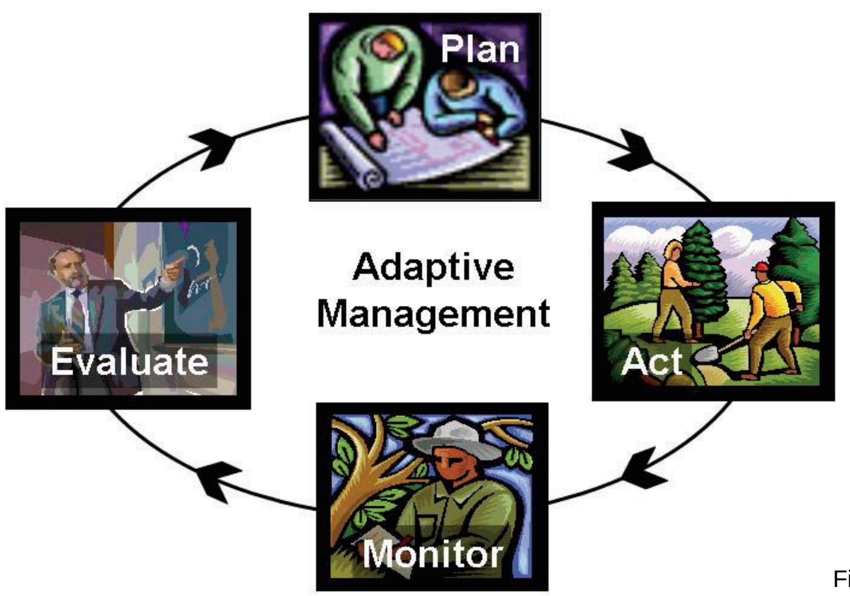

Figure 2.—The adaptive management cycle.

to management action (Fig. 2). In the first cycle, plans are constructed on existing knowledge, experience, and organizational goals. Actions are initiated on the ground and their effects monitored with scientific guidance (e.g., experimental design and layout, measured variables, appropriate data analyses). Monitoring results are evaluated in the final phase, which might trigger the cycle to reinitiate if existing practices are not meeting expectations. Practices failing to meet expectations can be dropped, reformulated, or replaced with new promising ones during the planning phase of the next cycle. Long-term commitment from all parties is essential to successfully carry out adaptive management and accrue its benefits (Bormann et al. 2007).

Employing an adaptive management approach for ecosystem restoration requires many steps, some of which run concurrently. First, the agency's intention to pursue ecosystem restoration must be conveyed to employees, potential partners, and the general public. Management opportunities for ecosystem restoration must be identified by National Forest/Grassland staff according to individual land management plans and affiliated field projects. Relevant research must be identified and interested scientists contacted to ensure best available science is used in all stages of planning, implementation, and monitoring.

Efficiencies can be maximized by developing an integrated network of study sites using a uniform experiment design and data collection methods (Yaussy et al. 2008). This unified approach allows for a preferred set of treatments to be identified and evaluated across a wide variety of conditions, forming a network of demonstration sites (for education) that meets scientific rigor (for true learning). Further efficiencies would be attained by pooling data for improved statistical analysis and trend detection. Some flexibility in treatments is acceptable, perhaps even desirable, so long as data sharing and analysis are not compromised. A strong research-land management partnership is required to ensure ecosystem restoration success, which by necessity requires a long-term commitment. Joint discussions should be held among researchers, land managers, resource specialists, and partners, whereby the above steps (and personnel carrying out those steps) are clarified to achieve ecosystem restoration.

ECOSYSTEM SELECTION FOR FIELD DEMONSTRATION

Ecosystem restoration is best demonstrated in the field. Fortunately, many individual restoration projects are already underway as National Forests/Grasslands implement their new land management plans. By linking these and future restoration projects across multiple Forests and Grasslands, we can demonstrate the advantages of taking a broader view through regional-scale analysis and evaluation. However, networking sites for data pooling and joint analysis requires focus on a single forest type or ecosystem. Selecting a representative ecosystem in which to employ this networked approach is difficult as the Eastern Region comprises a diverse number (from tallgrass prairies to sub-boreal conifer forests) with a variety of restoration needs. Indeed, all ecosystems are important and many are in dire need of recovery. For instance, red spruce forests in Appalachia have been severely affected by exploitive logging and wildfires of the late nineteenth and early twentieth centuries; only 12,000 ha of the original 600,000 ha currently remain in West Virginia (Rentch et al. 2007). Tallgrass prairies and associated oak savannas are considered the most severely degraded ecosystems on the North American continent, with virtually no original prairie land left in a pristine state (Nuzzo 1986, Packard and Mutel 1997).

