OVERVIEW OF ECOSYSTEM MANAGEMENT RESEARCH IN THE OUACHITA AND OZARK MOUNTAINS: PHASES I–III

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Abstract—When the shift away from clearcutting and planting on the Ouachita National Forest was implemented in the early 1990s, it became apparent that research support for reproduction cutting methods that employ natural regeneration in shortleaf pine stands in the Interior Highlands was lacking. To fill that need, research scientists and land managers established a three-phase research program that included demonstration case studies, replicated stand-level studies, and landscape studies at the watershed scale. This review of each of these three phases includes a brief history and justification, an overview of objectives and a summary of the study design, and a report on the status and future work planned in each phase.

INTRODUCTION

The development of the Land and Resource Management Plan on the Ouachita National Forest (NF) in the 1980s triggered considerable debate. In 1986, the release of the first draft of the plan to the public called for the continued and widespread use of clearcutting and planting as a primary means to regenerate shortleaf pine (*Pinus echinata* Mill.) and pine-hardwood stands in Ouachita Mountains. That draft attracted 11 appeals from individuals and organizations, and was in part responsible for a change in leadership on the Ouachita NF (Curran 1994). Between 1986 and 1990, the Forest Supervisor on the Ouachita NF led the effort to revise the draft. With the release of the Amended Land and Resource Management Plan (U.S. Department of Agriculture, Forest Service 1990), all appeals except one were dropped (Curran 1994). The locally renowned walk in the woods by two native Arkansans, Forest Service Chief Dale Robertson and Senator David Pryor, is described elsewhere (Robertson, in press).

That walk in the woods led to the establishment of the Ouachita NF as a "Lead Forest" under the New Perspectives Program. The Southern Forest Experiment Station (now part of the Southern Research Station) was directed by the Chief to provide scientific support for a shift in management philosophy away from clearcutting and planting, and toward even-aged and uneven-aged high-forest reproduction cutting methods that rely on natural regeneration. The Monticello-Crossett Forestry Sciences Laboratory was headed at that time by Dr. James Baker, who had been a college classmate of Chief Robertson. That laboratory had considerable expertise in silvicultural treatments using natural regeneration of mixed loblolly (*P. taeda* L.)-shortleaf pine stands of the upper west Gulf Coastal Plain. However, there was not much experience there or elsewhere in applying even-aged or uneven-aged silvicultural systems using natural regeneration of the pure shortleaf pine stands found across the Interior Highlands (Baker 1994).

As a result, a research team was assembled to develop silvicultural options for shortleaf pine and pine-hardwood forests, and to study the effects of those options on a host of resource attributes and values of interest to managers and scientists. With the advent of the ecosystem management approach for national forests and grasslands in 1992 (Robertson, in press), the work of this team came to be known as the Ouachita Mountains Ecosystem Management Research Project. With the Southern Research Station in the coordinating role, 10 research units have played a part in the research program. Other cooperators have included the Ouachita NF, the Ozark-St.Francis NF, Region 8 headquarters of the USDA Forest Service, more than a dozen universities in the region, Weyerhaeuser Company, the National Council of the Pulp and Paper Industry for Air and Stream Improvement (NCASI), and several State agencies and nongovernmental organizations.

Highlights of the establishment of the program included close working support with academia, establishment of a research liaison position on the staff of the Ouachita NF to work with the research team, and the development of independent funding through supplemental appropriations from Congress and through NCASI. Since then, the working relationship between the Ouachita NF and the Southern Research Station has been exceptionally close.

ORGANIZATION OF THE RESEARCH PROGRAM

The shortleaf pine forest type covers a majority of the area managed for timber production on the Ouachita NF. This forest type is dominated by shortleaf pine and also contains a minor and varying hardwood component that includes white and red oaks (*Quercus* spp.), hickories (*Carya* spp.), and elms (*Ulmus* spp.). Shortleaf pine and pine-hardwood stands in this forest type are typically found on south and southwest-facing slopes in the Ouachita Mountains, the Arkansas River Valley, and the Boston Mountains in Arkansas and Oklahoma. As a result, research study sites were located on the Ouachita NF in Arkansas and Oklahoma as well as the southern portion of the main unit of the Ozark NF in the Boston Mountains of Arkansas.

The Chief's interest was in the demonstration of alternatives to clearcutting and planting that could be quickly implemented and shown to professional resource managers and the

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public. That mandate quickly developed into a three-phase program of research and demonstration. Mersmann and others (1994) reviewed the origins of the project in detail, and they described operational planning procedures and public involvement in phases I and II.

Phase I—Demonstration Stands

The phase I demonstration stands were established in 1990–91 immediately after inception of the project. These demonstrations were intended as examples of the alternatives to clearcutting that were being considered. They allowed people inside and outside the agency to see and discuss those alternatives. They were established by modifying existing open timber sale projects; with contractor approval, sales were modified to illustrate the seed tree, shelterwood, single-tree selection, and group-selection reproduction cutting methods. Twenty-two demonstrations were established in three general areas: (1) the Winona Ranger District (RD) for tours originating in Little Rock, (2) the Womble RD for tours emanating from the Supervisor's Office in Hot Springs, and (3) the Kiamichi RD and Choctaw RD in eastern Oklahoma for tours originating there. The Womble RD tour stops were the most frequently visited. One of the phase I stands on the Womble RD that features classic uneven-aged foliar canopy structure in shortleaf pine is still used for demonstration.

