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Developing a Unified Monitoring and Reporting System: A Key to Successful Restoration of Mixed-Oak Forests Throughout the Central Hardwood Region

Daniel A. Yaussy, Gregory J. Nowacki, Thomas M. Schuler, Daniel C. Dey, and Eugene J. DeGayner

ABSTRACT

Many national forests and grasslands in the Central Hardwoods region of the United States recently have undergone Land Management Plan revision, which include management areas that promote restoration through a variety of management activities. Monitoring is a vital component of adaptive management whereby the effects from a variety of treatments (including controls) can be analyzed and compared all within a landscape context. A statistically sound and cost-effective opportunity is presented through a unified monitoring effort for national forests spanning the Central Hardwoods region. Statistical power will be gained by increased replications across the landscape and cumulative effects will be addressed more comprehensively. Sharing a common protocol for monitoring activities and a reporting system will enable collective analysis and inference. Challenges will undoubtedly arise in forming a unified monitoring system across multiple forests. The objectives of each forest's management areas and the measures of restoration success need to be similar and reconcilable among the forests. The process of developing and implementing a unified monitoring system must be mutually accepted and financially supported by participating Districts, Forests, Regions, and Research Stations.

An opportunity to efficiently and effectively monitor the ecological restoration of Central Hardwoods region is taking shape. It may be economically beneficial to the Regions and the forests if quick action to take advantage of the "economies of scale" available in designing and collectively implementing a unified monitoring system across forests occurs before each forest commits time, effort and funding to develop their own monitoring system.

Keywords: central Hardwoods, ecosystem restoration, monitoring, surface fires, adaptive management

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Daniel A. Yaussy is a research forester with the Northern Research Station, Forestry Sciences Laboratory, 359 Main Road, Delaware, OH 43015-8640. **Gregory J. Nowacki** is the regional ecologist for the Eastern Region, 626 East Wisconsin Avenue, Milwaukee, WI 53202. **Thomas M. Schuler** is a research forester with the Northern Research Station, Timber and Watershed Laboratory and the Fernow Experimental Forest, Parsons, WV 26287. **Daniel C. Dey** is a research forester with the Northern Research Station, 202 ABNR Building., University of Missouri-Columbia, Columbia, MO 65211-7260. **Eugene J. DeGayner**, is a wildlife ecologist leading the National Wildlife Program, Stop Code 1121, 1400 Independence Ave, SW, Washington, D.C. 20250-1121.

INTRODUCTION

Much of the eastern United States was covered by oak-dominated forests (*Quercus sp.*), woodlands, and savannahs prior to Euro-American settlement. Charcoal and pollen records (Delcourt 2002), fire-scars (Guyette and others 2006), and anecdotal accounts from early Euro-American settlers (Whitney 1994) indicate the widespread use of fire by Native Americans to manage habitats. Euro-Americans continued, and possibly increased, burning practices on many of these landscapes (Delcourt 2002, Schuler and McClain 2003) until fire suppression policies were implemented in the 1920s.

Oak-hickory remains the most abundant forest type in the United States, with oak dominated stands that regenerated prior to fire suppression. Because fire was removed as a natural process from these ecosystems, understories readily converted to shade-tolerant, fire-sensitive species such as red and sugar maples (*Acer rubrum, A. saccharum*), beech (*Fagus grandifolia*), and blackgum (*Nyssa sylvatica*) (Abrams 1992, 1998; Schuler 2004). Under these conditions, subsequent timber management that removes overstory canopies, releases these species to dominate the future forest (Abrams and Nowacki 1992). In heavily disturbed areas that are exposed to full sunlight by clearcutting, germinants of shade intolerant species such as yellow-poplar (*Liriodendron tulipifera*) and black cherry (*Prunus serotina*) grow rapidly in height to dominate the regeneration (Brashears and others 2004, Loftis 1990).

In the recent round of Land and Resource Management Plan (forest plan) revisions conducted by the national forests and grasslands in the Eastern and Southern Regions, there has been an increased emphasis on restoring and sustaining oak-dominated ecosystems (Forest Service 2004a-d, 2005a, 2005c, 2006a-e, 2007a-b). Multiple benefits are achieved by maintaining oak-dominated ecosystems through active management, including timber products, wildlife food (mast) and habitat, recreation, and rare plant species (Hutchinson and others 2005, McShea and Healy 2000). A framework for ecosystem restoration established by the National Forest System (Day and others 2006) provides a definition of ecosystem restoration and guiding principles such as a National Strategy and the need for collaboration in attaining these goals. Integration and collaboration within the agency are necessary to maximize limited resources because the magnitude of ecosystem restoration needs greatly exceeds the financial capacity of disparate units of the Forest Service or other resource management organizations. Equally important are external partnerships as ecosystems do not stop at administrative boundaries.