Ultimately, it made sense to concentrate efforts on an ecosystem having a large geographic extent (to maximize the number of demonstration sites and applicability across the Region) with a well documented history of ecological alteration or degradation. To aid this endeavor as well as to help define reference conditions, we created a literature database of more than 500 articles that cataloged presettlement composition, structure, and disturbance regimes and post-settlement land-use impacts for the entire eastern United States. While compiling this database, which included information from historical, paleoecological, dendrochronological, fire-scar, and land survey records, we identified three broadly distributed ecosystems that stood out as having been heavily altered by European activity: 1) the loss of hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*) in former conifer-northern hardwoods (Thompson et al. 2006, Schulte et al. 2007); 2) the near elimination of the tallgrass prairie-oak (*Quercus*) savanna mosaic in the Midwest (Transeau's [1935] "Prairie Peninsula," Anderson 1998); and 3) the ongoing conversion of oak-dominated systems to maple, beech, and other shade-tolerant trees (Nowacki and Abrams 2008).

The following logic was employed in ecosystem selection. In regards to the restoration of conifer-northern hardwoods, the prospects of re-establishing the conifer component look quite dim, especially for hemlock (Gustafson et al. 2007). First, thinning treatments would be needed to reduce hardwood (especially maple) competition in both the overstory and understory so that growing space would be made available for conifer regeneration. The lack of local seed sources due to preferential conifer removal by past logging and fire would require planting nursery stock in many locations—a substantial undertaking and expense. Moreover, even if conifer regeneration were successfully established, overbrowsing by white-tailed deer (*Odocoileus virginianus*) would threaten conifer growth and advancement in many areas (Alverson et al. 1988), necessitating additional control costs (e.g., fenced deer exclosures). Lastly, present-day investments into hemlock are questionable in light of the uncontrolled spread of the highly lethal hemlock woolly adelgid (*Adelges tsugae*) (Orwig and Foster 1998). In spite of these challenges, conifer restoration into northern hardwood forests is taking place on some National Forests where feasible.

Because of ownership patterns, the USFS's ability to effect change on the tallgrass prairie-oak savanna mosaic is largely limited to the Midewin National Tallgrass Prairie (Illinois) and Mark Twain National Forest (Missouri). Moreover, these units are already actively pursuing prairie-oak savanna restoration through prescribed burning.

Given the above situation, the expansive oak-dominated woodland-forest complex, which covers a sizable portion of the Eastern Region, is the logical choice for a multi-site restoration project. The benefits of restoring oak systems would be vast, greatly aiding mast-dependent wildlife populations and the rejuvenation of allied shrubs and ground flora requiring high-light conditions (Packard and Mutel 1997, McShea and Healy 2002). Research indicates that the near-universal conversion to shade-tolerant species is largely preventable through the intervention of silvicultural treatments, especially the reintroduction of fire (Brose et al. 2001; see also Dey and Fan this volume). Even in the presence of overabundant deer populations, it is ultimately the lack of understory light that causes the mortality of oak regeneration and associated ground flora (Anderson and Schwegman 1991, Oswalt et al. 2006, Yuska et al. 2008). A variety of silvicultural treatments look promising to improve light conditions and reduce competition, including thinning, prescribed burning, and herbicide treatment, either singly or in combination (Brose and Van Lear 1998, 1999; also Dey this volume).

CONCLUSION

The recently published ecosystem restoration framework and policy reaffirms the U.S. Forest Service's commitment to restoring ecosystems (Day et al. 2005, USDA FS 2008). With the recent completion of most Land Management Plans in the Eastern Region, National Forests and Grasslands are poised to initiate restoration efforts using framework guidance and policy. Since ecosystem restoration entails scientific knowledge, a broader landscape perspective, and multiple ownerships, the Eastern Regional Office has partnered with the Northern Research Station and The Nature Conservancy to facilitate these efforts. An adaptive management approach is envisioned whereby National Forests and Grasslands can collectively benefit through project networking. Specifically, by employing standardized methods of project layout and data collection, participants can test and compare different restoration techniques through shared data for a given forest type. Researchers will help in the experimental design and monitoring protocols, USFS ecologists and silviculturists will pool their knowledge to select the most promising restoration treatments, and resource specialists will implement and monitor treatments at the field level. We envision participants from both within and outside the agency learning to overcome significant challenges together as we restore oak ecosystems on the National Forests and Grasslands of the Eastern Region.

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