By the time the phase I tours were generally retired in 1994, they had supported more than 50 tours, with an estimated attendance of more than 1,000 participants. As unreplicated case studies, these demonstration stands provided little of scientific value. But they had tremendous value as a tool for allowing people to envision the changes embodied in the new perspectives and ecosystem management concepts being put forth at the time.

Phase II—Stand-Level Research

The phase II study was designed to test different reproduction cutting methods using a replicated experimental approach, which provides a higher standard of statistical rigor than was found in the unreplicated phase I demonstrations. The two main objectives of the phase II study are (1) to evaluate biological and economic feasibility of even-aged and uneven-aged high-forest reproduction cutting methods that rely on natural regeneration to establish and maintain shortleaf pine and pine-hardwood stands in the Interior Highlands, and (2) to quantify the effects of these alternatives on a spectrum of forest resources and values.

The phase II study design called for a test of 13 reproduction cutting methods (table 1) in 4 ecoregional blocks for a total of 52 stands (Baker 1994, Guldin and others 1994). The 52 stands were randomly selected, and treatments were randomly assigned such that each stand would have 1 reproduction cutting treatment imposed upon it with 4 stands of each given treatment in the study. The random assignment of treatments led to an interesting effect. Because each stand in the study was eligible for any of the reproduction cutting methods that were being tested, and because the management plans for the national forests restricted the use of clearcutting in stands near roads, the phase II stands are all some distance from major roads in the region.

The phase II study went through the standard operating procedure for compliance with provisions for public involvement. Mersmann and others (1994) describe in detail the preparation of the environmental assessment for the phase II study. As a result, the entire phase II study was considered a single decision, and it was not appealed.

Research crews inventoried stands and prepared marking guidelines for the treatments being imposed in each stand. Those marking guidelines were given to the RD marking crews that marked the stands in an operational manner as part of the district workload. The research harvest generated

Table 1—Reproduction cutting methods and residual basal area for the pine and hardwood component within each in the phase II stand-level studies

		Residual basal area	
Reproduction cutting method	S/W/X	Pine	Hardwood
		square feet per acre	
Clearcutting	W	0	2 – 5
Seed tree method, pine	S	20	2 – 5
Seed tree method, pine-hardwood	S	10	10
Shelterwood method, pine	S	40	2 – 5
Shelterwood method, pine-hardwood	S	30	10
Shelterwood method, pine-hardwood	W	30	10
Group selection method, pine	X	60	2 – 5[2]
Group selection method, pine-hardwood	W	50	10[2]
Single-tree selection method, pine	S	60	2 – 5
Single-tree selection method, pine-hardwood	S	50	10
Single-tree selection method, pine-hardwood	W	50	10
Single-tree selection method, low-impact	X	60	15
Unmanaged control	X	~100	~30

S = included in split-plot site preparation and release study; W = included in wildlife group habitat study; X = not included in either the split-plot or wildlife studies.

10 million board feet of sawtimber—roughly 8 percent of the annual timber harvest on the Ouachita NF in 1993.

As an element of operational work, RD personnel prepared sale area improvement plans for harvested areas on their respective districts, and collected Knutsen-Vandenberg (KV) funds for planting, site preparation, release, and monitoring. Through this process, the Ouachita and Ozark-St. Francis NFs allocated roughly $1 million in KV funds to the Southern Research Station from FY94 through FY98 to monitor the effects of KV-funded activities in the 48 harvested stands. Monitoring was structured within a statistically rigorous study design and it involved repeated visits to stands.

Seven groups contributed to the research and monitoring activities in phase II stands:

1. The woody vegetation group studied seed production, seedbed condition, woody plant regeneration development, shortleaf pine genetic diversity, overstory development, and the effects of site preparation and release
2. The understory vegetation group measured density, frequency, and cover of herbaceous and shrub species on plots nested within the woody vegetation plots
3. The wildlife research group studied small mammals, flying squirrels, neotropical migratory and resident birds, and general wildlife habitat conditions
4. The management economics group quantified harvesting costs and management costs associated with various reproduction cutting methods
5. The visual quality group measured visual impacts of recently harvested stands, conducted customer surveys of scenic preferences, and evaluated the effects of hardwood retention, season, and physiography on perceived scenic beauty
6. The arthropod and microbial communities group studied insect diversity (with emphasis on arthropods), cone and seed insects, southern pine beetle hazard ratings, and crown health of hardwoods
7. The water, soil, and cultural resources group studied the water chemistry of ephemeral streams, herbicide movement in streamwater, stream channel morphology and woody debris, soil disturbance associated with logging, and harvesting effects on cultural resources.

Some of the results of these many studies are contained in this proceedings. Other papers can be found in the refereed literature.