As stated in their forest plans, each national forest (NF) within the Central Hardwoods region will monitor their activities to determine if management actions are achieving the desired future conditions (DFCs). The movement toward these DFCs will be most easily evaluated if they are written with reasonable quantitative metrics as defined in forestry, ecology, and wildlife sciences. Current management activities include: harvesting, prescribed fire, herbicide treatments, and deer abatement techniques. Most monitoring schemes require collection and summarization of data to determine pre- to post-treatment changes and whether advances toward DFCs are truly taking place. Data collected from a single site can be used to explain specific management effects on that specific area. However, credibility is reduced when those results are extrapolated to other sites. For instance, if the Shawnee NF in Illinois finds that frequent, low-intensity fire improves plant biodiversity, it may be sensible to conclude that the same will hold true on the Mark Twain NF (Missouri) or Hoosier NF (Indiana). However, without data from neighboring forests, evidence supporting this claim could be called into question for the Uwharrie NF (North Carolina). As such, the networking of sites allows data comparisons of local vs. regional trends with more confident extrapolation of findings. The National Ecological Classification System (ECS) can be used to stratify the landscape and help guide placement of sites for monitoring. As data accumulate, we are more confident about making claims of positive movement toward DFCs as well as our understanding of what might cause differences in effects. The level of data collection needed to recognize a trend may be more than a single NF would be willing to fund. However, if the intensity of data collection was distributed across several NFs with similar management areas, in similar ECS units, and DFCs, the cost burden would be reduced substantially while maintaining the statistical power of the monitoring. Understanding the differences between sites can be quantified and interpolation of results to new sites is more defensible using an ECS framework.

The need and opportunity exists to establish a coordinated, unified monitoring system for managed oak-domi-

nated stands in eastern forest. However, there are many impediments that must be overcome in the adoption of such a monitoring system. This paper identifies some of these issues.

OBJECTIVES

Several NFs in the Central Hardwoods region have management areas on which they intend to utilize partial harvests and prescribed fire for restoration purposes. In this context, partial harvests are defined as shelterwood harvests and thinning from below, removing the mid-story and leaving the most dominate trees. However, restoration goals and the silvicultural practices used are not necessarily identical among management units or NFs. Typically, forest structure, oak regeneration, and habitat development are listed as objectives of the prescriptions, but these may be given different priorities among the several NFs. For instance, the Wayne NF (Ohio) intends its "Historical Forest" management area to mimic pre-Euro American settlement forests: open woodlands maintained with frequent, low-intensity fires. This forest structure should provide critical habitat for native wildlife species that co-evolved with this vegetation type. Timber production will be a by-product of these management efforts. On the Cherokee NF (Tennessee), restoring historic plant assemblages is the goal of the 9.H management prescription. The intent is to reduce stand density by partial harvesting and manipulate or maintain understory structure. The maintenance will be accomplished using low-intensity fires to create the proper conditions for encouraging oak reproduction and its recruitment into the overstory to provide sustainable woodland, barrens, or savanna ecosystems. The Daniel Boone NF emphasizes animal habitat diversity for prescription area 1.K. It is probable that a single monitoring scheme could be developed that would adequately evaluate the effectiveness of the treatments in attaining the various objectives on the different forests.

The proposed unified monitoring system requires measuring several relevant factors that help detect changes due to management or non-anthropogenic causes including: forest structure and composition, fuel loads, wildlife populations, plant diversity, water quality, and tree regeneration. Knowledge of the stand history, initial vegetation conditions, structure, composition, size distributions, densities, and other overstory and understory features are essential to interpreting the effectiveness of management practices toward achieving the DFC. Standards of factors to be measured will be developed to characterize initial starting conditions. There may be resistance from those in the field that are most knowledgeable about their specific forest conditions. They may feel that their ecosystems differ from other oak-dominated systems enough that a one-size-fits-all approach will not provide them with the information necessary to evaluate the changes specific to their forest. The program design will need flexibility to allow each NF to add local variables if needed without sacrificing the integrity of the regional monitoring scheme. For example: timber rattlesnakes are a species of interest in the state of Ohio. Therefore, if there is a rattlesnake population within their Historical Forest management area, the Wayne NF may wish to add a monitoring program to evaluate the effects of the management practices on the rattlesnake population. However, the addition of local variables requires more intensive sampling to detect changes at that specific site.

PROCESS

Networking and collection

Successful implementation of a unified monitoring program for the NFs in the Central Hardwoods region requires the cooperation and support of District, Forest, and Regional levels of the Forest Service. This endeavor would require a strategic monitoring plan and implementation standards and guidelines developed through collaboration among the Eastern and Southern Regions and the Northern and Southern Research Stations. The Eastern Region's "Courageous Conservation: A sustainable future, a legacy of restoration" strategic framework, promotes this type of collaboration through its mission as a "Partnership Agency" (Forest Service 2005d) and goal of "Protecting ecosystems across boundaries" (Forest Service 2005b).

Responsibilities and funding sources would need to be negotiated and formalized to ensure continued implementation of the program. Key participants will enter and exit positions whose duties include management, data collection, analysis, and reporting. The importance of maintaining the program on each forest will need to be communicated to these participants by their supervisors. Establishment of field data points must be timely, monumented, and fully recorded. Initial training of field data collection crews and continued quality control must be assured. The Forest

Service has an Inventory and Monitoring Institute and the Northern Station has the Northern Monitoring Program, both of which would be able to assist in organizing this unified monitoring program. Accessing the expertise of these groups should prevent "reinventing the wheel" regarding monitoring protocols. Tying into existing multi-organizational networks, such as The Natural Conservancy's Fire Learning Network, also would be advantageous.

Once a baseline of common variables and protocols is implemented, a standard database system would allow for pooling and sharing data and results for local and regional analyses. No network exists within the National Forest System for coordinating the data from different forests. Creating this network would be an ongoing process throughout the span of the restoration projects. Once the data are assembled, researchers will examine the response to treatments across a much broader environmental template. Personnel responsible for regional analysis will be identified in advance and can help to ensure monitoring protocols are followed. Analysis of monitoring data following oak restoration activities increases the feasibility for collaboration among NF and Research Station personnel.

The magnitude of the coordination and cooperation necessary to ensure the successful and continued implementation of a unified monitoring program will probably be the most difficult obstacle to overcome. It could start with a commitment by the Eastern and Southern Regional Foresters and the Station Directors of the Northern and Southern Research Stations and formalized in a memorandum of understanding signed by all parties.

The program would have to provide career and cost reduction benefits to be accepted widely. The monitoring would need to provide evaluations of management activities that are a higher quality and a lower cost than if each NF implemented individual monitoring programs. Scientists would buy into the program if the available data was of the quality and intensity necessary for rigorous statistical analysis. FIA data is used by many scientists for regional analyses. The exact locations of the data collection points are not released to protect the privacy of the cooperating land owners, limiting the ability of researchers to incorporate other georeferenced data into their analyses. Scientists would not have to worry about the limitation on data point locations for the monitoring data collected on NFs.

Adaptive Management

Once a unified monitoring program for the Central Hardwoods region is in place and generating data, individual NFs may have the option of adjusting management prescriptions for adherence to DFCs. DFCs may also need to be altered to fit redefined management objectives especially if the management changes can be quantified and analyzed as extensions to the existing practices. In the process of restoration, there may be one set of management activities used to move from the current state to the DFC, then a shift to a different set of management activities to maintain the DFC. Sustaining the desired state may require periods of variation in activity to allow for regeneration and recruitment of the regeneration into the overstory of the savannah or woodland. There is a possibility that the practices will change drastically enough that the management areas being monitored no longer fit into the monitoring program (e.g. no treatment). The overall monitoring program should not suffer greatly if a few NFs withdrew. The withdrawing NFs would still have a functioning monitoring program, albeit with less statistical power.

CONCLUSION

Many NFs in the Central Hardwoods region have revised forest plans that include management to restore and sustain oak-dominated ecosystems using thinning, regeneration harvests, and frequent, low-intensity prescribed fire. Even though the management practices and DFCs may differ in some aspects, it should be possible to design a unified monitoring program for use by those NFs involved in restoration. Most forests will collect more than this baseline data, but establishing a core set of variables and protocols will provide the ability to pool the data for improved evaluations. It would be a great benefit to all involved if this unified monitoring system could be developed before each forest spent the time and money developing its own stand-alone monitoring systems.

A new network or framework for pooling the monitoring data once it has been collected will increase the accessibility and usefulness to scientists. An integral part of this framework will be the personnel assigned to perform the analysis. The analysis will cover many interrelated components of oak-dominated ecosystems and will require several integrated teams to complete.

The greatest obstacle to implementation of such a program is obtaining the cooperation and support of all the various Forest Service staffs involved. Leadership from the Regional Offices and the Research Stations will be critical. Individual NFs and numerous laboratories within the Stations would have vested interests for participating. Essentially, a coordinated monitoring system applied to several forests in a forest type is a new way of doing business that leverages the assets of each entity. It will make monitoring more affordable and meaningful, research more applicable, management more effective, and increase the Forest Service's public accountability. This coordinated effort can begin with restoration of mixed-oak forests, but the framework and relationships could be used to address many management problems too big for any one entity to handle alone.

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