Phase III—Landscape-Scale Research

Early in phase II design, it became apparent that some questions could not be answered at the stand level. These questions include effects of management on hydrology and aquatic ecology, and the ecological ramifications of maintaining or imposing different vegetation patterns across a watershed or landscape.

The phase III study was developed to support operational implementation of ecosystem management at the landscape scale, defined for these purposes as watersheds. Emphasis was placed on research on watershed hydrology and aquatic ecology, linkages between terrestrial and aquatic systems, landscape analysis of forest patterns and processes, landscape-level terrestrial wildlife concerns, and the social context of ecosystem management.

In the planning for phase III, scientists took advantage of smaller stand-level studies when that was possible. Two examples are studies of the use of prescribed fire and studies of the effects of retaining trees within group openings in stands being managed using the group selection method.

Four watersheds make up the overall study design of phase III research. Each watershed has a unique desired forest condition; taken together, the watersheds reflect a range of models for ecosystem management. Since replication at the scale associated with this phase is difficult, a different approach to experimental design was required. That approach builds on a combination of approaches, including the use of repeated measurements across years, subdivision of existing watersheds or establishment of new watersheds for validation of modes, and traditional small-scale replicated research within the larger watersheds (Guldin, in press).

Of the four watersheds that are included in the landscape-scale study, three are in the Upper Lake Winona Basin of the Winona RD on the Ouachita NF; the fourth is on nearby forest industry land (table 2). Management intensity varies widely. The Alum Creek watershed represents essentially an unmanaged condition. The Little Glazypeau watershed supports intensive management of pine plantations for industrial timber production. The other two watersheds—Bread Creek and North Alum Creek—differ by percentage of industry ownership and, thus, by intensity of management overall. Overall, the intensity of management established for the watersheds during the baseline pretreatment measurement period reflects that distribution of ownership.

Table 2—Watersheds included in the phase III study with subjective classifications of ownership and management intensity

Watershed	Area	Ownership		Management intensity
		N.F.	Industry	
	acres	- - - *percent* - - -		
Alum Creek	3,700	100	0	Unmanaged
Bread Creek	3,800	100	0	Low
North Alum Creek	9,800	50	50	Moderate
Little Glazypeau Creek	5,600	5	95	High

N.F. = national forests.

Specific objectives in the phase III study are

1. to quantify core watershed hydrology through a series of flumes and uncontrolled cross-section gauging stations, which will be used to model hydrological factors and cumulative hydrology effects up to basin scale
2. to characterize and quantify sensitive and critical elements of aquatic and riparian ecology in concert with the studies of watershed hydrology
3. to quantify terrestrial ecological relationships of vegetation pattern, ecological classification, wildlife, and biodiversity across the core watersheds
4. to characterize the social dimensions of the landscape in which the core watersheds lie, including study of the prehistoric, historic, and current relationships of people with the land.

Baseline measurements in the phase III study were initiated in 1994, and carried forth through 1998. Papers included in this proceedings present baseline measurements of various types for that pretreatment period.

Treatments to carry the watersheds from their existing condition to their desired future condition are underway. The desired future condition in the phase III watersheds represents a synthesis of results to date from the stand-level research study with the interests of land managers with both the national forest and forest industry. The watershed under intensive management will remain so. It will quantify the effects of continued plantation management over time at the large scale. Half of the watershed in an unmanaged condition will continue in the unmanaged condition, and the remainder will be subject to single-tree selection silviculture, generally thought to be the least intensive of the reproduction cutting methods in the arsenal of the silviculturist. The Bread Creek watershed, wholly under Forest Service ownership and managed using typical national forest treatments in the past, will continue to support standard agency actions. The North Alum Creek watershed will be split three ways to support two variations of group selection treatments and a shortleaf pine-bluestem habitat restoration treatment (Guldin, in press).

As in phase II, these phase III treatments are being imposed in an operational manner by the regular management staff of the cooperating forest management organization. On industry land, typical schedules of harvest and associated cultural activities associated with intensive management of pine plantations for commercial timber production will continue as they would normally occur. On the national forest watersheds, actions have been planned and are being executed by the staff and field crews of the Jessieville and Winona RDs. An administrative study plan was written and approved that contains provisions for monitoring supported by KV funds. Those monitoring data and other data collected on public and private land will be indispensable in helping scientists and forest land managers understand the effects of concentrating management activities in a forested watershed.

SUMMARY

This symposium is linked to larger regional science issues through the Southern Research Station's strategic science framework. A crosscutting theme in the Station's strategic plan highlights the sustainability and productivity of the Interior Highlands ecosystem. The Ouachita Mountains Ecosystem Management Research Program is a key element of that theme, and work reported in this proceedings supports it directly.

The three-phase approach of demonstration, stand-level research, and landscape-scale research demonstrates how team-oriented science efforts bring "critical mass" to complex experiments at heterogeneous scales. However, the research project would not be possible without many Station partners in public and private sectors who have contributed time, talent, in-kind services, and both direct and indirect financial support.

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